# PROJECT SENERIZ : DEVELOPMENT OF THE ANAMBE BASIN

## SUMMARY AND CONCLUSIONS

Cereal grains form an important part of the diet of most Senegalese, and the consumption of cereals, particularly of rice, maize, and wheat, is increasing over time. However, domestic production of cereals has increased less than consumption, necessitating importation of, on the average, 31% of the cereals consumed. Rice has figured conspicuously in this importation, its value making up as much as 50% of the deficit in the national balance of payments. Projections of future demand for rice indicate that consumption of rice will at least double between 1974 and 1981, because it is the preferred cereal and people will have more money to spend for it.

Project SENERIZ was conceived to increase domestic production of cereals, especially rice, and if possible to make Senegal self-sufficient in rice. This study was commissioned to develop and evaluate a plan for the first portion of that project.

The site for the first realization of Project SENERIZ was to be selected within the Departments of Vélingara and Kolda in the Upper Casamance. The land in these departments shows little variation, and little basis for choice of a site, in topography, climate, vegetation, or population. The Anambé basin was chosen as the project site on the basis of its soils and its hydrology. The soils are better adapted than those of most other areas, and a site was found on the Kayanga River where construction of a dam would provide a measure of flood protection for the Anambé basin and simultaneously provide water for its irrigation. In addition, the local populace are

aware of their region's potential as a development site, and they desire strongly that a project be located there.

The basin is roughly circular in shape, with its center at the confluence of the Waïma and Anambé Rivers. The coordinates of the center of the basin are 13°01' North latitude and 14°08' West longitude. The basin lies about three-quarters in Vélingara and one-quarter in Kolda Department.

In geologic ages, the basin was a lake, and lake-bottom deposits of silt and clay produced heavy-textured, dark-colored soils in the center of the basin. Agricultural use of these soils will require some protection against the flooding which takes place each rainy season, as the engorgement of the Kayanga River prevents drainage from the Anambé. Topography is relatively flat and thus well adapted to large-scale cultivation.

Study of the soils of the basin reveal that three-quarters of the basin - some 30,000 hectares - would not be adapted to irrigated rice culture because of the light texture and excessive permeability of the soils. Of the remaining area, perhaps 7,300 hectares (the flooded portion) would be well suited to rice, given control of the floods, while the balance appears to be moderately well adapted. Low soil fertility and susceptibility to erosion are constraints on all of the basin soils, particularly the lighter-textured upland soils.

Near the center of the basin is the Anambé Classified Forest, a wooded area of 6,200 hectares that includes some of the best soils in the basin. SODAGRI recommends that the project area exclude the classified lands, and that their status as a protected resource not be modified at this time.

Current land use in the basin is for crops of sorghum, millet, maize, rice, peanuts, and cotton, for which perhaps one-fifth of the basin is in use at one time under a pattern of shifting cultivation.

Except for peanuts and cotton, which are raised as cash crops, agriculture is almost totally oriented to self-sufficiency.

Excluding the Anambé Classified Forest, 25,000 hectares are available to be cleared and developed for mechanized cultivation. Cultivation by peasants may be stabilized and expanded by about 40%, from the current 21,000 hectares (estimated) to about 30,000 hectares.

The Anambé basin is located within the limits of the Sudano-guinean semi-humid tropical belt and south of the Sahelian desertic climate zone. The principal meteorological characteristics of the region are :

- a rainy season of four months (June through September) of erratic but relatively dependable average precipitation, preceded and followed by months (May and October) of light transitional rainfall;

- a six-month dry season;

- a temperature regime featuring maximum highs in May before the onset of the heavy rains, declining values during the rains, a secondary high in November, and a relatively cooler season during December through January;

- a decline in rainfall from south to north.

Study of available climatological data reveals the importance of drought. In recent years, precipitation has been consistently less than the long-term average : total rainfall is less, and more and longer rain-free periods are encountered. While these data confirm the need for irrigation, they also raise the question of adequacy of rainfall to yield enough runoff to fill a reservoir, should the recent drought continue. The Kayanga River, with a large watershed located in a zone of heavier rainfall, is less likely than the Anambé to experience disastrous droughts.

Temperature is near-ideal for growing during the rainy season In the winter, night-time low temperatures approaching 10°C in Decemeber and January will limit selection of rice varieties, or lengthen the growing season.

The Anambé basin is relatively remote from the main population centersof Senegal, and no paved roads serve the area. Both difficulty of access and lack of local infrastructure will affect project development costs.

The main centers of population in the basin are Vélingara and Kounkandé. The population of the basin is estimated at 25.000 or about 23 persons per square kilometer, one-third more dense than the average for the upper Casamance.

The majority of the people in the project area (82%) are ethnically Fulani (Feuhl). They are organized into family compounds, each of which may contain up to about a dozen househoulds. Each household operates independently in raising crops, on land allocated to it by the village chief. When land is abandoned in the cycle of shifting cultivation, usage rightsrevert to the village. The local people strongly favor implementation of a development project in their region. Their chief concern is that pasturage for their cattle be available to replace the common lands in the basin that will be brought under cultivation.

Alternatives that were considered for hydro-agricultural development of the basin included (1) an earlier proposal for a reservoir in the center of the basin and a series of impoundments in small shallow valleys around the periphery of the basin; (2) construction of a reservoir between two dams in the valley that connects the basin with the Kayanga River; (3) a dam on the Kayanga River downstream of its confluence with the Anambé River; (4) irrigation from drilled wells, without construction of a reservoir; and (5) a development program based on rainfed agriculture and aid to local farmers, without provision of irrigation facilities. All of these

alternative project structures were rejected because they represented partial and ineffective development of the available resources (1 and 5); they would be too expensive to build and operate in relation to their potential production (1, 2, and 4); and/or they contained technical difficulties that seemed impractical to surmount (2 and 3).

The selected engineering solution calls for construction of an earth-fill dam on the Kayanga River near Niandouba. The dam will have a crest length of 2.2 kilometers and would create a reservoir having a maximum normal water storage capacity of 388 million $m^3$, with 240 million $m^3$ available for irrigation. Delivery of water from the reservoir will be by pump and gravity-flow to the Anambé basin. A drainage system in the basin, plus the reduced engorgement of the egress route for Anambé waters, will reduce flooding and permit development of most of the heavy rice-suited soils in the floor of the basin.

Agricultural development and use of the basin's best soils will be progressively implemented. Only lands not used by local farmers will be taken for use by the agro-industrial complex; these lands are the heavier-textured soils that are too difficult to plow with animal power. Mechanized tillage using large rubber-tired tractors and wide tillage implements will cope with the multiple problems of difficult tillage, yield response to reasonably deep plowing, and need for timeliness in soil preparation and planting. Sufficient irrigation water is expected to be available for 15 to 17,000 hectares of crops. Irrigation will concentrate on the best lands, some of which can be developed and used only after the flood control program is effective. Crops produced at the outset will be primarily rainfed rice, sorghum and maize. As irrigation water becomes available, emphasis will be on irrigated rice, with lesser areas of rainfed sorghum and maize. In the seventh year of the project and thereafter, rice yields averaging 3.5 tons per hectare for each of two crops on 17,000 hectares will permit production of 119,000 tons of paddy rice or 115,000 tons beyond seed requirements. In addition,

over 25,000 tons of sorghum and maize will be produced (beyond seed requirements) for a total cereals net production of 142,000 tons. Millet has been tentatively eliminated from the cropping program because it is a lower-yielding and less profitable crop than other rainfed crops. Cotton and peanuts will not be raised, as their inclusion would dilute the project's impact on cereals.

The yields of crops produced by the complex are expected to begin at a modest level and to increase as problems of adapted varieties, locally suited technology, skill of personnel, etc. are solved. A reasearch program will be carried on to solve these problems and to explore alternative crops such as soybeans, sugar cane, vegetables for canning, fruits, etc.

The agro-industrial complex will be administered and operated from a project headquarters which will include offices, lodging for administrative personnel, maintenance and repair facilities, a transport unit, water supply and electrical power facilities, and the necessary installations for handling all the crops produced.

A cereals center will be provided, with storage capacity for 50,000 tons of grain. This facility will be able to receive, clean, dry, and store the cereals crops produced by the complex and also by the neighboring farmers. A seed plant with five tons per hour capacity will clean, dry, store, test, treat, and prepare for distribution quality seed of improved varieties. A rice milling plant of ten tons per hour capacity will produce a superior quality of milled rice from the paddy rice grown by the project. A feed mill having a capacity of five tons per hour will use industrial by-products and other ingredients to produce a feed supplement for cattle. This feed supplement, plus by-products of cereals stalks and straw from the fields of the complex, will permit up to 10,000 young cattle from the sylvo-pastoral region of the Sahel to be "grown out". Similar feed supplement plus rice bran and hulls and by-product forages will serve to fatten up to 5,. Ofeeder cattle each year.

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A program of teaching and assistance (T and A) for local farmers will broaden the impact of the improved technology introduced by the complex and refined by the research center. Trained information agents will teach farmers new ways and demonstrate new varieties and new techniques. The inputs of seed, fertilizer, etc., necessary to a farmer to permit him to implement the new methods will be available on credit through this T and A program, which is expected to reach 1,500 farm families in the seventh year of the project and to increase their production of cereals by about 30,000 tons.

Senegalese employees will be trained as technicians in a comprehensive program of on-the-job training. Training abroad will be offered to selected employees, to prepare them for certain technical and administrative posts. Senegalization of top level posts will be carried out as rapidly as personnel are qualified. It is intended that all expatriates will be replaced by Senegalese nationals in the seventh year of the project.

The implementation of this development program will begin with research and data collection to fill voids in knowledge about the resources of the Anambé basin. At the outset, meteorology stations in the basin will be established or upgraded to provide data on temperature, humidity, wind, evaporation, etc. Stream-flow gauges will be installed on the Anambé and Kayanga Rivers. Exploratory drilling of deep wells will reveal the feasibility of using ground water for irrigation. A study of tenure and land use will improve data on land ownership. Soil surveys will show, with much greater precision than has been available to date, the area and location of the various soil types, to permit improved planning for irrigation and crop production. Agronomic research, to fine-tune the techniques to be introduced, will begin.

Topographic mapping will be started, as will geologic data gathering. The information so gathered will permit detailed design of a dam and reservoir, an irrigation network and drainage system, and

a network of roads that will permit access to all parts of the basin, to the damsite and to sources of construction materials (sand, gravel, rip-rap, etc.), needed for the dam and other civil works.

If the program of data gathering is begun promptly, the design work can be done in the second year, and construction done in the third and fourth year. This will provide flood protection for the lowlands of the basin, and irrigation water for the same lands, in the fifth and subsequent years.

A number of the characteristics of the project and the costs of the components of the development plan are summarized in Summary Table A. Annually, the investment increases from 2832 million CFA in the first year to 10 546 million in the fourth year, and totals 34524 million CFA in six years. Replacement of equipment calls for 1 011 million CFA average annual investment after the seventh year. Of the total investment, 17 472 million CFA, or 50%, represents foreign costs, the balance being local costs payable in Senegalese currency.

Revenues of the project arise from sale of cereals, from fees charged to ONCAD for handling of cereals and milling of rice, from sale of cattle, and from sale of seed and cattle feed to local farmers. These revenues begin (at 138 million CFA) in the second year of the project, and increase to 9 995 million CFA in the seventh and subsequent years.

Operating expenses have been calculated based on estimated inputs, labor requirements, etc. Variable costs of crop production increase to 1 262 million CFA in the seventh year, while cattle production costs reach 571 million CFA annually. Costs of the agro-industrial complex amount to 2 303 million CFA per year, while fixed cost or overhead for the project stabilizes in Year 8 at 1 435 million francs. Total operating costs are 5 511 million CFA per year beginning in Year 8.

Project cashflow is negative for the first several years,

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being negative by as much as 10 777 million CFA in Year 4, then becoming positive in Year 7 and stabilizing at + 3 473 million CFA per year in Year 8. Cumulative cashflow reaches a negative maximum of 32 350 million CFA in Year 6, becomes positive in Year 16, and generates a cumulative cashflow of 52 090 million CFA (208 million dollars) over the thirty years.

The internal rate of return (RCR) for the project as it has been described in 7.53%. This means that if all money expended required an investment payment of 7.53% annually, the project cashflow would "come out even" - at exactly zero - after 30 years.

The foregoing situation represents the "base case" for the project. The effect of a number of possible changes has been calculated. For example, if yields were 10% higher than previously calculated, the RCR would be increased to 9.25%, and if yields were 10% lower, the RCR would drop to 5.66%. This sensitivity analysis showed that the greatest impact on RCR would come from elimination of grain handling, storage and rice blending fees, which in concert would give a negative rate of return (ROR = -.73). Reduction by 50% of land development costs would permit the most profit (ROR = 9.74%), while 10% higher variable costs would cut ROR to 6.04 percent. Most of the eventualities considered, including delayed and accelerated implementation, expansion of area and elimination of the T and A program, modified the RCR by not more than ± 2 percent.

Financing for the project is bein sought. Various lenders have expressed interest and made oral promises, but firm commitments must await the availability of this report on the pre-investment study.

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SUMMARY TABLE A : Project SENERIZ : Physical and Economic Characteristics, by years (in tons, units, and millions of francs CFA).

| | YEAR OF PROJECT | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Project targets : | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Cropland developed, ha. | 1 000 | 2 000 | 4 000 | 5 000 | 7 000 | 6 000 | - | - |
| Cropland in use, ha. | 0 | 1 000 | 3 000 | 7 000 | 12 000 | 19 000 | 25 000 | 25 000 |
| Complex rice net production, tons | 0 | 1 342 | 5 988 | 13 806 | 22 660 | 105 463 | 115 260 | 115 260 |
| " other cereals net production, tons | 0 | 751 | 1 599 | 6 144 | 13 504 | 14 622 | 26 762 | 26 762 |
| " calves and cattle sold | 0 | 50 | 600 | 1 600 | 3 000 | 10 000 | 15 000 | 15 000 |
| Participating farmers, number | 0 | 100 | 200 | 400 | 600 | 1 000 | 1 500 | 1 500 |
| " cereals production (increase) tons | 0 | 242 | 443 | 2 894 | 7 134 | 15 154 | 30 395 | 30 395 |
| " calves and cattle (increase) | 0 | 113 | 150 | 697 | 1 640 | 3 419 | 6 743 | 6 743 |
| Project employees, number | 0 | 250 | 350 | 570 | 700 | 1 000 | 1 200 | 1 200 |
| Investment ($10^6$ CFA) : | | | | | | | | |
| Data collection and research | 154 | 50 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation and water supply | 153 | 500 | 3 450 | 3 450 | 0 | 0 | 0 | 0 |
| Plantation development | 600 | 1 225 | 2 400 | 3 000 | 4 200 | 3 600 | 0 | 0 |
| Equipment | 358 | 589 | 553 | 665 | 959 | 774 | 0 | 768 |
| Industrial facilities | 1 530 | 505 | 1 560 | 3 150 | 410 | 0 | 0 | 243 |
| Training programs | 27 | 36 | 19 | 20 | 0 | 0 | 0 | 0 |
| Working capital | 0 | 173 | 224 | 116 | 63 | 0 | 0 | 0 |
| Totals | 2 833 | 3 078 | 8 061 | 10 546 | 5 632 | 4 374 | 0 | 1 011 |
| Operating costs ($10^6$ CFA) : | | | | | | | | |
| Variable costs , crop production | 0 | 27 | 86 | 200 | 349 | 1 101 | 1 262 | 1 262 |
| Variable costs, cattle production | 0 | 9 | 35 | 80 | 197 | 511 | 511 | 511 |
| Var. costs, agro-industrial complex | 0 | 198 | 422 | 669 | 1 037 | 2 207 | 2 303 | 2 303 |
| Fixed cost/Overhead | 0 | 250 | 453 | 693 | 1 057 | 1 435 | 1 536 | 1 435 |
| Total operating costs | 0 | 484 | 996 | 1 642 | 2 650 | 5 254 | 5 512 | 5 511 |
| Gross cashflow ($10^6$CFA) | 0 | -346 | -447 | -231 | -125 | 3 323 | 4 383 | 4 484 |
| Project cashflow | -2 833 | -3 424 | -8 508 | -10 777 | -5 757 | -1 051 | 4 383 | 3 473 |
| Cumulative Project cashflow | -2 833 | -6 257 | -14 765 | -25 542 | -31 299 | -32 350 | -27 967 | -24 494 |

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The following personnel of SODAGRI have participated in the study in the capacities listed :

Dr. Robert M. Reeser : agricultural economist and general coordinator if the study.

Mr. Mama Dabo, engineer and advisor on policy.

Mrs. Annie Abouchar, translator and manager of report preparation.

Miss Paula D'Alton, research assistant and translator.

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# CHAPTER 1.

## CEREALS IN SENEGAL :

## THEIR PRODUCTION AND USE.

1.0. INTRODUCTION.

1.1. CEREALS IN HISTORICAL PERSPECTIVE.

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# CHAPTER 1.

## CEREALS IN SENEGAL :

## THEIR PRODUCTION AND USE.

### 1.0. INTRODUCTION.

The rural economy of Senegal is based on cereals. Despite the vaunted and acknowledged importance of peanuts in providing employment and in earning foreign exchange, it is the cereals that provide the real foundation of rural life and population support Cereals occupy the majority of the Senegalese farmers' crop land. and they provide the majority of foodstuffs eaten by the Senegalese people.

As an illustration of this importance of cereals, Table 1.0.A. shows the area and production of the leading crops in the department of Velingara. Of the six most important crops, four are cereals, and they account for 55 % of both area and production.

Furthermore, the basic system of organization in rural areas is subsistence agriculture : production by the family to meet its own needs, and limitation of consumption to that which is produced by the family. Thus the importance of the cereal crops is even greater than indicated by their proportion of area, production or value, because these crops represent food and therefore life to their producers, the rural habitants who make up 70 % of Senegalese population.

Nonetheless, given the growing urbanization and increasing modernization of the country, the importation and sale of cereals on a massive scale must be taken into account.

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TABLE 1.0.A. Relative Importance of the Leading Agricultural crops, Department of Velingara.

| | Hectares | % | Tons | % |
|---|---|---|---|---|
| Sorghum | 13300 | 24,6 | 16 93 | 27,2 |
| Peanuts | 12800 | 23,7 | 12672 | 21,4 |
| Cotton | 11500 | 21,2 | 13800 | 23,4 |
| Millet | 9400 | 17,4 | 8460 | 14,3 |
| Maize | 4138 | 7,64 | 4904 | 8,3 |
| Rice | 2970 | 5,5 | 3178 | 5,4 |
| Total | 54108 | 100 | 69107 | 100 |

Statistics on the imports of cereals in Senegal bear wirness to the importance of imported cereals. Imports of cereals have increased from 176000 tons in 1961 to 292000 tons in 1974 - an increase of 66%. During the same period total consumption of cereals increased by 45%, while the indicated domestic production increased by only 38% (Table 1.0.B.) To make matters worse, the value of the imports has increased out of proportion to the quantity, averaging in 1971-74 about 270 percent of the 1961-65 average.

In the context of Senegal 's need to import manufactured goods as well as foodstuffs, and with limited exports, the importation of cereal products contributes importantly to the foreign exchange problem. Rice, which has made up nearly 60 percent of the tonnage of cereal imports, has in certain years represented up to 50 percent of the deficit for the entire balance of payments.

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TABLE 1.0.B. Total Imports and Total Cereal Consumption, 1961 - 1974

| Calendar Year | Net Cereal Imports (1) Tons | % of Base year | Total Cereal Consumption Tons | % of Base year | % Imports of Total Consumption |
|---|---|---|---|---|---|
| 1961 | 175 913 | 100 | 647 164 | 100 | 27,2 |
| 1962 | 177 143 | 101 | 670 585 | 104 | 26,4 |
| 1963 | 190 221 | 108 | 710 977 | 110 | 26,8 |
| 1964 | 254 757 | 145 | 847 522 | 131 | 30,1 |
| 1965 | 252 607 | 144 | 903 628 | 140 | 28,0 |
| 1966 | 228 234 | 130 | 873 122 | 135 | 26,1 |
| 1967 | 224 372 | 128 | 844 644 | 131 | 26,6 |
| 1968 | 242 044 | 138 | 995 740 | 154 | 24,3 |
| 1969 | 324 379 | 184 | 907 412 | 140 | 35,8 |
| 1970 | 255 884 | 145 | 971 295 | 150 | 26,3 |
| 1971 | 363 996 | 207 | 912 633 | 141 | 39,6 |
| 1972 | 290 175 | 165 | 902 354 | 139 | 32,2 |
| 1973 | 450 458 | 256 | 876 002 | 135 | 51,4 |
| 1974 | 291 928 | 166 | 941 180 | 145 | 31,0 |
| Average 61/74 | 265 808 | 151 | 857 447 | 132 | 31 |

(1) Calculated according to statistics of the Statistical Economic Bulletin of Senegal. In the net import column, wheat has been converted into its wheat flour equivalent by a coefficient of 1.43, and paddy rice into its treated rice equivalent by a coefficient of 1.43

(2) Imports (internal production consumed : 3/4 production of the agricultural season t - S/t + 1/4 production of the season t/t + I)

Source : Actions Planiferes de Production Cerealiere.
Ministry of Rural Development and Hydraulics.
December, 1976.

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It must be emphasized that the primary role of cereals is the nourishment of the human population and that cereals represent "a least cost" solution to nutritional needs. Thus, no austerity program can be applied to reduce cereals requirements. On the contrary, the key to solution of the problem lies in increasing the domestic production of cereals crops.

Such an increase in cereal production is the objective of project SENERIZ. The report of which this chapter is a part discussed in some detail the resources available for that project, the constraint on use of these resources, and their organization into a development project to achieve the objectives.

In this chapter, the cereal situation is presented in relation to historical context and to the needs of the Senegalese people, both rural and urban. This is followed by a forecast of the future needs of Senegal in cereals and the rationale for a new project for the increase of the production of cereals in Senegal.

## 1.1. CEREALS IN HISTORICAL PERSPECTIVE.

To gain a perspective of the cereal production situation in Senegal, one must look at area, yield and production of the various crops singly and in combination. Table 1.1.A. presents basic data for anlysis of the situation, and Figures 1.1.A. et 1.1.B. present graphically information on area and production. Several observations can be made, based on these data.

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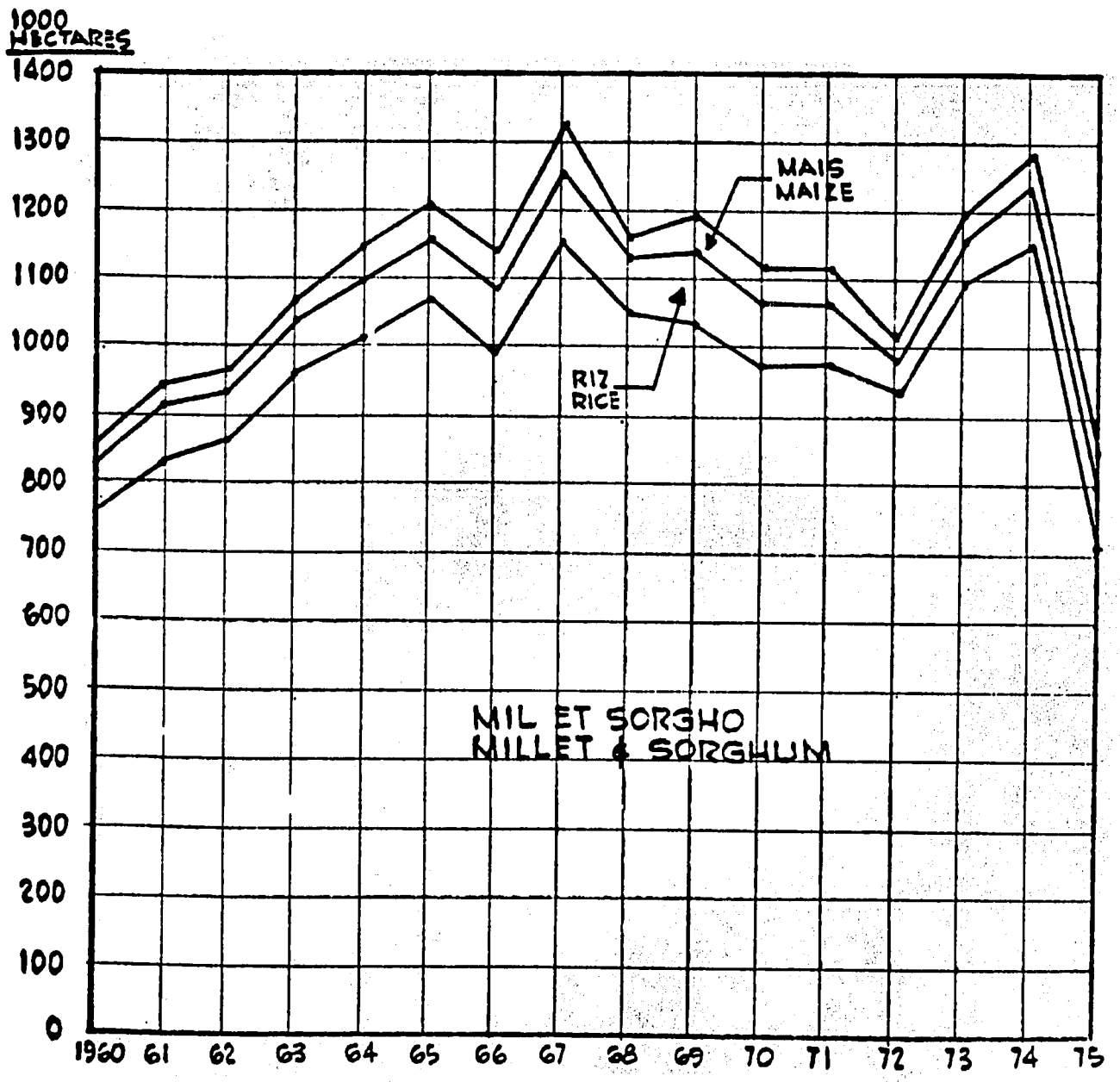
Graphique 1.1 A
Figure 1.1 A

Superficies des Céréales Principales au Sénégal, 1960-1975

Area of Principal Cereals in Senegal, 1960-1975

(graphique des bandes cumulatives)
(cumulative band chart)




N.B. La largeur de chaque bande réprésente la superficie de cette céréale-là.

N.B. The width of each band is proportional to the area of that cereal.

Source: Tableau 1 de l'Annexe 1/1.
Table 1 of Annex, Chapter 1.

Graphique 1.1 B

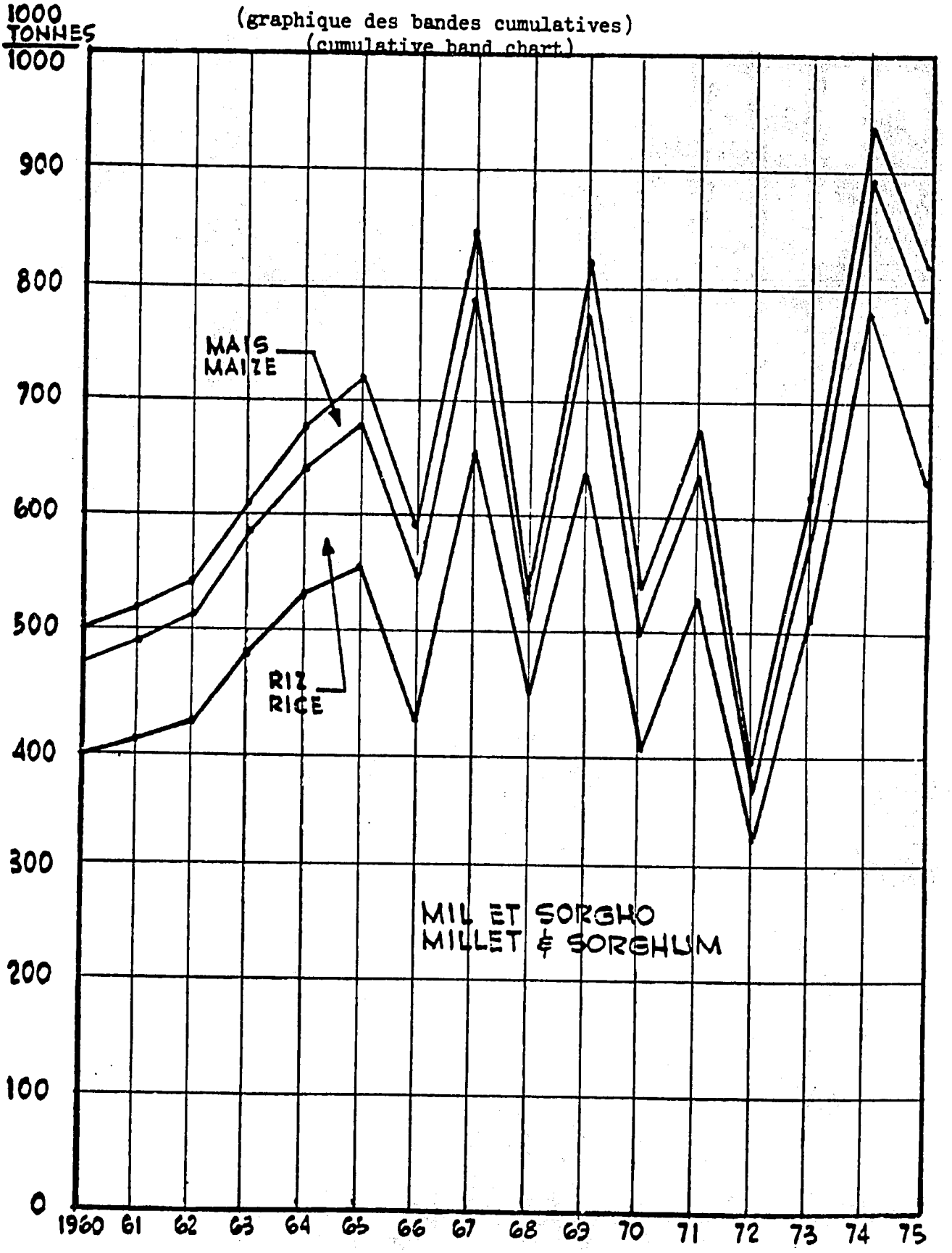
Figure 1.1 B

Production des Céréales Principales au Sénégal, 1960-1975

Production of Principal Cereals in Senegal, 1960-1975

(graphique des bandes cumulatives)

(cumulative band chart)




.B. La largeur de chaque bande réprésente la production de cette céréale-là.

.B. The width of each band is proportional to the production of that cereal.

Source: Tableau 2 de l'Annexe 1/1

Total area and production of cereals on both trending toward increase. The effect of the trend is most conspicious in the case of millet and sorghum production. However each of the series shows extreme variation from one year to another. Variation is particularly evident for production because of the wide fluctuations of yields depending on rainfall and other weather factors. Yields in any one year may vary from the long term average by as much as - 37% for rice and - 67% for millet and sorghum (Table 1.1.B.) and of course yields of individual farmers vary far more than that.

Sorghum and millet, despite their variability of yield, make up the great majority of Senegalese cereal area and production about 89% of area, and 79% of production, over the 16 year old period 1960-1975.

Senegalese cereal production is heavily dependent on weather. The depressed and widely fluctuating production in the late 1960's and early 1970's was undoubtedly at base a function of weather, particularly rainfall. Since rainfall is not subject to significant control, the desirability of irrigation projects to moderate the fluctuation in production is evident.

## 1.2. THE ROLE OF CEREALS : RICE, MILLET, AND SORGHUM, MAIZE AND WHEAT.

At the present time, the use of cereals as feed for livestock or in industry is significant ; cereals in Senegal serve almost exclusively for the satisfaction of human nutritional needs.

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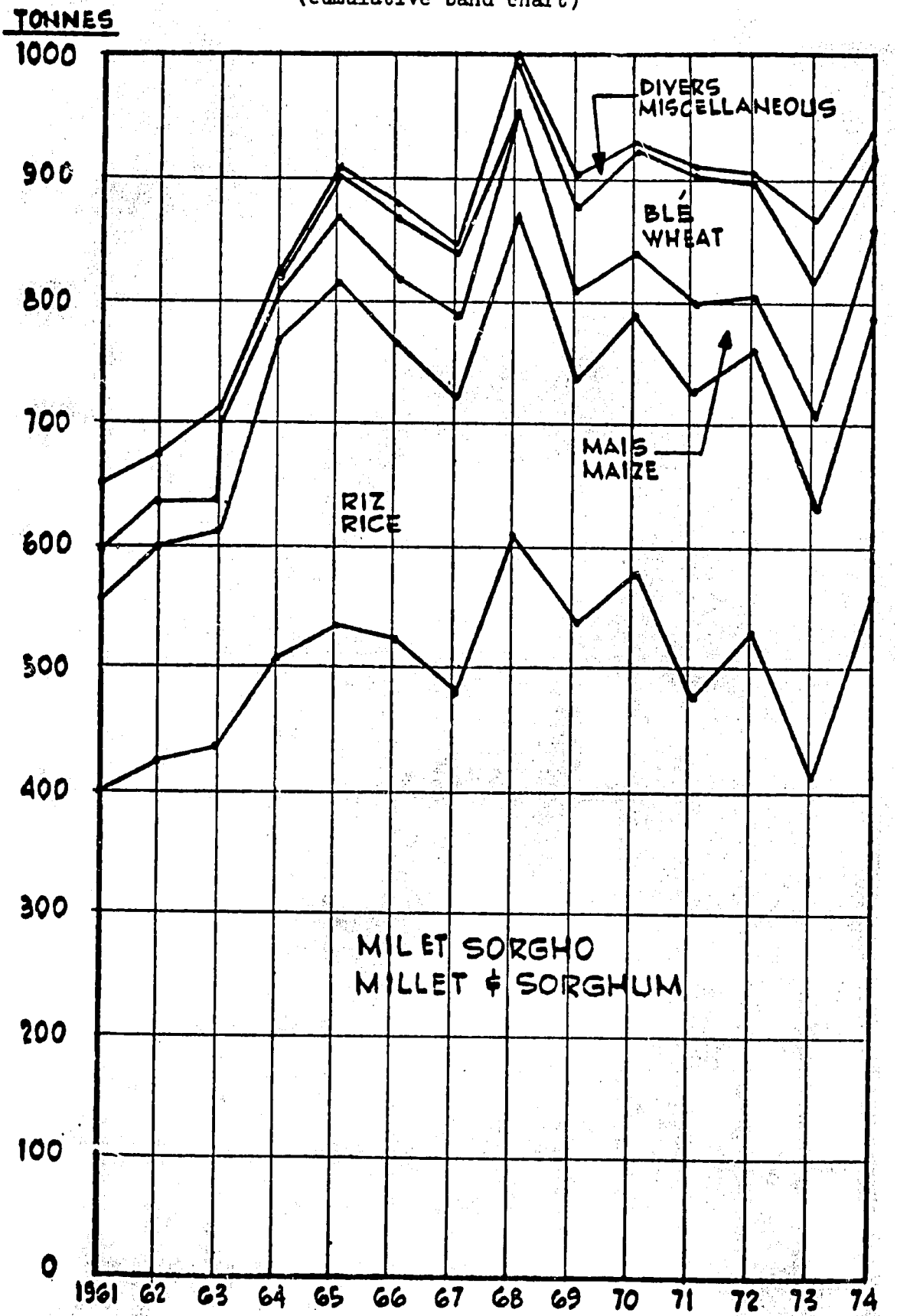
Figure 1.2
Consommation des Céréales et des Produits Céréaliers au Sénégal, 1961-1974
Consumption of Cereals and Cereal Products in Senegal, 1961-1974
(graphique des bandes cumulatives)
(cumulative band chart)




La largeur de chaque bande réprésente la consommation de ce produit-là.

The width of each band is proportional to the consumption of that product.

Source: Tableau 3 de l'Annexe 1/1.
Table 3 of Annex, Chapter 1.

**TABLE 1.1.A. Cultivated Area, Yields and Production of the Principal Cereals.**

1. Millet - Sorghum.

| Calendar Year | Production (1000 T) | Cultivated Area (1000 ha) | Yield (Kg/ha) |
|---|---|---|---|
| 1960 | 392,4 | 762,2 | 514 |
| 1961 | 406,5 | 830,8 | 489 |
| 1962 | 424,1 | 864,7 | 490 |
| 1963 | 478,4 | 959,4 | 498 |
| 1964 | 531,8 | 1 010,9 | 526 |
| 1965 | 554,1 | 1 069,4 | 518 |
| 1966 | 423,2 | 996,7 | 424 |
| 1967 | 654,2 | 1 155,4 | 566 |
| 1968 | 450,0 | 1 053,7 | 427 |
| 1969 | 634,8 | 1 037,3 | 612 |
| 1970 | 400,9 | 972,2 | 412 |
| 1971 | 582,7 | 974,6 | 597 |
| 1972 | 322,9 | 936,3 | 344 |
| 1973 | 510,8 | 1 093,5 | 467 |
| 1974 | 777,0 | 1 155,1 | 673 |
| 1975 | 630,0 | 715,5 | 880 |

2. Rice

| | | | |
|---|---|---|---|
| 1960 | 81,5 | 67,8 | 1 200 |
| 1961 | 83,8 | 72,9 | 1 151 |
| 1962 | 90,4 | 71,9 | 1 256 |
| 1963 | 105,8 | 74,8 | 1 415 |
| 1964 | 108,8 | 86,9 | 1 252 |
| 1965 | 125,2 | 82,6 | 1 517 |
| 1966 | 125,2 | 87,9 | 1 424 |
| 1967 | 134,5 | 101,4 | 1 327 |
| 1968 | 58,8 | 77,5 | 1 317 |
| 1969 | 140,8 | 104,3 | 1 349 |
| 1970 | 98,7 | 93,3 | 1 058 |
| 1971 | 108,2 | 83,7 | 1 242 |
| 1972 | 43,6 | 50,3 | 866 |
| 1973 | 64,3 | 64,6 | 996 |
| 1974 | 117,0 | 85,6 | 1 366 |
| 19775 | 144,0 | 89,2 | 1 605 |

.../...

Table 1.1.A. Concluded

3. Maize

| Calendar Year | Production (1000 T) | Cultivated Area (1000 ha) | Yield (kg/ha) |
|---|---|---|---|
| 1960 | 27,2 | 30,5 | 889 |
| 1961 | 28,3 | 32,2 | 885 |
| 1962 | 26,6 | 31,5 | 847 |
| 1963 | 26,6 | 32,6 | 815 |
| 1964 | 37,2 | 47,2 | 788 |
| 1965 | 40,8 | 54,3 | 751 |
| 1966 | 41,8 | 53,8 | 777 |
| 1967 | 56,8 | 71,7 | 792 |
| 1968 | 25,3 | 36,3 | 696 |
| 1969 | 48,8 | 55,4 | 881 |
| 1970 | 38,7 | 50,6 | 765 |
| 1971 | 38,5 | 48,9 | 787 |
| 1972 | 20,2 | 32,3 | 625 |
| 1973 | 33,8 | 39,2 | 862 |
| 1974 | 43,2 | 48,6 | 888 |
| 1975 | 45,2 | 46,7 | 968 |

Source : Actions Planiferes de Production Cerealiere. Ministere du Developpement Rural et de l'Hydraulique, Decembre 1976.

Table 1.1.B. Long Term Average of Principal Cereals, and Variations from Average.

| | Millet-Sorghum | Rice | Maize |
|---|---|---|---|
| 16 year average of yields | 527 | 1 364 | 813 |
| Maximum Yield - Year | 880 (1975) | 1 605 (1975) | 968 (1975) |
| Minimum Yield - Year | 424 (1972) | 866 (1972) | 625 (1972) |
| Percent Variation | + 67, - 20 | + 18, - 37 | + 19, - 23 |

Source : calculated from data of Table 1.1.A.

Of all the cereals consumed in Senegal, rice is the basic and preferred foodstuff for urban populations. In certain regions of Senegal, notably in the lower Casamance, rice is also consumed as the basic foods stuff, Consumers in general both urban and rural show a preference for rice.

As shown in Table 1.0.B, total consumption of cereals in Senegal uncreased steadily during the decade of the 1960 to a peak in 1968, with irregular decreases since a better understanding of the pattern of change can be had from figure 1.2. During the period of increase it was rice that increased the most strikingly. In the period since 1968, wheat has increased while other cereals decreased, and in most recent years has exceeded maize in importance. It is particularly significant that both grains showing increases in consumption are imported ; wheat is hardly produced in Senegal, and increases in rice consumption are mostly due to increased imports. These increases in rice and wheat consumption are essentially urban phenomens. Imported rice is purchased, not home-grown, monetarily gainful employment which implies urban dwelling is a precondition for its purchase. As for wheat, it is above all in the urban centers that consumption is increasing. The total consumption of wheat flour per capita is greater, in certain years, than that of maize flour. Imports of wheat flour in the period from 1971 to 1974 doubled in comparison to the period from 1966 to 1970, and equqlly important, the consumption of wheat flour per capita doubled from 1965 to 1974. This leads to the assumption that consumers show a preference for wheat (or more precisely for bread) just as they show a preference for rice.

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The consumption of maize is small in comparison to the other cereals. and its role in the diet of city dwellers is very restricted, Nonetheless, maize has its place in traditional cuisine. Consumption is on the rise, largely as a function of its availability. Significant progress in the production of this crop, above all in the Sine-Saloum, in the Casamance, and in eastern Senegal, has resulted from expanded rise of animal powered plowing and chemical fertilizers, and these factors are subject to further large increases in the future.

Millet and sorghum are the most-consumed of all cereals. They are the traditional basic foodstuff, especially in the rural environment. Their traditional role, however, is threatened by other cereals. Yet there is no danger of millet an sorghum becoming redundant. Cereal production in Senegal has not yet reached the stage where it supports a major milling industry (the exception is two wheat and maize flour mills in Dakar, which mill fairly large amounts of these grains). Industrial processing of cereals and their use can accomodate quantities of cereal far larger than currently available.

## 1.3. CASAMANCE : ITS ROLE IN CEREAL PRODUCTION.

The Casamance is a very important agricultural region of Senegal, having an immense potential because of its resources of soil, water and climate. More than one fourth of the nation's total cereal production comes from the Casamance, and about three-fourths of the nations rice production. (Table 1.3.)

.../...

Table 1.3. Compared Production of Cereal : Casamance/Senegal.

1. Millet and Sorghum.

| Year : | Senegal | Casamance | % C/S |
|---|---|---|---|
| 69 - 70 | 634 833 | 121 415 | 19 % |
| 70 - 71 | 400 876 | 100 316 | 35 % |
| 71 - 72 | 582 713 | 90 509 | 15.5 % |
| 72 - 73 | 322 865 | 74 771 | 23 % |
| 73 - 74 | 510 793 | 84 333 | 16.5 % |
| 74 - 75 | 795 045 | 101 935 | 13 % |
| 75 - 76 | 620 966 | 79 050 | 13 % |
| Average of 7 years | 552 584 | 93 190 | 16,9 % |

2. Rice.

| | | | |
|---|---|---|---|
| 69 - 70 | 137 746 | 103 377 | 75 % |
| 70 - 71 | 90 545 | 68 486 | 76 % |
| 71 - 72 | 108 166 | 73 010 | 67 % |
| 72 - 73 | 36 686 | 26 584 | 72 % |
| 73 - 74 | 64 340 | 49 154 | 76 % |
| 74 - 75 | 116 975 | 86 360 | 74 % |
| 75 - 76 | 115 707 | 97 397 | 84 % |
| Average of 7 years | 95 738 | 72 053 | 75.3 % |

3. Maize.

| | | | |
|---|---|---|---|
| 69 - 70 | 48 840 | 28 162 | 58 % |
| 70 - 71 | 38 746 | 18 549 | 48 % |
| 71 - 72 | 38 503 | 17 145 | 44.5 % |
| 72 - 73 | 20 210 | 29 726 | 48 % |
| 73 - 74 | 45 308 | 13 929 | 31 % |
| 74 - 75 | 43 294 | 16 470 | 38 % |
| 75 - 76 | 48 900 | 16 470 | 34 % |
| Average of 7 years | 40 543 | 17 207 | 42.4 % |

4. Total

| | | | |
|---|---|---|---|
| 69 - 70 | 830 419 | 252 954 | 30 % |
| 70 - 71 | 530 167 | 187 351 | 35 % |
| 71 - 72 | 729 382 | 180 664 | 25 % |
| 72 - 73 | 379 761 | 111 081 | 29% |
| 73 - 74 | 620 441 | 147 415 | 24 % |
| 74 - 75 | 955 314 | 204 765 | 21 % |
| 75 - 76 | 785 573 | 192 917 | 24.5 % |
| Average of 7 years | 635 900 | 182 450 | 29.7 % |

Source : Ministry of Rural Development and Hydraulics: Annual Reports : from 1969 - 1970 to 1975 - 1976.

.../...

The proportion of millet and sorghum produced in the Casamance has declined somewhat in recent years, and the proportion of maize produced there has dropped significantly. Rice production, however, has held its own, at least in relation to the total produced in Senegal. An actual decline has occured in quantity of millet, sorghum and maize produced there. One hypothesis advanced to explain this phenomenon is that the Casamance has suffered from neglect, and that lack of investments, scarcity of support for development programs, and the continuing exodus of the rural people toward the urban centers may actually be related in a causative way to the stagnation of cereal production.

Whether or not this hypothesis is the real explanation, one can hardly doubt that the Casamance has the potential for regaining its rank in cereals production and perhaps even for domination of that field of endeavor. The question of suitability of resources for production of rice and other cereals will be addressed in detail in a subsequent chapter.

## 1.4. FUTURE CONSUMPTION OF CEREALS.

Consumption of cereals can be projected for some future point in time based on known present consumption (calculated on a per capita basis), with adjustments of individual consumption reflecting the elasticity of demand for cereals and changes in per capita income. Three important variables - population growth, income, and elasticity - thus control the projection and determine its accuracy.

It should be emphasized that a projection is not the same as a prediction and that the effects of a governmental incentive policy or any other program to influence consumption were not taken into account in the calculations, which are thus a reflexion of current trends only.

The following projections of consumption are those of the 5th Plan, as presented in the report of the Ministry Rural Development and Hydraulics entitled Actions Planiferes de Production Cerealiere, 1977 à 1985. All data are quoted from that report.

Population growth is projected as follows :

| | |
|---|---|
| Population base (1974 | 860 000 |
| Annual growth rate | 2.6 % [1] |
| Projected population, 1981: | 5 816 000 |
| Projected population, 1985: | 6 445 000 |

Per capita income is projected at rates that would result in tripling of 1969 per capita income by 2001 : 2.5 % per year until 1981, then 3.3 %. The data may be summerized as follows :

| | |
|---|---|
| Base for projections : per capita income in 1974 ( F.CFA) | 51 005 |
| Annual growth rate, 1974-81 | 2.6 % |
| Projected per capita income, 1981: | 60 936 |
| Revised annual growth rate 1981-1985 | 3.3 % |
| Projected per capita income 1985 | 68 901 |

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1. Annual growth of 2.6 % from a 1974 base of 4 860 000 would result in 1976 population of 5 116 000. The 1976 census reported a population of 5 085 388, suggesting a slower rate of population growth of about 2.3 %.

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To provide a check on the reasonableness of the foregoing projections, SODAGRI offers another set of projections of consumption of cereals. These projections are far less sophisticated, being based on only two assumptions : (1) that consumption and the changes in consumption over a period of time can be summarized by and expressed as a "trend line" (a linear regression line fit by the method of least squares) ; and (2) that the trend line will continue to express consumption in the future.

Trend line projections of cereal consumption are given in Table 1.4. To emphasize that a trend line shows only general patterns rather than precise estimations, trend line figures are given for the first and last years of the series being projected, that is from 1964 to 1974 ; it will be noted that they do not "tally" exactly with historical data. It should also be observed that the projected total consumption is a projection of historical series of data ; the "total" for one year is unlikely to equal the sum of projections based on component historical series.

Projections for 1981 and 1985 made by the two different systems are reasonably close, except for rice where the Ministry of Rural Development and Hydraulics projection is far higher - 71% higher in 1981 and 88% higher in 1985. These higher figures reflect the assumptions built into their projection, concerning higher per-capita income and the Senegalese consumers preference for rice if they can afford it. In other words, the Ministry of Rural Development and Hydraulic projection shows that demand for rice will increase in the future.

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Table 1.4. Trend Line Projections of Consumption of Cereals in Senegal. ( Tons )

| | Millet and Sorghum | Rice | Maize | Wheat | Misc. | Total |
|---|---|---|---|---|---|---|
| Actual Consumption : | | | | | | |
| 1961 | 398 883 | 157 633 | 36 656 | 52 705 | 4 522 | 651 396 |
| 1974 | 560 574 | 226 387 | 71 427 | 61 371 | 15 430 | 935 189 |
| Trend line projections : | | | | | | |
| 1960 | 462 258 | 191 788 | 39 201 | 26 942 | (2 486) | 717 991 |
| 1974 | 540 707 | 245 397 | 73 864 | 92 256 | 21 219 | 973 328 |
| 1981 | 579 931 | 272 201 | 91 195 | 124 914 | 33 071 | 1 100 997 |
| 1985 | 602 345 | 287 517 | 101 098 | 143 575 | 38 844 | 1 173 950 |
| 1990 | 630 362 | 306 663 | 113 478 | 166 902 | 48 310 | 1 265 142 |
| 1995 | 658 380 | 325 809 | 125 857 | 190 228 | 56 776 | 1 356 334 |
| 2000 | 686 397 | 344 955 | 138 236 | 213 554 | 65 241 | 1 447 526 |

considerably faster than it has increased in the past. If this is true, as seems reasonable, the importance of efforts to increase domestic production rice is again underlined.

In the projections of cereal products consumption, the elasticity of demand used in the calculation is based on studies of urban consumers. Table 6 shows the elasticities and the projected consumption of products made from cereals. These figures are converted to their equivalents in raw cereals, which are shown in the following tables. Thus, it can be seen that according to the calculations made by the Ministry of Rural Development, expected consumption of rice in 1981 will be 289, 202 tons, which will require a production of paddy rice of of 465,000 tons per year, 1.61 times the amount of milled rice.

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Table 1.5. Projected Net Domestic Supply of Cereals.

| | 1974 | 1975/76 | 1980/81 | 1981/86 |
|---|---|---|---|---|
| Wheat | 0 | 10 | 24 830 | 53 000 |
| Paddy rice | 133 000 | 95 400 | 260 000 | 312 000 |
| Maize | 38 000 | 35 700 | 119 700 | 151 000 |
| Millet | 491 000 | 462 300 | 630 500 | 672 000 |
| Total | 662 000 | 593 400 | 1 035 030 | 1 188 000 |

Source : Ministry of Rural Development and Hydraulics.

Table 1.6.A. Elasticity and Projected Consumption of Cereal products.

| Product | Elasticity | Total Consumption (T) 1974 | 1981 | 1985 |
|---|---|---|---|---|
| Wheat flour | 0,7 | 73 722 | 99 933 | 120 683 |
| Rice | 0,4 | 225 588 | 289 202 | 335 174 |
| Maize flour | 0,3 | 56 907 | 71 521 | 81 588 |
| Millet flour | 0,2 | 296 005 | 342 905 | 372 700 |
| Total Products from cereals | | 652 222 | 803 561 | 920 145 |

Table 1.6.B. Calculated consumption of cereal equivalents.

| Product | Factor of Transformation | Product needs (T) 1974 | 1981 | 1985 |
|---|---|---|---|---|
| Wheat | 1,25 | 92 000 | 124 500 | 151 000 |
| Paddy rice | 1,61 | 363 000 | 465 000 | 539 500 |
| Maize | 1,17 | 66 500 | 83 500 | 95 500 |
| Millet | 1,66 | 491 000 | 569 000 | 618 500 |
| Total cereals | | 1 012 500 | 1 242 500 | 1 404 500 |

## 1.5. : PROJECTIONS OF FUTURE [illegible] OF CEREALS.

In the other side of the coin, net domestic supply of cereals is shown in Table 1.5, which presents long terms trend projections to 1981 and 1985.

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Comparison of projected supply and demand (using the Minis' try of Rural Development and Hydraulics) indicates that a serious shortage will be encountered with respect to wheat, paddy rice and maize. Only in the case of millet will projected supply be adequqte, but the surplus of millet is far from being adequate to substitute for the other cereals. Again, the importance of increasing production at a rate faster than in the past underlined.

## 1.6. THE NEED FOR INCREASES IN DOMESTIC PRODUCTION.

To meet the production needs corresponding to the projected consumption, shown above, the Ministry of Rural Development and Hydraulics has established targets. According to these targets the four cereals should be increased, as follows :

| Grain | Average present situation | Goal, 1981 | % of increase, where 100 : present situation |
|---|---|---|---|
| Wheat | 5 ha. | 10,000 ha. | - |
| Paddy rice | 83,000 ha. | 125,000 ha. | 150% |
| Millet-Sorghum | 979,000 ha. | 1,080,000 ha. | 116% |
| Maize | 48,000 ha. | 87,000 ha. | 181 % |

The areas devoted to rice should thus be increased by 50 % over the present areas and other cereals should follow suit. At the same time, yields should be improved. A target for rice yield is established that aims at an increase from the present official average yield of 1,330 kilograms per hectare, to a yield in 1981 of 2,400 kilograms per hectare. Major yield increases are also targeted for the

.../...

other cereals.

For the Casamance, an expansion of the areas under rice cultivation by 15,000 hectares is planned for the upcoming agricultural campain, 1977-78

All of these targets and plans for action indicate not only strong awarenes on the part of the Senegalese government of the prospective difficulties in respect to cereals production and consumption, but a firm intent to meet the challenge.

1.7. CONCLUSIONS.

The overall situation in cereal production and consumption in Senegal shows clearly that steps must be taken to increase national production, for a variety of related reasons : to better nourish the people of Senegal ; to insure the health and livelihood of this and future generations ; to improve Senegal's position vis-à-vis its commercial deficit and place it on more competitive footing with other nations in the modern trade community, and to provide a firm base for expansion into other domains, both agricultural and industrial, with the concomitant creation of jobs and increases in per capita income. Steps properly taken will open new vistas for the exploitation of the natural resources of Senegal.

Project SENERIZ is designed to participate in the implemetation of the national policy aimed at reducing the imports of

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cereals and reinforcing the Senegalese economy in its most fundamental aspect. The exact increases in production expected to result from the project, as well as constraints, techniques, schedules, and financial aspects, are presented in the following chapters.

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ANNEX

Table 1. Area of Principle Cereal Crops in Senegal 1960 - 1975 Progressively Cumulated (1 000 ha.)

| | Millet and Sorghum | Rice | Subtotal | Maize | Total |
|---|---|---|---|---|---|
| 1960 | 762.2 | 67.9 | 830.1 | 30.5 | 860.6 |
| 1961 | 830.8 | 72.9 | 913.7 | 32.2 | 945.9 |
| 1962 | 864.7 | 71.9 | 936.6 | 31.5 | 968.1 |
| 1963 | 959,4 | 74.8 | 1034.2 | 32.6 | 1066.8 |
| 1964 | 1010,9 | 86.9 | 1097.8 | 47.2 | 1145.0 |
| 1965 | 1069,4 | 82.6 | 1152.0 | 54.3 | 1206.3 |
| 1966 | 996.7 | 87.9 | 1084.6 | 53.8 | 1138.4 |
| 1967 | 1155.4 | 101.4 | 1256.8 | 71.7 | 1328.5 |
| 1968 | 1053.7 | 77.5 | 1131.2 | 36.3 | 1167.5 |
| 1969 | 1037.3 | 104.3 | 1141.6 | 55.4 | 1197.0 |
| 1970 | 972.2 | 93.3 | 1065.5 | 50.6 | 1116.1 |
| 1971 | 974.6 | 83.7 | 1068.3 | 48.9 | 1117.2 |
| 1972 | 936.3 | 50.3 | 986.6 | 32.3 | 1018.9 |
| 1973 | 1093.5 | 64.6 | 1158.1 | 39.2 | 1197.3 |
| 1974 | 1155.1 | 85.6 | 1240.7 | 48.6 | 1289.3 |
| 1975 | 715.5 | 89.7 | 805.2 | 46.7 | 851.9 |

Source : Table 1.1.A.

Table 2. Production of Principal Cereal Crops in Senegal 1960-75 (1000 tons)

| | Millet and Sorghum | Rice | Subtotal | Maize | Total |
|---|---|---|---|---|---|
| 1960 | 392.4 | 81.5 | 473.9 | 27.2 | 501.1 |
| 1961 | 406.5 | 83.8 | 490.3 | 28.3 | 518,6 |
| 1962 | 424.1 | 90.4 | 514.5 | 26.6 | 541.1 |
| 1963 | 478.4 | 105.8 | 584.2 | 26.6 | 610.8 |
| 1964 | 531.8 | 108.8 | 640.6 | 37.2 | 677.8 |
| 1965 | 554.1 | 125.2 | 679.3 | 40.8 | 720.1 |
| 1966 | 423.2 | 125.2 | 548.4 | 41.8 | 590.2 |
| 1967 | 654.9 | 134.5 | 789.4 | 56.8 | 846.2 |
| 1968 | 450.0 | 58.8 | 508.8 | 25.3 | 534.1 |
| 1969 | 634.8 | 140.8 | 775.6 | 48.8 | 824.4 |
| 1970 | 400.9 | 98.7 | 499.6 | 38.7 | 538.3 |
| 1971 | 528.7 | 108.2 | 636.9 | 38.5 | 675.4 |
| 1972 | 322.9 | 43.6 | 366.5 | 20.2 | 386.7 |
| 1973 | 520.8 | 64.3 | 585.1 | 33.8 | 618.9 |
| 1974 | 777.0 | 117.0 | 894.0 | 43.2 | 937.2 |
| 1975 | 630.0 | 144.0 | 774.0 | 45.2 | 819.2 |

Source : Table 1.1.A.

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Table 3. Total Senegalese Consumption of Cereals and Cereal products 1961-1964 (progressively cumulated by category) Tons.

| | Millet Sorghum | Rice | Maize | Wheat | Misc. | Total |
|---|---|---|---|---|---|---|
| 1961 | 398 883 | 157 633 | 36 653 | 52 705 | 4 522 | 651 396 |
| 1962 | 424 741 | 172 787 | 40 217 | 32 744 | 2 280 | 672 769 |
| 1963 | 460 688 | 157 235 | 47 040 | 45 193 | 3 746 | 713 902 |
| 1964 | 512 072 | 256 206 | 40 401 | 38 182 | 2 746 | 849 607 |
| 1965 | 559 849 | 254 823 | 54 687 | 34 299 | 2 256 | 905 914 |
| 1966 | 524 516 | 241 738 | 51 037 | 51 037 | 11 225 | 879 549 |
| 1967 | 484 446 | 239 447 | 65 479 | 52 431 | 4 438 | 846 241 |
| 1968 | 606 678 | 264 011 | 84 307 | 40 026 | 3 197 | 998 215 |
| 1969 | 535 003 | 201 336 | 72 448 | 69 079 | 25 215 | 903 081 |
| 1970 | 576 528 | 212 788 | 51 331 | 83 995 | 6 087 | 930 729 |
| 1971 | 476 599 | 251 127 | 71 534 | 105 350 | 6 265 | 910 875 |
| 1972 | 528 157 | 230 403 | 44 295 | 95 218 | 4 221 | 902 294 |
| 1973 | 411 249 | 221 180 | 77 938 | 105 422 | 51 353 | 867 142 |
| 1974 | 560 574 | 226 387 | 71 427 | 61 371 | 15 430 | 935 189 |

Source : Actions Planiferes de Production Cerealiere, Ministry of Rural Development and Hydraulics, December 1976.

X
X X

# CHAPTER 2 :

# THE ANAMBE BASIN AS A PROJECT SITE.

## 2.1. CRITERIA FOR THE CHOICE OF THE SITE.

## 2.2. APPLICATION OF CRITERIA AND JUSTIFICATION OF THE CHOICE.

## CHAPTER 2

## THE ANAMBE BASIN AS A PROJECT SITE

### 2.I. CRITERIA FOR THE CHOICE OF THE SITE

Project Seneriz has for its principle objective increasing domestic production of rice in Senegal to such a level that importation of rice would be eliminated or greatly reduced. Thus, the selection of the site for carrying out Project Seneriz should be related very closely to the suitability of the region for increases in rice production.

Other objectives for the project also exist, either specified in the documentation of the project, or implied by the government's overall development policy. These objectives include iprovement of the foreign exchange balance, economic benefits and a higher level of living for rural habitants, and provision of employment opportunities.

This complex of project objectives implies that the criteria for judgement of the project at the design stage or during implementation would also be complex, and that an assortment of criteria for evaluation of the site for the project would be needed.

SODAGRI's contract for the Seneriz study specifies that a site for the project will be chosen within the departments of Kolda and Velingara. Sites in Lower Casamance, Senegal Oriental, or north of Gambia are thus eliminated from consideration. Choice among the possible sites in Kolda and Velingara departments might utilize the following criteria :

Climate : adaptability of temperature, rainfall, humidity, etc. to rice production

Topography : adaptability to water storage, water control and water use, and minimum cost for levelling.

Soils : adequacy of area suitable for cultivation, amenability to development, and potential productivity.

Vegetation : feasibility of clearing the land or of controlling noxious vegetation.

Water : availability and cost of water of satisfactory quality and dependability for irrigation.

Human Resources : interest of local population in development, absence of institutional constraints, availability of agricultural laborers.

Remoteness : sufficiently remote from the centers of population to qualify as a developmemt project, but with reasonable access to major consuming areas.

Current Developmemt : a level of development amenable to significant improvement.

## 2.2. APPLICATION OF CRITERIA AND JUSTIFICATION OF THE CHOICE.

Application of the listed criteria to the potential sites in the departments of Kolda and Velingara results in selection of the valley of the Anambe in preference to any other site. Following is a step-by-step justification of this conclusion :

.../...

While no region is completely homogeneous, and while some amount of variation must be expected in any geographic region, the departments of Velingara and Kolda present little variation in terms of topography, climate, vegetation, population, etc. The general flatness of the region is unbroken by any outstandingly superior site for a water storage reservoir. The variation in temperature, rainfall, solar energy and other climatological features between north and south, east and west parts of the region are not such as to make obvious any differences in adaptability to a project of this nature. The population density does not vary greatly from one end of the region to the other. These characteristics can be seen in the available data, and were confirmed by the SODAGRI study team by visits to various points in both departments by surface transport and by overflying the entire region.

The conclusion to be drawn from these data (within limits) any one site in the region is closely comparable to any other site, viewed from the macro-geographic and demographic points of view. Thus, other criteria of choice must be applied.

The exceptions to the general principle of homogeneity are in respect to soils and surface hydrology. The soils resources of the Anambe basin are among the best suited to cultivation using indigenous technology ; this is apparent from maps such as "Carte de l'Afrique de l'Ouest, 1:200,000, 1952" by Institut Geographique National, Paris, that show obvious concentration of villages and of cultivated land in a ring surrounding the flood-plains of the Anambe River. Such concentration is also apparent to the aerial

.../...

viewer. Potential soil productivity is another matter, and detailed study and analysis are needed to differentiate soils by potential for raising crops. However, the Anambe Basin has large areas of the heavy-textured soils believed to be relatively high in potential productivity.

As for surface hydrology, the interior of the region is characterized by few perennial streams, whereas, more important rivers are located at or beyond the margins of the region. The Casamance River near Kolda, the upper Gambia River in Senegal Oriental, the Koulountou River which flows into the Gambia, and the Kayanga River in the southern part of the department of Velingara are all perennial streams. Therefore, they possess significantly more potential as sources of irrigation water than the wet-weather streams of the interior which cease to flow during the dry season.

Despite this obvious superiority of the regions adjacent to these perennial rivers from the standpoint of hydrology, three of the four potential sites must be rejected. The Gambia River is outside of the region of this study. The Koulountou River is so located that its development would be at least partly outside the region. Possible development of the Casamance River is the subject of other studies, and some competition or conflict between this project and others downstream might arise, should the waters of the upper Casamance be withdrawn for irrigation. However, the Kayanga River appears to have potential as a source of irrigation water, and to be relatively free of problems in its development.

.../...

The basin of the Anambe River has several characteristics which place it in a category apart from all other possible development sites. Because of its location adjacent to and connecting with the Kayanga River, possibility of irrigation development is better than most sites. In addition, "the basin" is perceived by the local populace and by admimistrators in the government as being demarcated as a unit, and as possessing an individuality as a potential unit for development. Previous studies of this basin (including the GERCA study in 1962 and the SERDA study in 1976) have confirmed this demarcation, and have legitimized the idea of development there. The local populace is aware of and shares in the perception of the basin as a development unit, and they feel that a major development scheme in that region is not only appropriate and desirable, but is their right.

The Anambe Basin Project Site, compared to other sites within the departments of Kolda and Velingara, is unique in that it is neither preempted for some other project nor excluded from selection for some valid reason. Its soil and water resources are probably superior to other sites. Finally, even if appraisal of the physical resources were inconclusive, the existence of past studies and the general acceptance of the pattern projected by those studies, virtually dictate the choice of the Amambe Basin for a development project.

# CHAPTER 3 - AN OVERVIEW OF THE ANAMBE BASIN

## 3.1. PHYSICAL ASPECTS

1.1. Location and size
1.2. Geology
1.3. Topography
1.4. Climate
1.5. Hydrology
1.6. Soils
1.7. Adaptation to cultivation
1.8. Current land use

## 3.2. DEMOGRAPHY

2.1. Population
2.2. Distribution of the population
2.3. Characteristics of the population
2.4. Attitudes

## 3.3. INFRASTRUCTURE

3.1. Roads
3.2. Ports and shipping
3.3. Telephone
3.4. Air transport
3.5. Domestic Water supplies
3.6. Electricity
3.7. Construction materials and commodities
3.8. Constrained areas : the classified forest.

# CHAPTER 3

## AN OVERVIEW OF THE ANAMBE BASIN

In this chapter, background information is given about the physical, demographic and infra-structural aspects of the Anambe Basin. Succeeding chapters deal at length with the subdivisions of climate, soils, and sociology, so only a summary of those topics is found in this chapter. However, for geology, topography and infrastructure, somewhat more detail is given in this chapter.

### 3.1. PHYSICAL ASPECTS

#### 3.1.1. Location -

The Casamance Region forms the southern section of Senegal. It is bordered on the south by Guinea-Bissau, on the south-east by Guinea and on the north by the Gambia. The region takes its name from its principle watercourse, the Casamance River.

The Casamance has an area of 28,300 square kilometers and a total population of about 795,000 persons. It is divided into three sub-regions : Lower, Middle and Upper Casamance. Lower Casamance, also called, appropriately, Maritime Casamance, is extensively dissected by tidal rivers and inlets of the sea, and the climate is heavily influenced by the ocean. The maximum elevation of the land is only a few meters above sea level.

Middle and Upper Casamance are successive steps in a progression : they are less maritime and more continental in climate ; they are less dissected by waterways and less well watered by rainfall, and their elevation is somewhat higher.

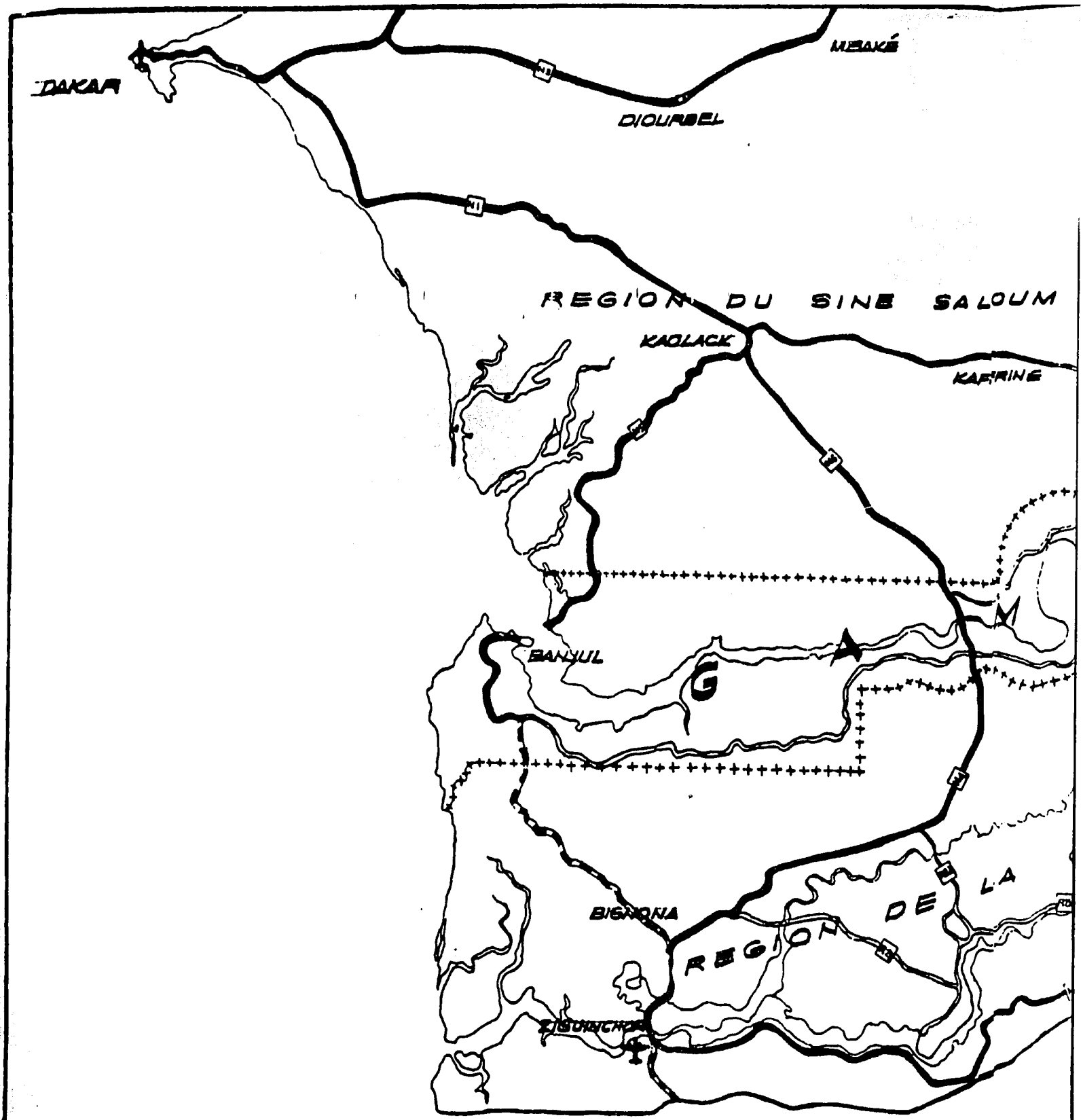
Upper Casamance includes the Departments of Kolda and Velingara. It is within these departments that the site of project SENERIZ is found

The Anambe Basin, the site of project SENERIZ, is understood to mean the watershed or drainage area that contributes to or is drained by the Anambe River. The Basin is a roughly circular area, of which the geographic center is the juncture of the Anambe and Waïma Rivers, at the extreme North-East corner of the arrondissement of Dabo, Department of Kolda. The center is located at 13°01' North latitude, 14°81 West longitude. The periphery of the Basin is the divide or ridge separating the flow of rainfall toward or away from the Anambe river. The Basin has an average diameter of about 37 kilometers, and an area of 1.100 $km^2$ (110,000 hectares). Since the extreme outer fringes of the Basin, along the divide are for the most part sparsely populated and little cultivated, an error of one or two kilometers would make but little difference in the total of cultivated lands or of population included in the Basin.

About 74%, or 81,500 hectares of the Basin lie in Kounkandé Arrondissement, Department of Velingara. About 26%, or 28,500 hectares, are found in Dabo Arrondissement, Department of Kolda.

A source of irrigation water having been chosen outside the Anambe Basin itself, the site of the dam and artificial lake must also be included in the project site. This is an area about 5 km by 20 km lying eastward from Niandouba and straddling the Kayanga River. The part south of the river is a part of the Kayanga National Forest. The part north of the river is sparsely populated an has only a few villages. Administratively, the area is entirely within the Department of Velingara, with about 60 percent in the Arrondissement of Kounkande and about 40 percent in the Arrondissement of Bonconto.

.../...

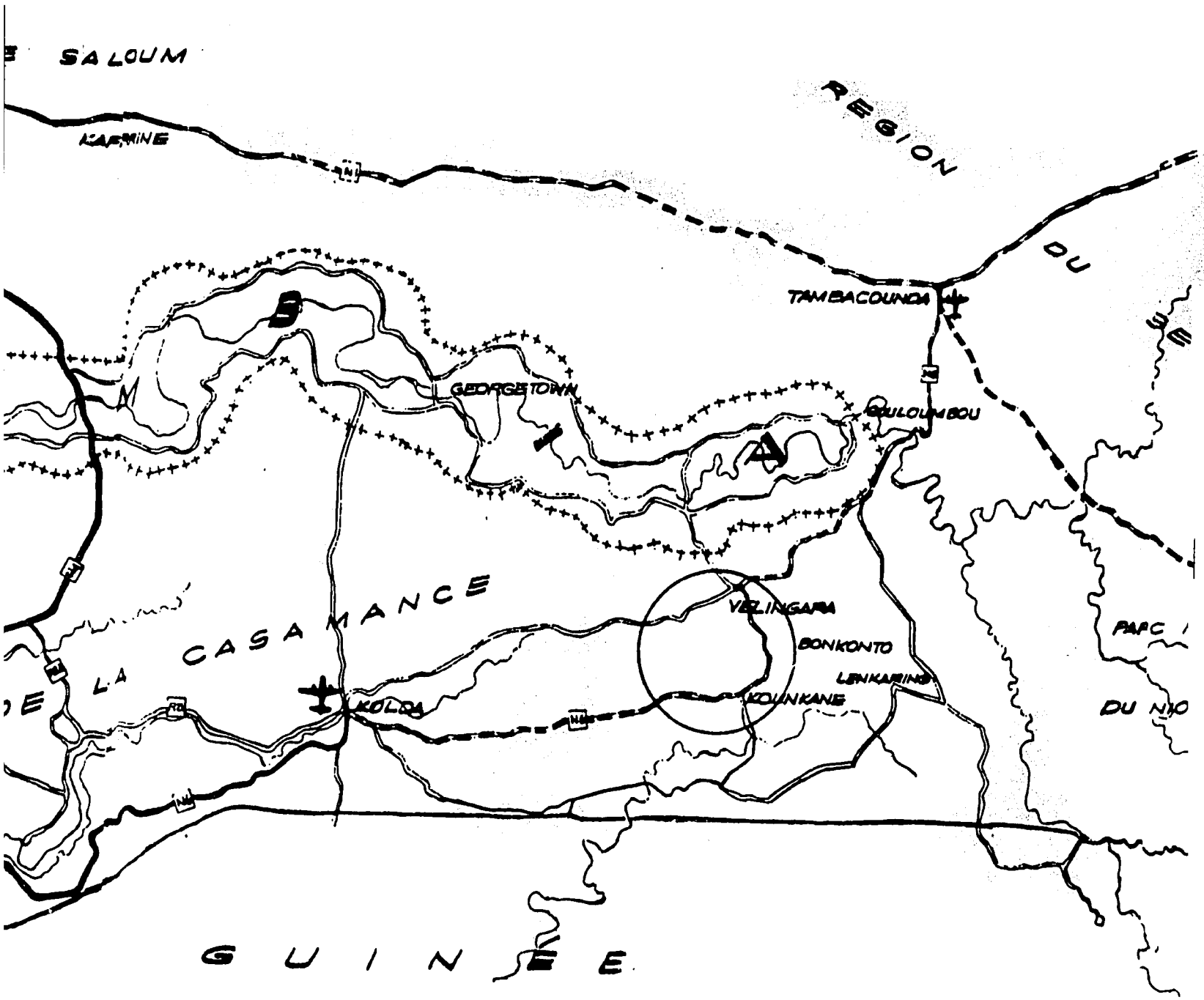



SCALE
ÉCHELLE 1/1,500,000

LEGENDE:

| | |
|---|---|
| ROUTE PRINCIPALE BITUMÉE | MAIN ROAD - TARMAC |
| ROUTE PRINCIPALE DE PRATICABILITÉ PERMANENTE | MAIN ROAD - DIRT, BU ALL WEATHER |
| ROUTE SECONDAIRE DE PRATICABILITÉ PERMANENTE | SECONDARY ROAD - BUT ALL WEATHER |
| PISTE UTILISABLE PAR LES AUTOMOBILES | TRAIL SUITABLE FOR C |

47




ROAD - TARMAC

ROAD - DIRT BUT WEATHER

QUARY ROAD - DIRT ALL WEATHER SUITABLE FOR CARS

AÉRODROME

AIRPORT

POUR PLUS DE DETAILS VOIR CARTE GENERALE DU SENEGAL ET CARTES IGN 1:200,000

FOR GREATER DETAIL SEE TOTAL MAP OF SENEGAL 1:1,000,000 AND IGN MAPS AT 1:200,000

48

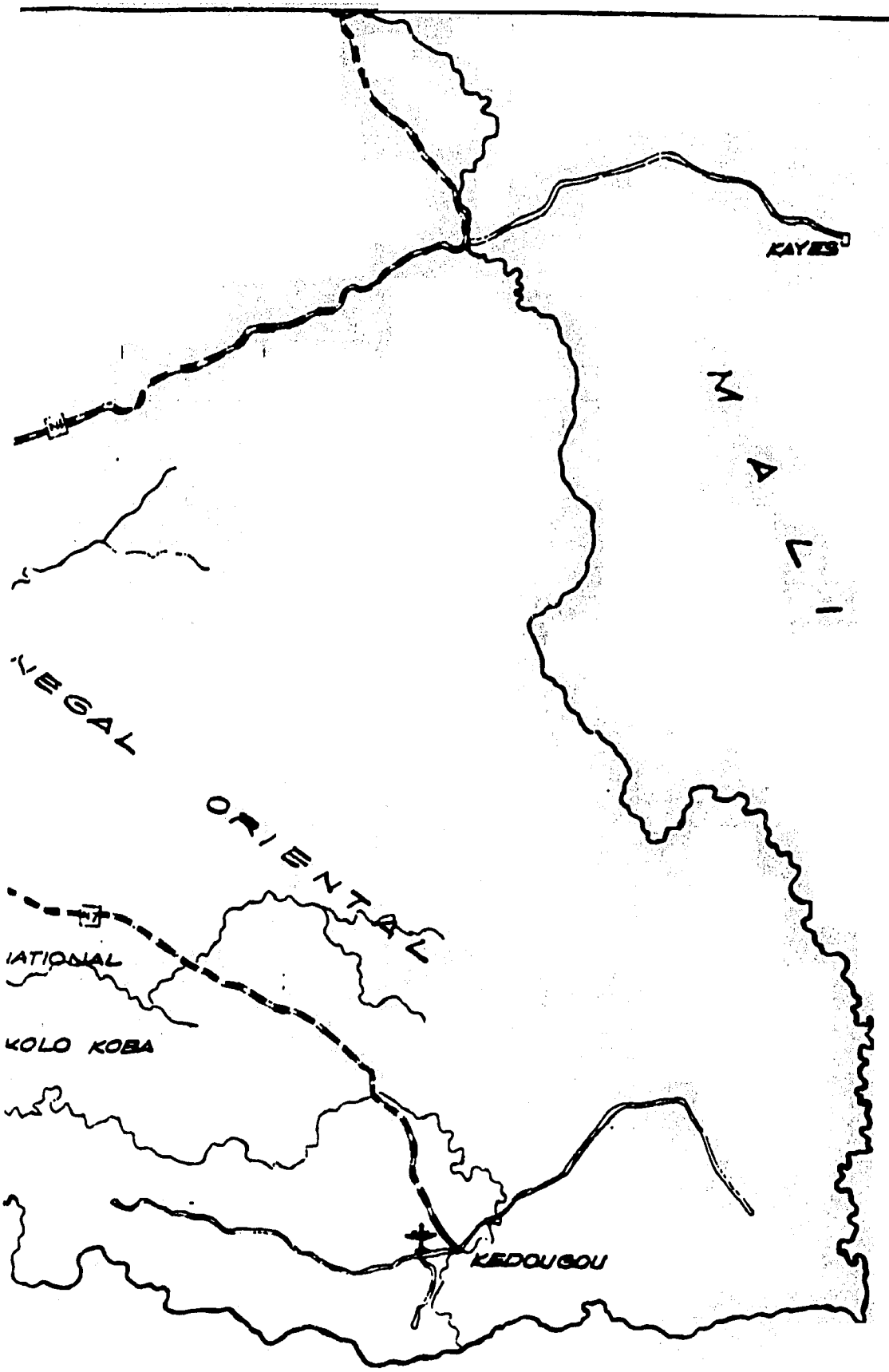
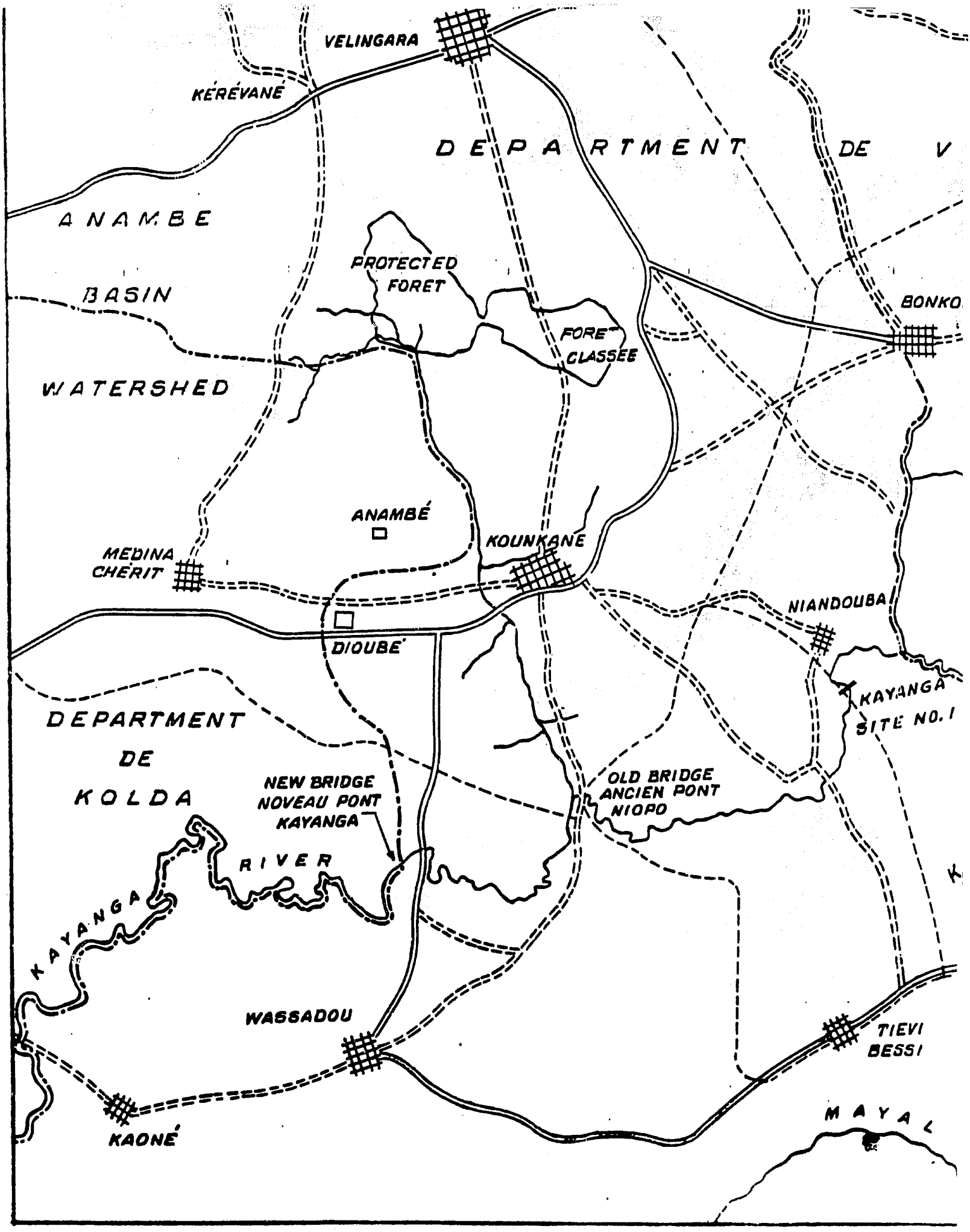
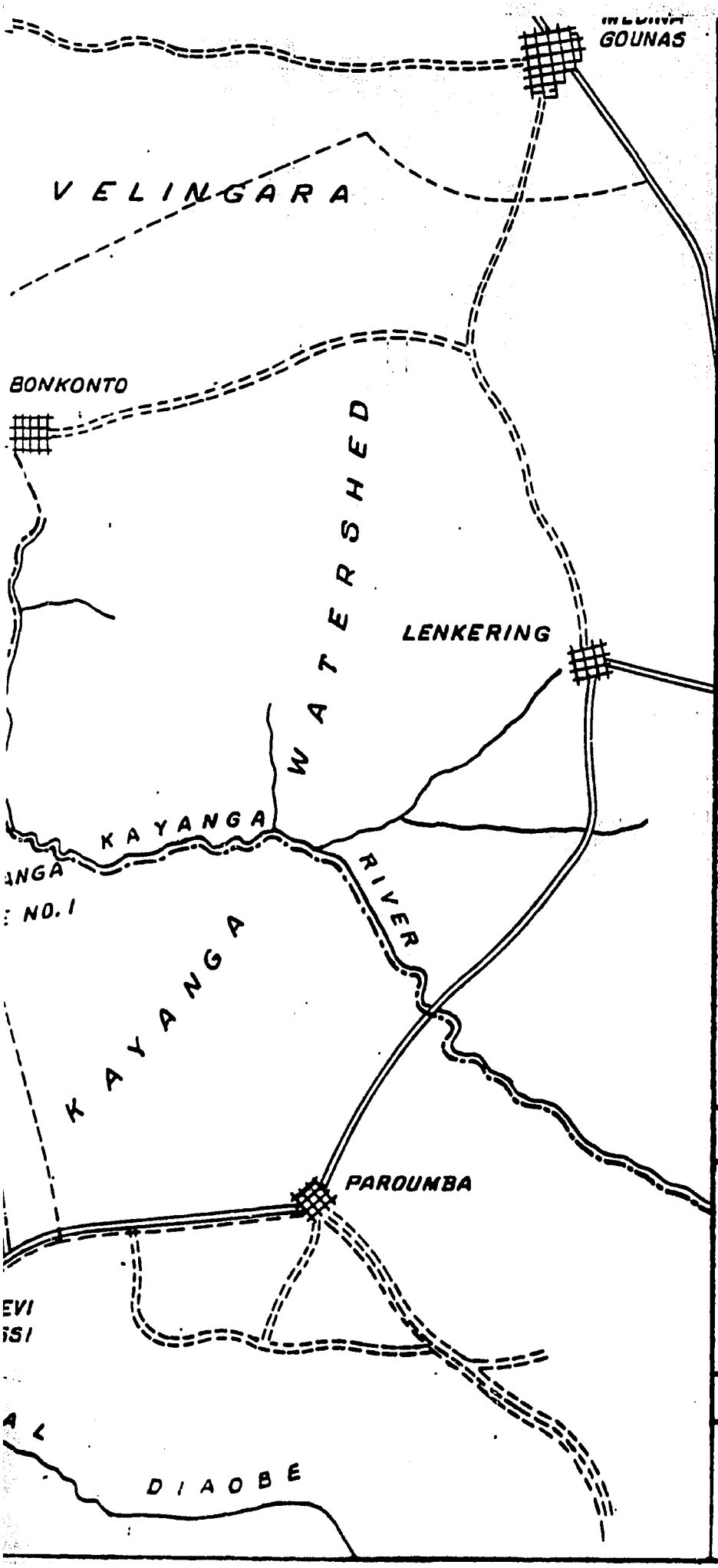



FIGURE - 3·1·1A

| | |
|---|---|
| PROJECT SENERIZ<br>PROJET SENERIZ | WEITZ HETTELSATER CORP. - SODAGRI |
| | SOUTHERN SENEGAL<br>LE SUD DU SENEGAL |
| | DRAWING Nº 01-3.1-1<br>DESIGNED BY: AFTER THE MAPS OF IGN<br>A' PARTIR DES CARTES IGN<br>DRAWN BY : JL PEREZ DATE : 4-7-77 |


VELINGARA
KÉRÉVANÉ
DEPARTMENT DE V
ANAMBE
BASIN
WATERSHED
PROTECTED FORET
FORE CLASSEE
BONKO
ANAMBÉ
KOUNKANE
MEDINA CHERIT
NIANDOUBA
DIOUBÉ
KAYANGA SITE NO. 1
DEPARTMENT DE KOLDA
NEW BRIDGE NOVEAU PONT KAYANGA
OLD BRIDGE ANCIEN PONT NIOPO
RIVER
KAYANGA
WASSADOU
TIEVI BESSI
KAONÉ
MAYAL

50




## LEGENDE

ECHELLE 1 : 200,000

SCALE 0 5 10KM.

ROUTE DE PRATICABILITE PERMANENTE A 2 OU 3 VOIES NON GOUDRONNEE
GOOD ALL WEATHER LATERITE ROAD 3 OR 2 LANES

PISTE PRINCIPALE UTILISABLE PAR DES AUTOS
IMPORTANT DIRT TRACK PASSABLE BY CAR.

RIVIERE OU MARIGOT
RIVER OR WATERCOURSE

LIMITES DES BASSINS VERSANTS.
BOUNDARY OF WATERSHED

LIMITE DU DEPARTEMENT OU ARRONDISSEMENT
BOUNDARY OF DEPARTMENT OR ARRONDISSEMENT

## NOTES

1) CETTE CARTE A ETE PREPAREE A PARTIR DES CARTES I.G.N. FEUILLES 28 ND IV, V, X, XI.

THIS MAP WAS PREPARED USING INFORMATION GIVEN BY THE I.G.N. MAPS. SHEET 28 ND IV, V, X, XI.

FIGURE - 3.1.1B

WEITZ HETTELSATER CORP.-GOD AGRI

**PROJECT SENERIZ**
**PROJET SENERIZ**

**LOCATION**
**LOCALISATION**

DRAWING Nº 02.3.1.1

PREPARED BY : P.D. BUNTING
PREPARE PAR

DRAWN BY : E.J. CAYO
DESSINE PAR DATE : 4-8-77

3.1.2. Geology -

A general but brief description of the geology of Senegal follows, to provide perspective for subsequent discussions of the Anambe Basin, the availability of construction materials and the development of deep aquifers.

Geological History of Senegal - Structurally, the most dominant feature of this part of West Africa is the Senegal-Mauritania sedimentary basin. It extended as much as 500 km inland from the present coastline, and from Guinea-Bissau in the South to Port-Etienne in Mauritania in the North. In the project area the original bed-rock, although now somewhat altered and also having been subjected to igneous activity, outcrops forming the south-easterly limit of the Basin.

As a general rule, the age of the sedimentary deposits decreases from West to East, while the extent of the bed increases and the thickness of the stratum decreases. From these observations, it has been concluded that the Basin was subjected to successive advances and retreats of the sea, during which time the deposits were laid down.

A stratigraphic succession is described below. It is noteworthy that the Maestrichtien stratum is the sandiest of all the strata, which may indicate a fluvial environment. However, this idea seems difficult to accept when the extent of the Maestrichtien beds in Senegal is considered.

Tectonic activity has been limited to recent periods and its magnitude is small. A fault exists, very approximately running North to South on the 15°15' meridian.

Stratigraphy - Four major groups are recognized : the bedrock and the secondary deposits.

.../...

Bedrock - The bedrock of this region has often been referred to as schists, but more detailed information reveals the diverse nature of these rocks. From deep boreholes and from surface outcrops in the Southeast of Senegal, many rocks have been recognized ; white granite, metamorphosed schists, quartzite,diorite, basalt, rhyolite and micro-granite. This divergence of rock type suggests the presence of extensive igneous activity at some period.

Secondary - Secondary deposits are of varying thickness throughout Senegal and are normally found below 500m. They have been classified as Albian, Turonian, and lower Senonian. Typical deposits include calcareous sandstones, black sands, clays and limestones.

Also included in the secondary group is the Maestrichtien, which deserves special mention :

- Maestrichtien : - Three different facies may be recognized :
- To the west of 17° 15' W. - principally clayey with occasional seams of sandstone.
- Between 17° 15' W and 16° W - sands and sandstones, often with calcareous cement, often traversed by beds of black clay and sandy clay of varying thickness. The sandy deposits are often extensive.
- To the East of 16° W - principally sands, with some regional variations.

Tertiary - Five periods are recognized : - Paleocoic, Lower Eocene, Middle Eocene, Upper Eocene, and Contental Terminal.

The older four periods typically contain marl and limestones. The Upper Eocene is represented in Lower Casamance by chalky clays, limestones and yellow sands with clay.

.../...

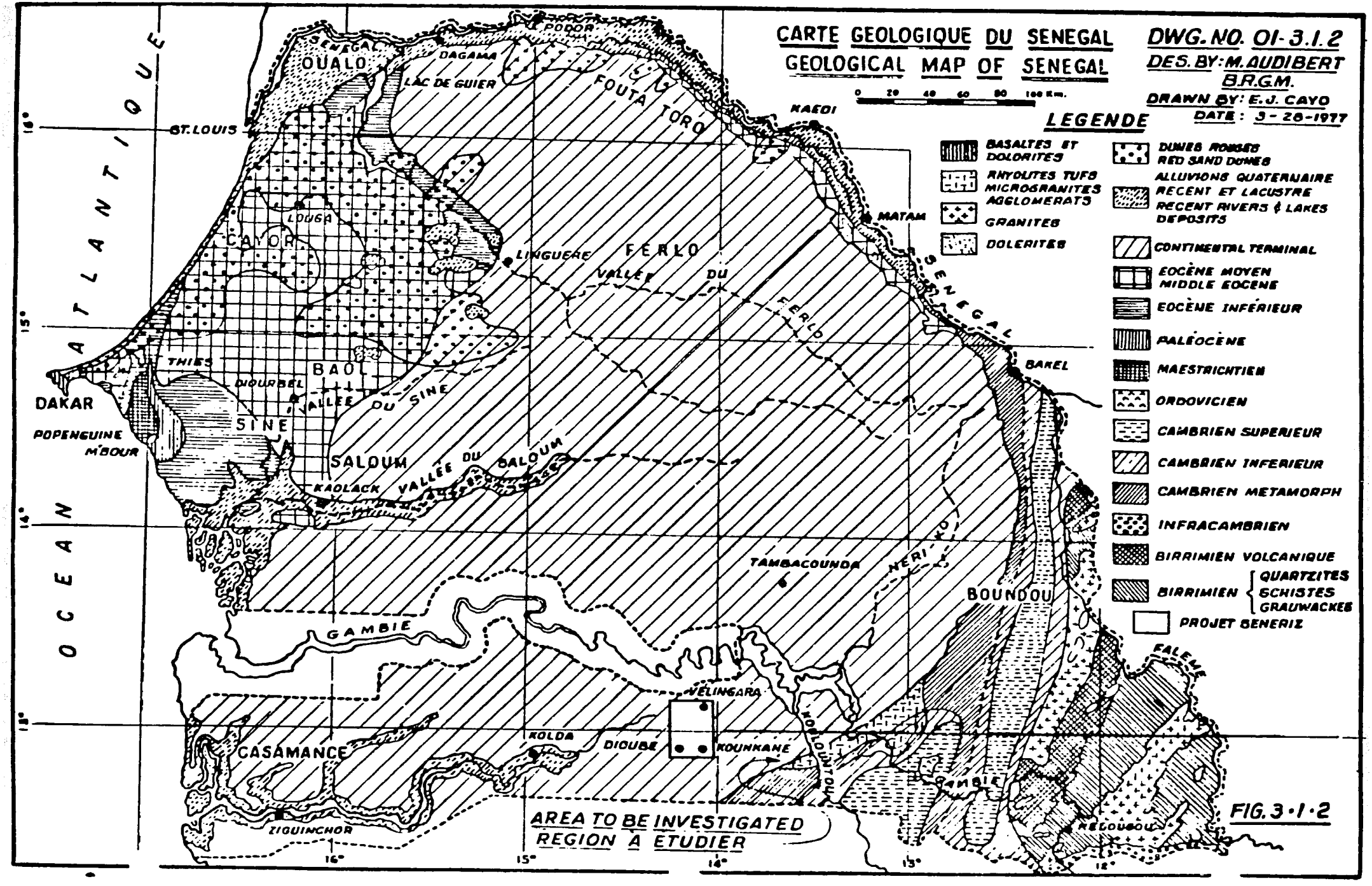

CARTE GEOLOGIQUE DU SENEGAL
GEOLOGICAL MAP OF SENEGAL
DWG. NO. 01-3.1.2
DES. BY: M. AUDIBERT
B.R.G.M.
DRAWN BY: E.J. CAYO
DATE: 3-28-1977
0 20 40 60 80 100 Km.
LEGENDE
BASALTES ET DOLORITES
RHYOLITES TUFS MICROGRANITES AGGLOMERATS
GRANITES
DOLERITES
DUNES ROUGES RED SAND DUNES
ALLUVIONS QUATERNAIRE RECENT ET LACUSTRE RECENT RIVERS & LAKES DEPOSITS
CONTINENTAL TERMINAL
EOCÈNE MOYEN MIDDLE EOCENE
EOCÈNE INFÉRIEUR
PALÉOCÈNE
MAESTRICHTIEN
ORDOVICIEN
CAMBRIEN SUPERIEUR
CAMBRIEN INFERIEUR
CAMBRIEN METAMORPH
INFRACAMBRIEN
BIRRIMIEN VOLCANIQUE
BIRRIMIEN { QUARTZITES SCHISTES GRAUWACKES
PROJET SENERIZ
OCEAN ATLANTIQUE
SENEGAL
OUALO
DAGANA
PODOR
LAC DE GUIER
FOUTA TORO
KAEDI
ST. LOUIS
LOUGA
CAYOR
LINGUERE
FERLO
VALLEE DU FERLO
MATAM
SENEGAL
BAKEL
THIES
DIOURBEL
BAOL
VALLEE DU SINE
DAKAR
POPENGUINE
M'BOUR
SINE
SALOUM
VALLEE DU SALOUM
KAOLACK
TAMBACOUNDA
NERI
BOUNDOU
GAMBIE
FALEME
VELINGARA
KOLDA
DIOUBE
KOUNKANE
KOULOUNTOU
CASAMANCE
ZIGUINCHOR
GAMBIE
KEDOUGOU
AREA TO BE INVESTIGATED
REGION A ETUDIER
16°
15°
14°
13°
12°
18°
17°
15°
14°

FIG. 3·1·2

Deposits from the Continental Terminal period cover most of Senegal today, and are typically represented by clayey sandstone, clays with red sand, and mottled clays. In many areas of the Upper and Middle Casamance, lateritic rock outcrops appear. The maximum thickness of these deposits - 150 meters - is found at Tambacounda.

Quaternary - Found principally on the Altantic coast, these most recent deposits form the older red and more recent white sand dunes.

The formation of the Anambe Basin - At one time, the Anambe Basin was the site of a lake, which probably remained from the submersion during the Continental Terminal period. Geologically speaking, this happened very recently. Despite the very low relief, an exit valley from the lake leading to the Kayanga River Valley was formed. Today this valley still provides the natural surface drainage way. It is known as the Vendou or Anambe Valley. Within the past few thousand years, the low-lying backwater regions of the Anambe Basin have been subjected to deposits of alluvium.

### 3.1.3. Topography.

The general relief of the Upper Casamance presents a very flat aspect, situated at 60-70 m elevation. This flat relief is broken only by river valleys, notably the valleys of the Gambia in the North, the Koulountou in the East, and the Kayanga to the South. The Anambe Basin forms the most extraordinary topographic feature of the region. The typical elevation of its central lowest section is 21 m and thus an average slope of 1.2$^{c}$ is estimated.

During the dry season, particularly when viewed from the air, the relief of the basin is barely noticeable. However, the wet season and the attendant flooding emphasize the relief of the basin. Flooding

.../...

of 2.5 meters depth occurs in the central section, extending over 75 $km^2$.

Natural drainage is towards the centre of the basin, whence flood waters flow from the Basin via the Anambe Valley or Vendou. This valley has lateral slopes of 1.25° and a natural grade .28° in its upper section, steepening to .75° leading southwards towards the Kayanga Valley.

The Kayanga River rises in higher lands, at 80m elevation in the border country between Senegal and Guinea. After descending to Velingara Pakane, the Kayanga continues at a grade of .27° to the Niapo Bridge, and afterwards at a grade of 0.07° to Missira Kaone. Downstream from Niapo Bridge the River is extremely sluggish. After 140 km in Senegal, the Kayanga crosses the border into Guinea-Bissau. It is then known as the Rio Geba, and continues to flow in a south-westerly direction to the sea.

The Anambe Basin may be considered briefly in three parts, according to elevation. The highlands constitue 650 $km^2$ of the basin and are situated higher than 38m elevation. They are distinguished by sandy lateritic soils typical of the surrounding plateau. This highland belt is crossed by several very shallow valleys, radially disposed to the centre of the Basin. In previous literature these have been called thalwegs, although indistinct drainage ways would be a more apt description.

A circular belt of 300 $km^2$ lies between the 38m and 23 m elevations. Typical slopes vary between .5° and 1.5°. This area is subject to some flooding in the wet season, the upper reaches for only short duration during periods of heavy run-off, but the lower levels being completely flooded at the end of any exceptional wet season.

The central section of the Basin is situated below the 23m level and is subjected to regular seasonal flooding to a maximum depth of two and one-half meters.



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3.1.4. Climate.

Rainfall between the equator and the 20° parallel along the wet coast of Central Africa follows two distinct patterns, both of which appear to be spawned in the Gulf of Guinea. The first pattern begins in February and moves northward form the gulf in an orderly progression towards the southern Sahara Desert. The second pattern starts later in the year and moves in and out along the equatorial belt in a northeastern direction in two rainy seasons. The later pattern is responsible for the heavy rains along the coasts of Gabon and Cameroun (3,000 to 4,000mm per year) and throughout central equatorial Africa.

The first pattern brings the annual single rainfall season to Senegal and the northwestern portion of Africa. The front normally enters southern Senegal during May, peaks in August, than rapidly recedes and exits completely by November. The heaviest rainfall from this pattern centers around Conakry, Guinea, where on the average, over 4,000 mm per year are recorded.

Figure 3.1.4. A shows annual isohyetal lines, based on a 30 year period of records (1931-1960) for that portion of the West African Coast directly influenced by these two patterns. Figures 3.1.4.1. (A) through 3.1.4.1. (L) which are included in the Annex to this report, give monthly isohyets for this period and clearly show the described patterns. Figure 3.1.4.B. which follows, gives annual isohyets and average days of rain per year for Senegal for the period 1931-1960 and shows the approximate location of the Anambe basin. It can be seen on this Figure, that the project area lies between the 1,100 and the 1,200 mm precipitation lines and, on the average, receives recordable precipitation 78 days per year.

These figures, while providing effective [illegible]tal patterns for a 30-year period of relatively normal rainfall, do not reflect the period

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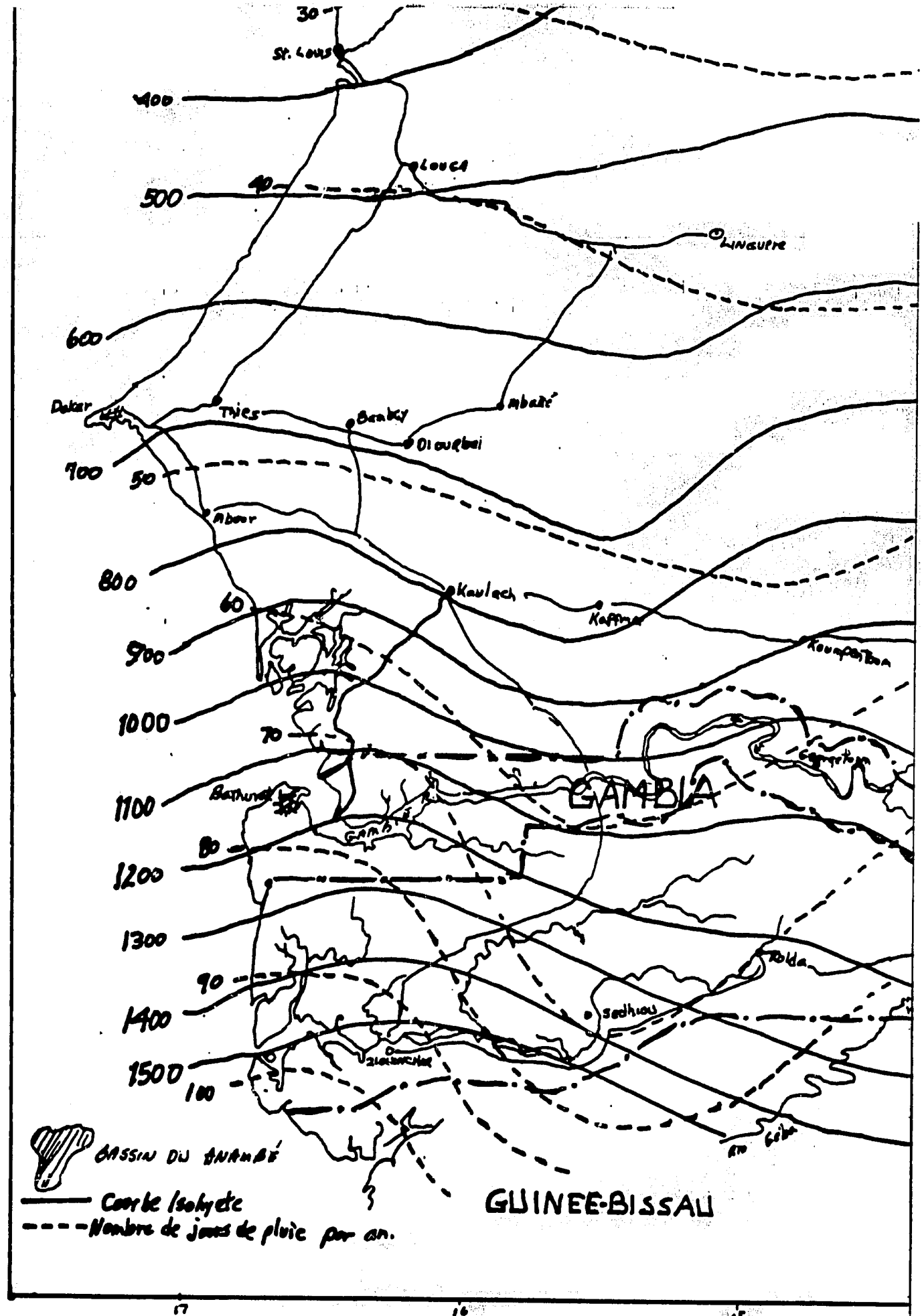
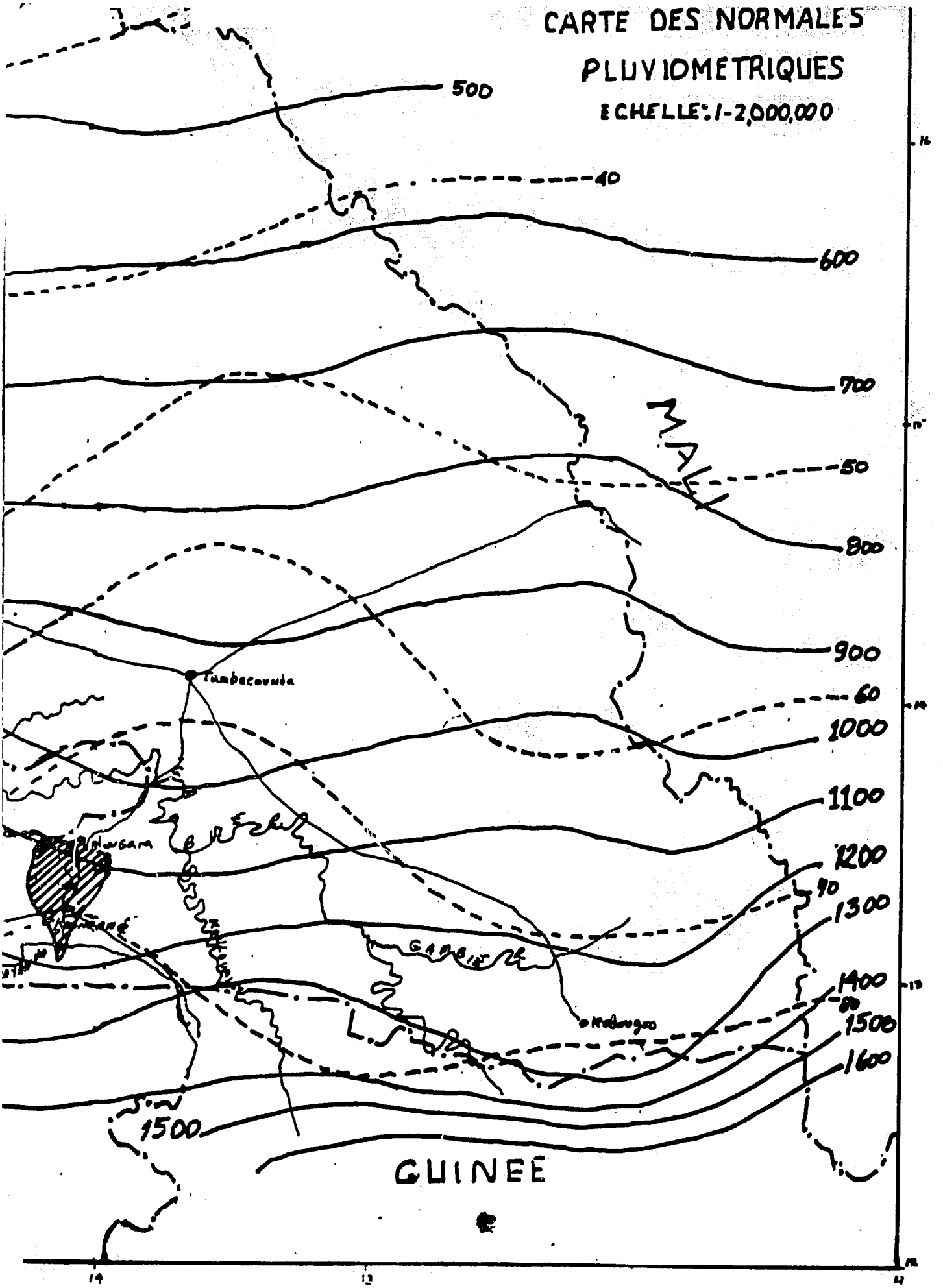

30
St. Louis
400
Louga
40
500
Linguère
600
Dakar
Thies
Bambey
Mbaké
Diourbel
700
50
Abéché
800
Kaolack
60
Kaffrine
900
Koumpentoum
1000
70
Tambacounda
GAMBIA
1100
Bathurst
Gambie
80
1200
1300
Tolda
90
1400
Sedhiou
Ziguinchor
1500
100
Rio Geba
BASSIN DU SINAMBÉ
Courbe Isohyete
Nombre de jours de pluie par an.
GUINEE-BISSAU
17
16
15


CARTE DES NORMALES
PLUVIOMETRIQUES
ECHELLE: 1-2,000,000
500
40
600
700
MALI
50
800
900
Tambacounda
60
1000
1100
1200
90
1300
1400
80
1500
1600
1500
GUINEE

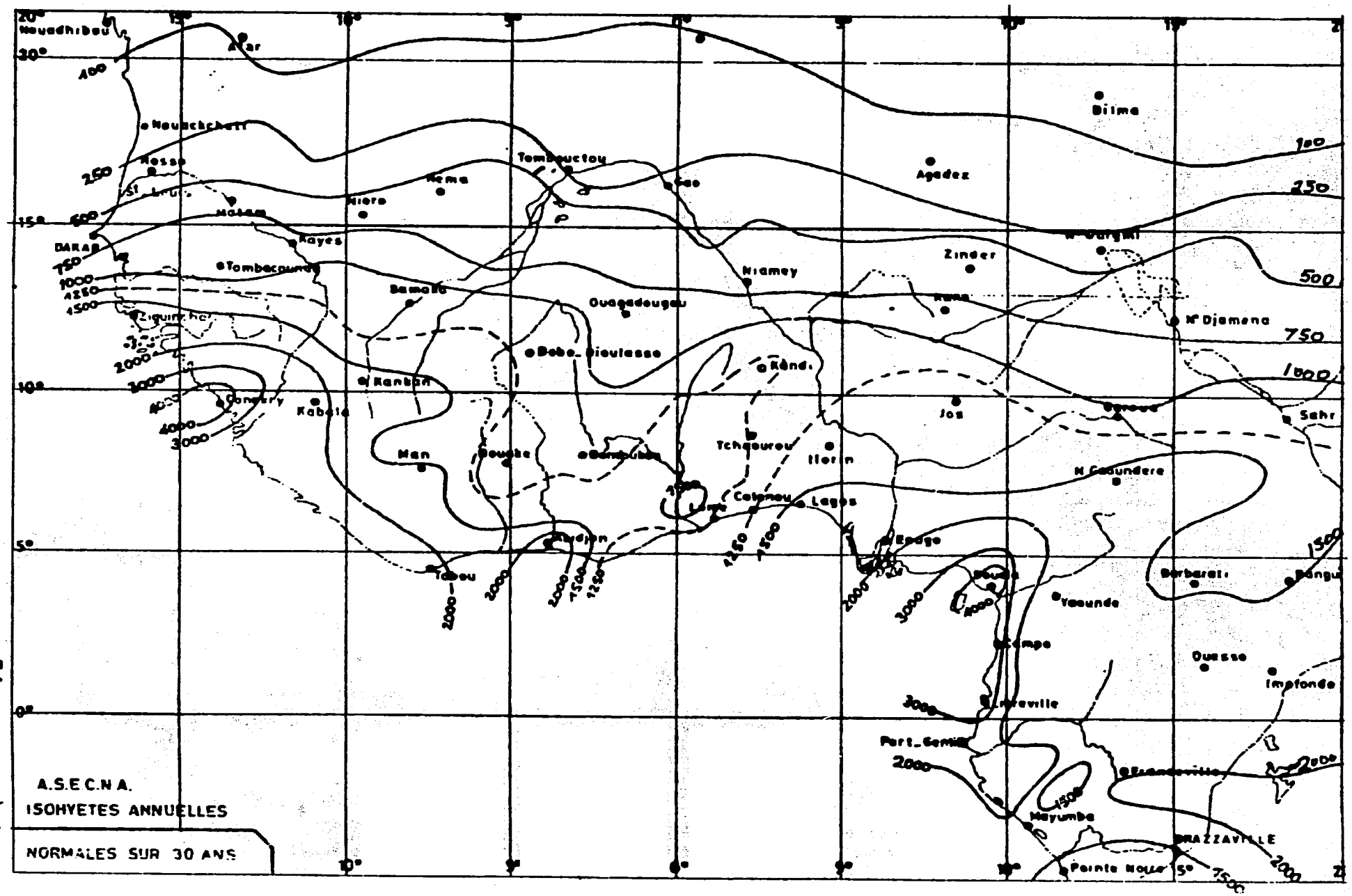

A.S.E.C.N.A.
ISOHYETES ANNUELLES
NORMALES SUR 30 ANS
Nouadhibou
Atar
Nouakchott
Nasso
St Louis
Matam
DAKAR
Kayes
Tombacounda
Ziguinchor
Bamako
Kiéra
Nema
Tombouctou
Gao
Niamey
Ouagadougou
Bobo Dioulasso
Rand.
Zinder
Agadez
Bilma
N'Djamena
Kano
Jos
Sokoto
Sahr
Conakry
Kabala
Man
Bouake
Abidjan
Tchaourou
Ilorin
Cotonou
Lagos
Enugu
Douala
Yaounde
Bangui
Bambari
Ouesso
Impfondo
Libreville
Port-Gentil
Mayumba
Pointe Noire
BRAZZAVILLE
Brazzaville
N'Gaoundere
Tabou
100
250
500
750
1000
1500
2000
3000
4000
4250
4500
7500
1250

Figure 3.1.4 A

of unprecedented drought which began in 1968 and, with the exception of 1975, is apparently continuing. The very severe drought conditions which affected the entire Sahel Region between 1970 and 1974 caused widespread famine and demographic migrations towards regions of more dependable precipitation and towards riverswhich maintained perennial flows. Figures 3.1.4.C. and 3.1.4.D. show isohyets for the years of 1973 and 1974 for that portion of the West African Coast under study ; these are representative of conditions during the drought.

Climatology - Simplistic Pattern - The Anambe Basin is located within the limits of the Sudano-Guinean semi-humid tropical belt and south of the Sahelian desertic climate zone. The principal meteorological characteristics defining the general region are :

- a rainy season with four months of erratic but relatively dependable average precipitation (June through September) preceded and followed by months of light transitional rainfall (May and October) ;

- a six month dry season very infrequently interrupted by light rainfall of no agricultural significance ;

- a temperature regime featuring maximum highs in May before the onset of the heavy rains, declining values during the rains, a secondary high in November and a relatively cooler season during December through February ;

- a decline in rainfall in a clearly defined relationship with latitude (from South to North) with a secondary decline eastward away from the coastal influence ; and

- a precipitation which does not appear to be related to elevation, probably due to the absence of dominating geographical variations in topography in Senegal.

.../...

3.1.5. Hydrology.

The hydrology of the Anambe Basin is directly influenced by the regimes of two streams, the Kayanga River and its affluent, the Anambe. The Kayanga is normally a perennial stream with a base flow of between 0.8 and 1.0 cubic meters per second near the point of discharge from the Anambe Basin, and an average of about 13 cubic meters per second. The maximum recorded flow was 135 cubic meters per second, but much larger flows are known to have occurred. Both rivers reach peak flood stage during September and October when the Kayanga flow blocks the Anambe discharge and causes increased flooding within the Basin. It has been observed that an early rise in the Kayanga, if not coinciding with high flows from the Anambe, will push Kayanga waters back into the Anambe Basin.

3.1.6. Soils.

In general, the soils of the Anambe Basin are low in fertility in comparison to major agricultural soils of the world. But they compare favorably to soils in other regions of Senegal, and must be considered as good enough to support major agricultural development.

The soils of the Basin range from light textures and rapid permeability at the rim of the basin to heavy, relatively impermeable soils in the center. The latter soils have the highest potential productivity, given protection from flooding, adequate drainage and proper management.

3.1.7. Adaptation to Cultivation.

In general, the Anambe Basin would be readily adapted to cultivation due to favorable topography.

.../...

62

Much of the Basin is forested and would have to be cleared before cultivation.

A sizable area of the lower portion of the basin is subject to flooding and adequate drainage facilities would have to be provided before cultivation could begin. In addition, some localized drainage would have to be provided in the upper part of the Basin to prevent areas of water impoundment.

The suitability of the soils to indigenous cultivation is apparent from their use. However, it is only the lighter textured soils that are tilled by the natives, the heavier textures being too difficult to plow with available power and tools. The heavier soils are however suitable for cultivation with tractors and mechanized equipment.

### 3.1.8. Current land Use.

The area of crops and the land use of the Anambe Basin can be estimated from study of maps and aerial photos, and comparison with regions for which statistics are available. This procedure has been followed to produce the following table :

Table 3.1.8. : Area of Crops and Land Use in Kounkande Arrondissement and Anambe Basin. Project Year 0 - (Hectares)

| Crop | Kounkande Arrondissement (a) | Anambe Basin (b) |
|---|---|---|
| Sorghum | 9,600 | 5,500 |
| Millet | 4,400 | 2,600 |
| Maize | 2,800 | 1,700 |
| Rice | 1,4000 | 800 |
| Peanuts | 10,400 | 6,000 |
| Cotton | 7,600 | 4,400 |
| Total area of crops | 36,200 | 21,000 |
| Total land area | 255,000 | 110,000 |
| % of land used for crops | 14 % | 19 % |

(a) - Including a part of the Anambe Basin
Source : Kounkandé : rounded average of 3 years, 1974 - 1976
Anambe : SODAGRI estimates.

(b) - Including parts of Kounkandé and Dabo arrondissements.

## 3.2. DEMOGRAPHY -

### 3.2.1. Population.

The Anambe Basin is a geographic rather than an administrative region. For this reason official statistics of population for the Basin are not available. However, they can be estimated.

The economy of the Upper Casamance is basically an economy of self-sufficiency and subsistence agriculture, with only a small proportion of the agricultural output being shipped out of the area. Under such conditions, the distribution of population and the cultivation of land are necessarily very closely correlated. This is the basis for estimations of cropland area based on census of population.

The relationship is used to estimate the population of the Anambe Basin from the foregoing measures and estimates of cropland in the Basin.

If coefficients of cropland per person and size and characteristics of family that were observed elsewhere hold true in this region, population of the Anambé Basin must be approximately 25,000 persons, of whom about 16,000 persons are economically active, and who are divided into about 1,700 families, each having an average of 14.7 persons and 9.6 "actives".

.../...

3.2.2. Distribution of the population.

Calculated density of population for Kounkande arrondissement is 17 inhabitants per square kilometer. The calculated density for the Anambe Basin, based on Sodagri's estimates of population, is somewhat more dense, about 19 persons per square kilometer. This greater concentration is to be expected, given the concentration of agricultural crop production in the Basin.

Large areas of the Basin are totally uninhabited. The Anambe National Forest and the central part of the Basin that is regularly flooded are among these uninhabited regions.

On the other extreme, the two villages of Velingara and Kounkande have between them probably a third of the region's population. The remainder live in smaller villages distributed for the most part in a circular band following the higher elevations and the lighter, more easily cultivated soils around the rim of the Basin.

Coincidentally, the main roads of the region are in this populated band, which suggests that distribution of population may be a function of accessibility.

3.2.3. Characteristics of the population.

Ethnically, the great majority of the people are Fulani, also called Peuhl or Fulbé. The Mandingo are the most numerous of the minorities.

Migration is a phenomenon common to this region. The Fulani migrated to this region from what is now Guinea and immigration continues from that source. The people have not completely lost their former semi-nomadic habits, and occasionally move within the region. In addition,

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it is common for young men to leave the region seasonally or even permanently in search of employment.

The extended family system is the basis for organization of this patriarchal polygamous society.

The population is young, more than half being less than 20 years of age.

Considerable detail on socio-economic organization, division of tasks, property rights, and other characteristics of the society is presented in Chapter 6 of this report.

3.2.4. Attitudes.

Rarely can people be induced to cooperate effectively and to participate efficiently in a program or a project that they do not approve or do not want. Recognizing this, the Sodagri team studied carefully the attitudes of the people of the Anambe Basin toward development in general and toward the proposed project in particular.

It was found that the people of the project region are strongly in support of the project, because they envision benefits to themselves in terms of local availability of employment, the means for better yields and greater income, and a better life. These anticipated benefits are, of course, squarely in accord with the expectations of the designers of the project.

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## 3.3. INFRASTRUCTURE.

### 3.3.1. Roads -

The Casamance is relatively isolated from the rest of Senegal. both geographically and infrastructurally. The intrusion of Gambia to a depth of almost two thirds of Senegal's width, coupled with the absence of a bridge accross the Gamvia River, complicated and delays transportation by road of both personnel and freight destined for the entire Casamance region.

Project Seneriz, being located in the Casamance, will share its difficulties of contacting the capital city, Dakar. To this burden, must be added the difficulties of travel and communication within the Casamance.

The principal routes of road communication to the project site are :

a/ Route N1, Dakar - Tambacounda - Bakel, Bitumen surfaced from Dakar to Maleme-Hodar, 280 km. Laterite road f Maleme-Hodar to Tambacounda, 260 km.

b/ Route N6, Ziguinchor - Velingara - Tambacounda, Bitumem surfaced from Ziguinchor to Kolda, 188 km. Laterite road from Kolda to Velingara, 130 km. Laterite road from Velingara to Tambacounda, 105 km.

c/ Route N1-N4, Trans-Gambia Highway : Dakar - Kaolack - Farafenni - Georgetown - Basse - Velingara. Bitumen surfaced from Dakar to Kaolack, 192 km. From Kaolack to Farafenni, 89 km. Good laterite road from Farafenni to ferries across the River Gambia at Georgetown, 70 Km. Good laterite road from Georgetown to Senegalese/Gambia Border at Badiara, 140 Km. Poor

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dirt road to Velingara, 10 km.

At present, the shortest route from Dakar to Velingara by car is via the Trans-Gambia Highway. The route via Tambacounda is certainly longer, but if travelling with commercial goods avoids waits for ferries and customs in the Gambia. It is reported that the laterite section of the N6 from Velingara to Tambacounda becomes very difficult in the wet season.

In the Anambe Basin itself, roads are very limited. The N6 which skirts the southern limit of the Basin to Kounkane and then turns north to Velingara is the only road of any consequence. It is an all weather road, protected against flooding by an adequate bridge over the Anambe River, 2 km, west of Kounkane. A series of large diameter corrugated iron and concrete culverts have been installed on the N6 where the road crosses drainage ways between Kounkane and Velingara ; these appear quite adequate, with one exception. The exception is South-West of Kandiaye, where the road was overtopped in 1975 ; the height of the road embankment at that point should be increased by 1 m. and more culvert sections installed.

No other routes which deserve the name of road exist in the Basin. Tracks lead from Kerevane (West of Velingara) southward via several villages, situated on the western side of the Basin, including Poula Pissan (locally known as Kedougoudikory), Darou, Sare Mankoto (locally known as Mountoumba), Awataba, Anambe and Kabendou, where they meet the N6 highway. The former Kounkane to Velingara road still exists, but is now nothing more than a track virtually impassable during the wet season. In the east-west direction there are no tracks which cross the Basin, although at one time Sare Quinor and Toungoulel were linked. This track has become disused and overgrown since Toungoulel was abandoned owing to flooding.

To the South of the Basin only one all weather laterite road exists ; construction was completed in 1975 on this road which leads from the N6 just south of Kabendou to Wassadou, crossing the Kayanga River with an adequate bridge downstream of the Anambe-Kayanga confluence. This bridge was constructed by SATOM.

Tracks, normally only passable in the dry season, lead from Kounkane to the Niapo Bridge and the proposed dam site near Niandouba. The best route to the proposed dam site leaves the N6 3 km. east of Kounkane and heads S.S.E. to Missira Mamadou Ibrahima, and then north towards Niandouba for 2.5 km. A walk of 1.5 km takes one to the proposed dam site.

3.3.2. Ports and Shipping.

Velingara and the project site are linked by road to Ziguinchor and Dakar. When the Seneriz Project reaches the construction stage, major items of machinery and other imports will pass through one or the other of these ports. Looking to the future, these ports will also handle exports of agricultural produce. The following facilities are available :

Dakar is a large international port capable of dealing with all project needs. The only details deemed noteworthy are :

- Lifting capacity : - a/ 6 T cranes normal.
  - b/ 1 60 T crane mounted on a floating barge
  - c/ 1 125 T crane mounted on a floating barge is available for hire from a private company SOFRA T.P. FOUGERELLE.
- Customs : - Normally allow 4-5 weeks, but in the case of emergencies matters can normally be expedited.

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Ziguinchor : is a secondary port of Senegal. whose harbour may only be reached by first crossing a bar.

a/ At low tide, a maximum of 3.6 m of water

b/ At very best conditions, a maximum of 4.5. m of water.

c/ All ships must pass via Dakar to collect a qualified pilot.

d/ Customs - if necessarv all formalities can be dealt with.

e/ Unloading and Storage :

340 m of wharf

22,000 $m^2$ open storage

2,400 $m^2$ of covered storage. No cranes available, only Hysters.

- Existing Shipping - Dakar is served by many European lines. Connections with the U.S.A. are a little more tenuous, but Delta Steamship Lines run from the Gulf ports of the U.S.A., and a French company C.M.C.R. (Compagnie Maritime des Chargeurs Réunis) is believed to have a filial company with runs from the Eastern seaboard.

Some seventy foreign boats, typically 1500-2500 T D.W. visited Ziguinchor in 1976. Most of these boats delivered to other West African ports and for the return cargo picked up oil cake bound for Europe.

A passenger/light cargo boat owned by COSENA pays weekly visits to Ziguinchor from Dakar. Its lifting capacity is limited to a 5 T crane.

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### 3.3.3. Telephone

Telephone links from Velingara to Kolda and Tambacounda are installed, but the service functions poorly. Communications to Dakar may be achieved with patience, but any international call from Velingara should not be attempted seriously.

### 3.3.4. Air Transport.

Air Senegal operates daily services to Ziguinchor, several flights per week to Tambacounda and occasional flights to Kolda. This service is quite efficient, but the long drive from any of the airports to reach the project site diminishes the advantages of such flights. No maintained airstrip exists in Velingara Department.

### 3.3.5. Domestic Water Supplies.

All villages in the Anambe Basin are supplied by hand-dug wells tapping the phreatic water table, the wells being typically 3-13 m. deep, with static water levels located 2-12 m. from ground level. Yields of 3 $m^3$/hr are the best that can be expected, water being hand drawn. Many of the wells are concrete lined and some are equipped with a cattle trough

Static water levels fluctuate seasonally. Many wells are of inadequate depth and go dry during the period preceeding the onset of the rains.

Two knownhand dug wells in the area are equipped with pumps, one at the CER in Kounkane has a hand pump. At Velingara, SONEES, a

private water company working throughout Senegal, operates a commercial well supplying the town of Velingara from a dug well.

Details of this facility :

- Well : hand dug : 2.5 m dia. 12.2 m deep. Concrete lined.
- Pump : 380 V submerged electric. Believed to be 5 h.p. Total head 37 m. Maximum discharge 30 $m^3$/hr.
- Water tower : reinforced concrete. Elevated storage at approximately 10 m.
- Other equipment : a manometer, hand throttling valve, flow meter and accumulator, a water softener which was not operating owing to lack of chemicals.
- Normal operations : 2 x 2 hours/day, giving a total daily discharge of 100 $m^3$.
- Water price : 104.5 CFA/$m^3$. Each user is equipped with a water meter.

One 8 inch (20.3 cm) bored welltapping the Continental Terminal is installed at the Sodefitex factory at Velingara. It is believed to be 50 m. deep and to yield at best 35 $m^3$/hr, the pumping period being unknown.

These exceptional cases apart, the typical farmer and his family in Anambe Basin are obliged to draw water by hand from hand-dug wells. However, the quality of tasted samples was reasonable.

3.3.6. Electricity.

Throughout Senegal, electricity is produced and sold by SENELEC. Their plant at Velingara was inspected and was found to be

clean and apparently well maintained.

Details of their equipment follows :

- 2 Diesel Alternators :

  1 x 3 cylinders at 45 KVA

  1 x 4 cylinders at 60 KVA

- RPM 1.000
- 3 Ph. 220/380 V Delta or Star
- 50 Hz
- Power factor : 0.8
- Service Factor : 1.0
- Voltage : Town supply 220 V.

  Cinema and SONEES : 380 V.

- Operating schedule : 1 hour in the morning

  2 hours at midday

  5 hours in the evening.

- Distribution - overhead cable

At the Sodefitex factory at Velingara, Diesel generating equipment is installed as follows :

| No of Unit | 1 | 2 | 3 |
|---|---|---|---|
| KVA | 275 | 225 | 50 |
| KW | 220 | 180 | 40 |
| RPM | 1,500 | 1,500 | 1,000 |
| Hz | 50 | 50 | 50 |
| Ph | 3 | 3 | 3 |
| Power Factor | 0.8 | 0.8 | 0.8 |
| Delta/Start V. | 380/220 | 180 / 220 | Unknown |

.../...

At the Kerevane "Centre de Perfectionnement Agricole" a small generating set, 2 x 5 KVA, had at one time been installed, and apparently, it had been used to provide power to provide power to administrative buildings, workshops and a small submersible well pump. At the time of the SODAGRI visit, it was broken down, beyond reasonable hope of repair.

Thus, electricity from SENELEC is the only source available to the local inhabitants, apart from any private generators which may exist.

3.3.7. Construction Materials and Commodities.

Diesel, Fuel, Gasoline and Oil. Imported crude oil is refined in Senegal by the Societe Africaine de Raffinage. It is distributed by B.P., Esso, Mobil, Texaco, Total and Iransen, the latter being a recently established company that took over Shell's distribution network in Dakar.

Typical 1977 prices of basic products were :

| | Tax Free | With Tax |
|---|---|---|
| - Premium Gasoline | 59.98 CFA/1 | 97 CFA/1 |
| - Regular Gasoline | 55.98 CFA/1 | 91 CFA/1 |
| - Diesel Fuel | 46.39 CFA/1 | |

Note : - these are tax-free negotiable prices.

For a major consumer, B.P. will install storage tanks, of capacity as required up to 10,000 1, free of charge. Other companies may offer the same service. A variety of oils and lubricants are available in Senegal.

Cement. Cement is produced for the Senegalese market by SOCOCIM at their plant at Dakar.

The plant's total capacity is 400,000 T cement/year.

Present output is about 350,000 T cement/year.

Three types of cement are produced, all of which, according to SOCOCIM, are compatible with international standards.

a/ Cap Vert C.P.A. 325 (325 $Kg/cm^2$ at 28 days).

b/ Super Cap Vert C.P.A. 400 (400 $Kg.cm^2$ at 28 days)

c/ Cap Vert Maritime C.P.A. 325 (325 $Kg/cm^2$ at 28 days) for marine use.

All three types are packed in 50 kg triple-ply sacks.

Price in Feb. 1977 was 10,265 CFA/Ton at the factory, or approximately 18,000 CFA/Ton delivered to Velingara. Normal transport costs are 12 CFA/Km/T.

Aggregate and Construction Stone. The principal source of aggregate in Senegal is the basalt quarries of the Cap-Vert region, near Dakar.

Prices at the quarry in 1977 are as follows :

- 3/8 inch 3,550 CFA per $m^3$
- 1/2 inch 3,570 CFA per $m^3$
- 16/25 inch 3,200 CFA per $m^3$

These prices and the cost of transport to Velingara are prohibitive, and the use of alternatives must be considered.

a/ The use of lateritic gravels as aggregate in low quality concrete is normally allowed only for low strength/durability domes-



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tic use . As a rule it is not recommended for water retaining concrete because of the rather dusty and friable nature of the laterite grains.

b/ South-East of the Project area, older metamorphic and igneous rocks outcrop. No commercial quarries are known to exist at the moment. This area is 80 km. from the Anambe Basin and is a potentail source of road stone, rip-rap and aggregate.

c/ Laterite boulders are available in certain parts of the Project area .

Sand and Dirt. Deposits of high quality clean sand are to be found in Velingara Department and these sands would be suitable for all general construction use.

Laterite soils of various qualities are available in the Anambe Basin. It is believed that carefully chosen borrow pits would provide sufficient fill for the dam.

3.3.8. Constrained Areas - The Classified Forest.

A number of "Forêts Classées" (protected forests) have been established in the Departments of Velingara and Kolda. One forest, The Anambe Classified Forest, is located midway between Velingara and Kounkande and lies wholly within the Anambe Basin. The forest is an irregular hourglass shaped area stretching from the Velingara-Kounkande road in the East to an undefined border abutting the Anambe River in the West. A total of 6,200 hectares, or roughly 6% of the basin's gross hectarage are enclosed within the boundaries of the reserve, which includes portions of each major soils association.

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In subsequent chapters of this report, development alternatives and a recommended future project structure are proposed.

The alternatives for the future of the Anambe Forest are continuation as protected forest land, or inclusion in the area to be developed for agricultural production.

Continuation as forest would continue 6,200 hectares in its present and relatively unproductive use, to save the resources for future generations. However, it would also preserve the forest as a physical barrier to irrigation canals and access roads, and would significantly reduce the area of the better, potentially more productive soils available for development. This in turn would reduce the benefits of the project, and the number of beneficiaries.

The development alternative, in the other hand, would reduce the total area of classified forests in Senegal by 6200 hectares, but since most of the land now in the forest could be irrigated, the potentail cropland area gained (under double cropping) would be twice the area of the forest taken. Declassification of the forest also would eliminate a major obstacle and impediment in the eventual installation of an irrigation system.

SODAGRI feels that the economics of the choice are clearly in favor of declassification. However, SODAGRI also recognizes that sentiment and the conservation ethic are strong in Senegal, and that considering probable opposition the process of declassification is likely to take considerable time. Any conflict over declassification would divert energies from productive work, and might interfere with prompt approval and implementation of the rest of the development project.



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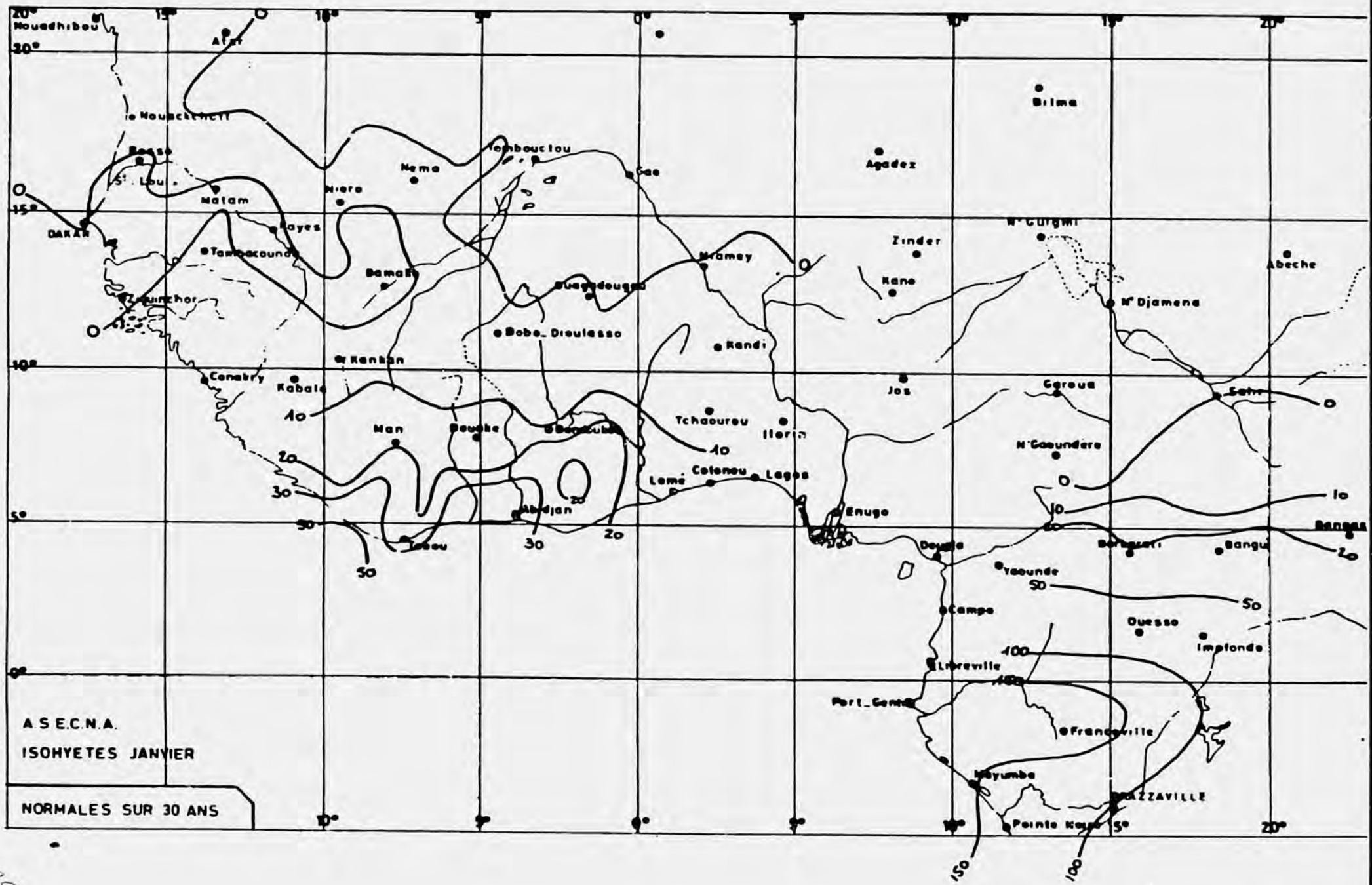
For these reasons, SODAGRI proposes that the Anambe Basin Protected Forest remain as such for the present, and that the Project SENERIZ be implemented with minimal interference or damage to the forest. At some future date, when benefits from intensive crop production in the Anambe Basin are self-evident, the question of declassification of the forest can be reconsidered.




Annex - Figure 3.1.4.1 (A)

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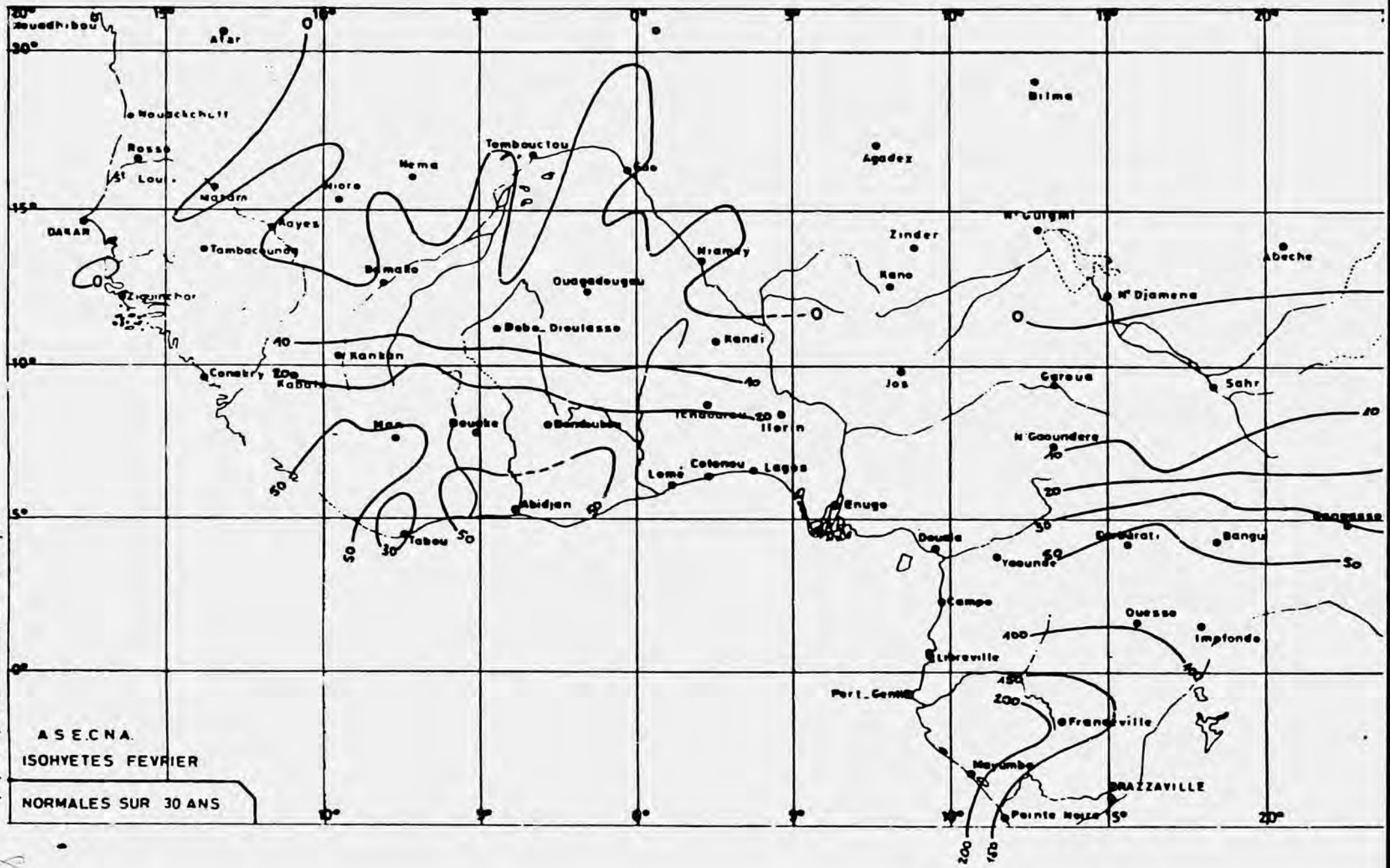
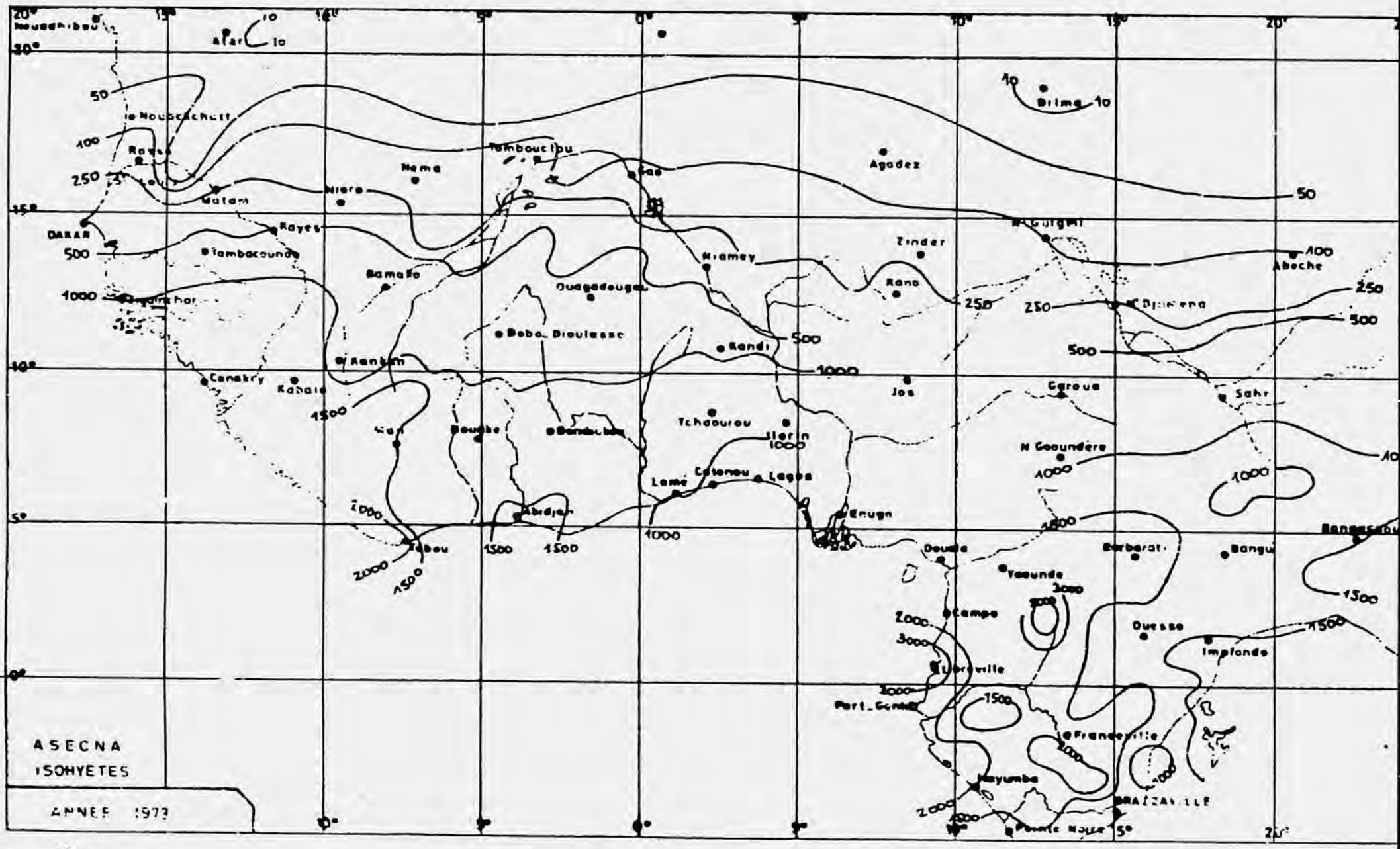



Annex - Figure 3.1.4.1 (B)


ASECNA
ISOHYETES
ANNEE 1973
DAKAR
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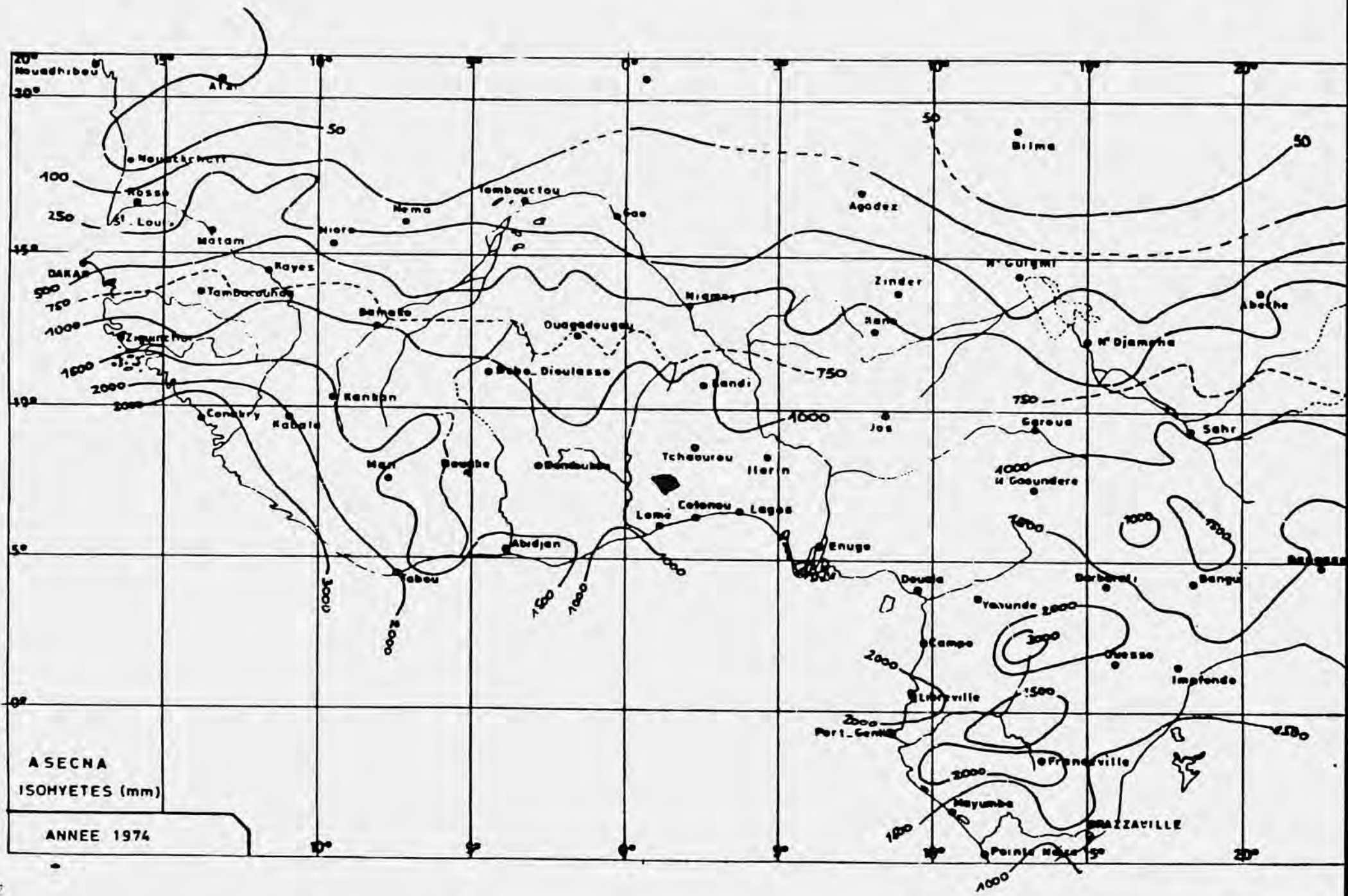
Nouadhibou
Atar
Kayes
Matam
Niore
Nema
Tombouctou
Gao
Agadez
Bilma
Niamey
Zinder
Maiduguri
Abeche
Djamena
Bamako
Ouagadougou
Bobo Dioulasso
Kandi
Kano
Jos
Sokoto
Gaoua
Sahr
Conakry
Kabala
Kankan
Tchaourou
Ilorin
Lome
Cotonou
Lagos
Enugu
Abidjan
Tabou
Douala
Yaounde
Bertoua
Bangui
Campo
Libreville
Port Gentil
Franceville
Mayumba
BRAZZAVILLE
Pointe Noire
Dusse
Impfondo
Bangassou

Figure 3.1.4 C


ASECNA
ISOHYETES (mm)
ANNEE 1974
Nouadhibou
Atar
Nouakchott
Rosso
St. Louis
Matam
DAKAR
Kayes
Tambacounda
Ziguinchor
Nioro
Nema
Tombouctou
Gao
Niamey
Ouagadougou
Bobo-Dioulasso
Kankan
Conakry
Kabala
Man
Bouake
Bandoukou
Abidjan
Tabou
Lome
Cotonou
Lagos
Enugo
Tchaourou
Ilorin
Sandi
Jos
Kano
Zinder
Agadez
Bilma
N'Guigmi
N'Djamena
Abeche
Garoua
Sahr
N'Gaoundere
Douala
Yaounde
Campo
Libreville
Port-Gentil
Franceville
Mayumba
BRAZZAVILLE
Pointe Noire
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Berberati
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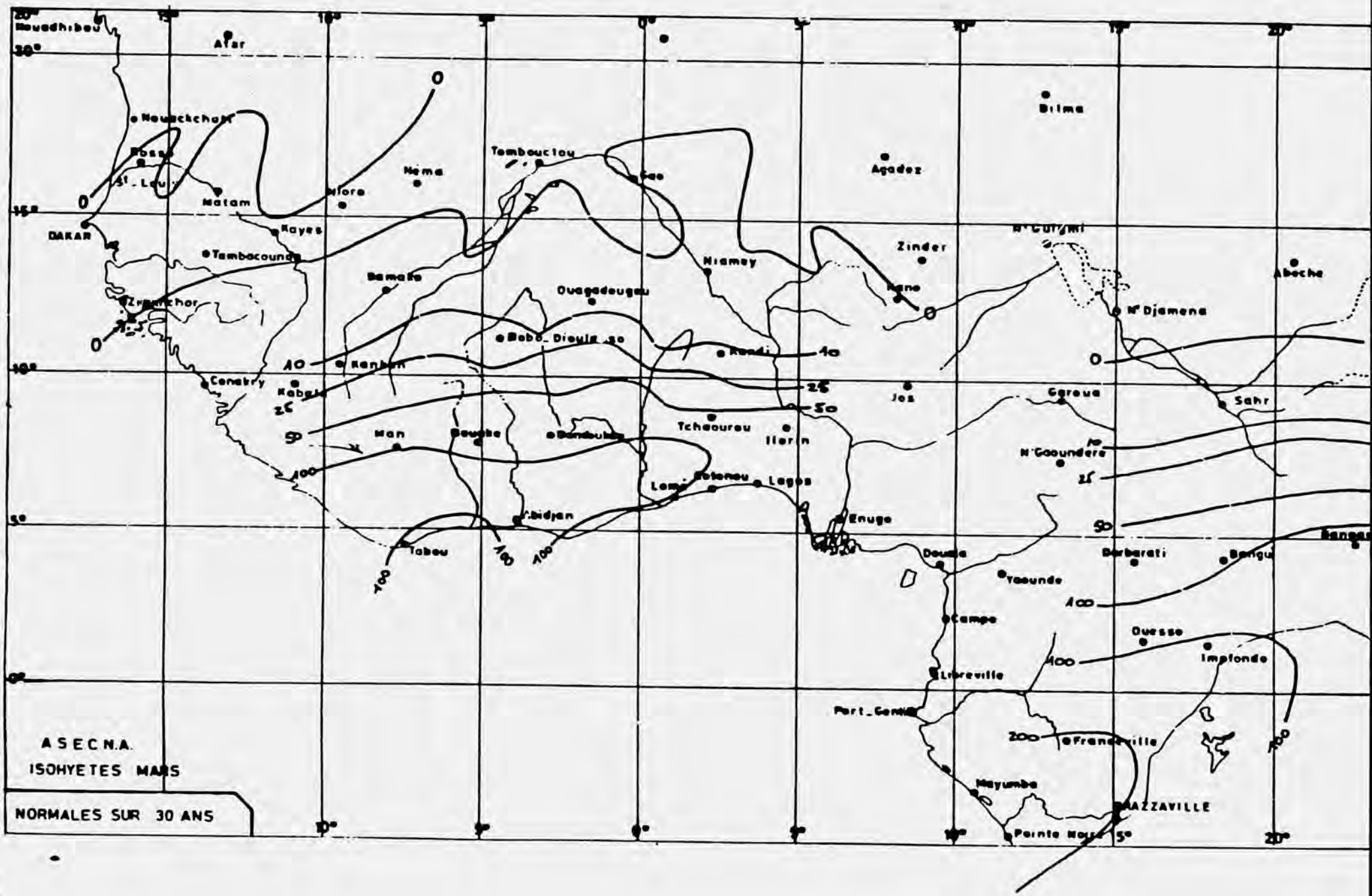
Figure 3.1.4 D

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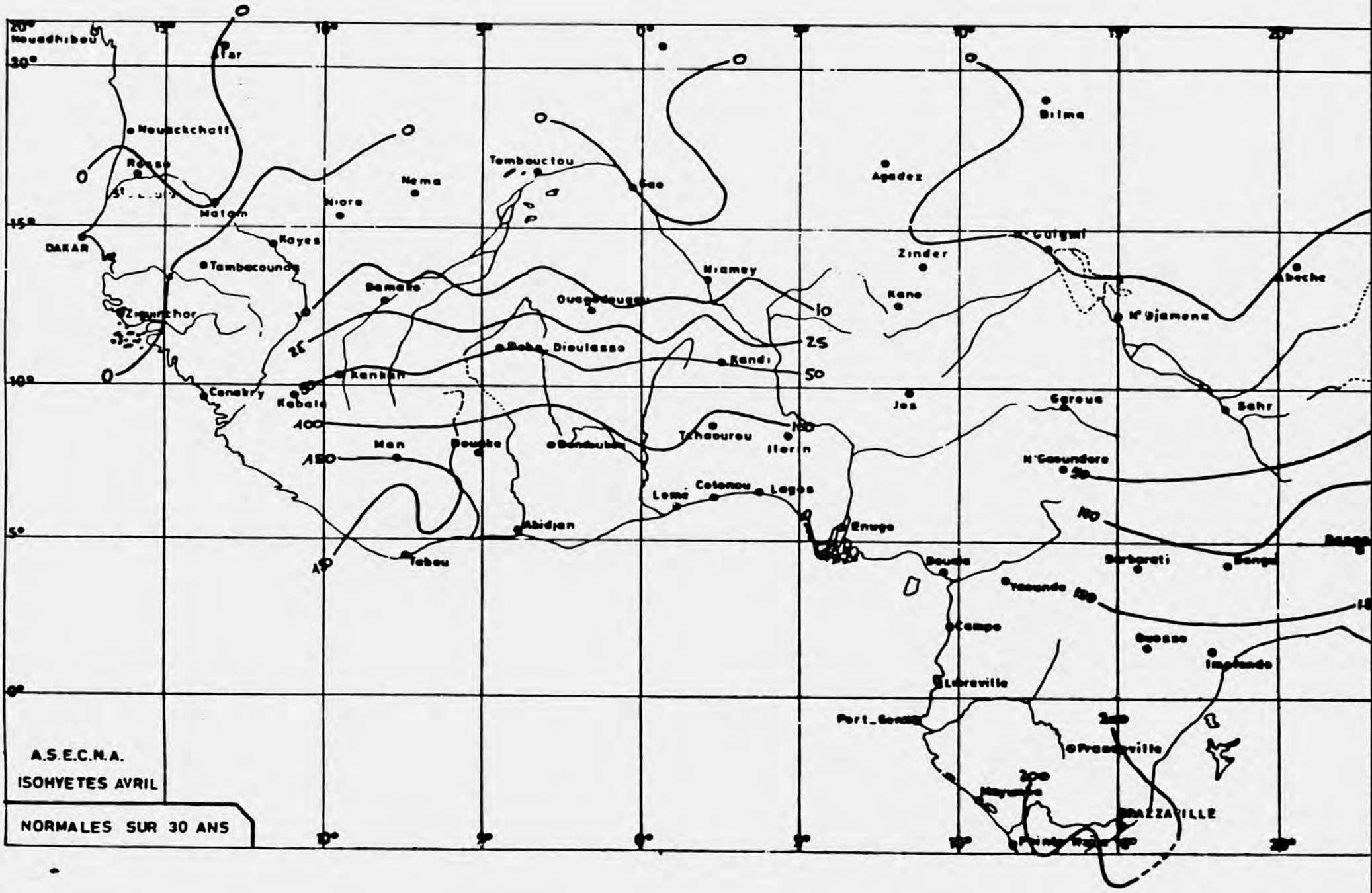


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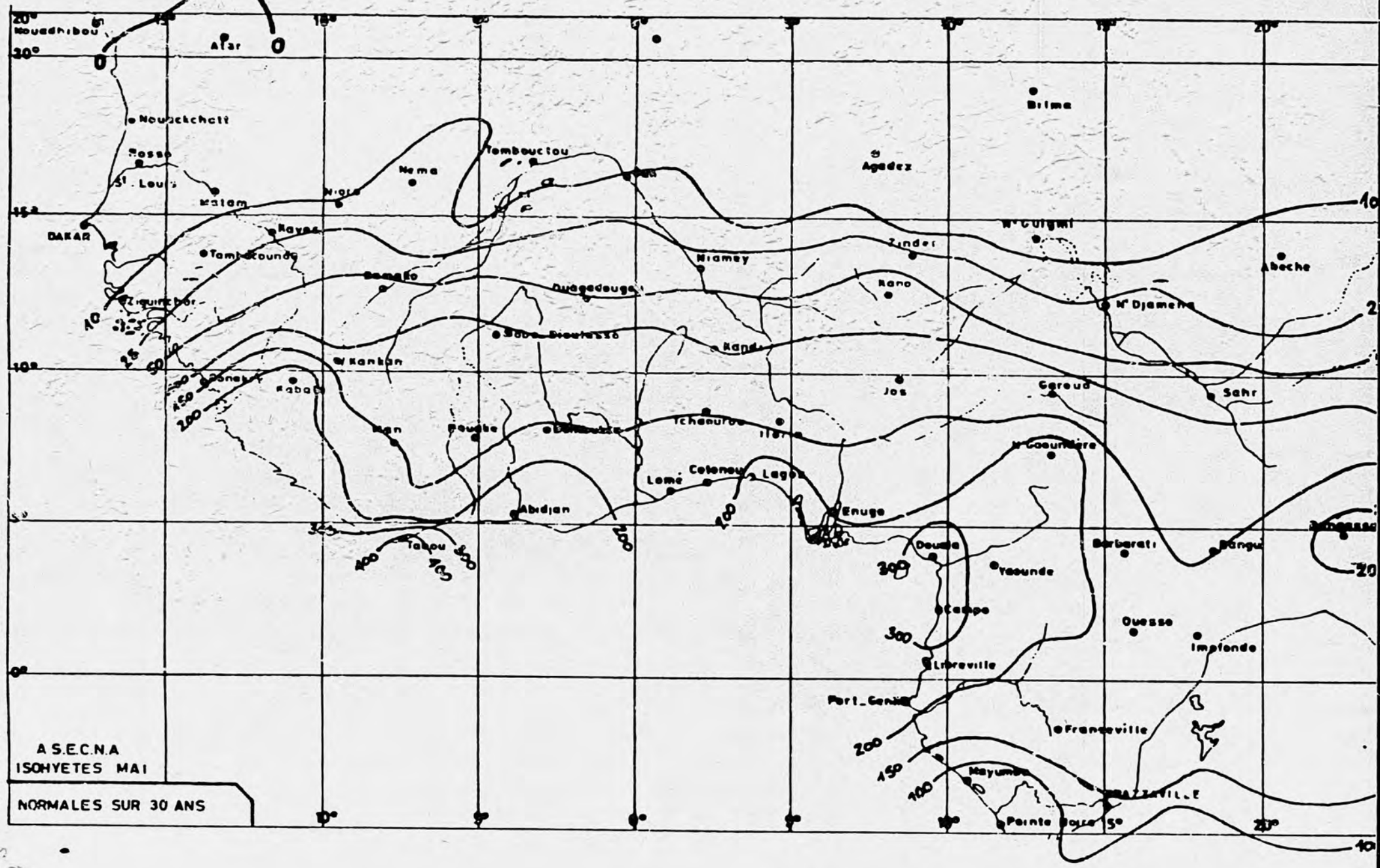


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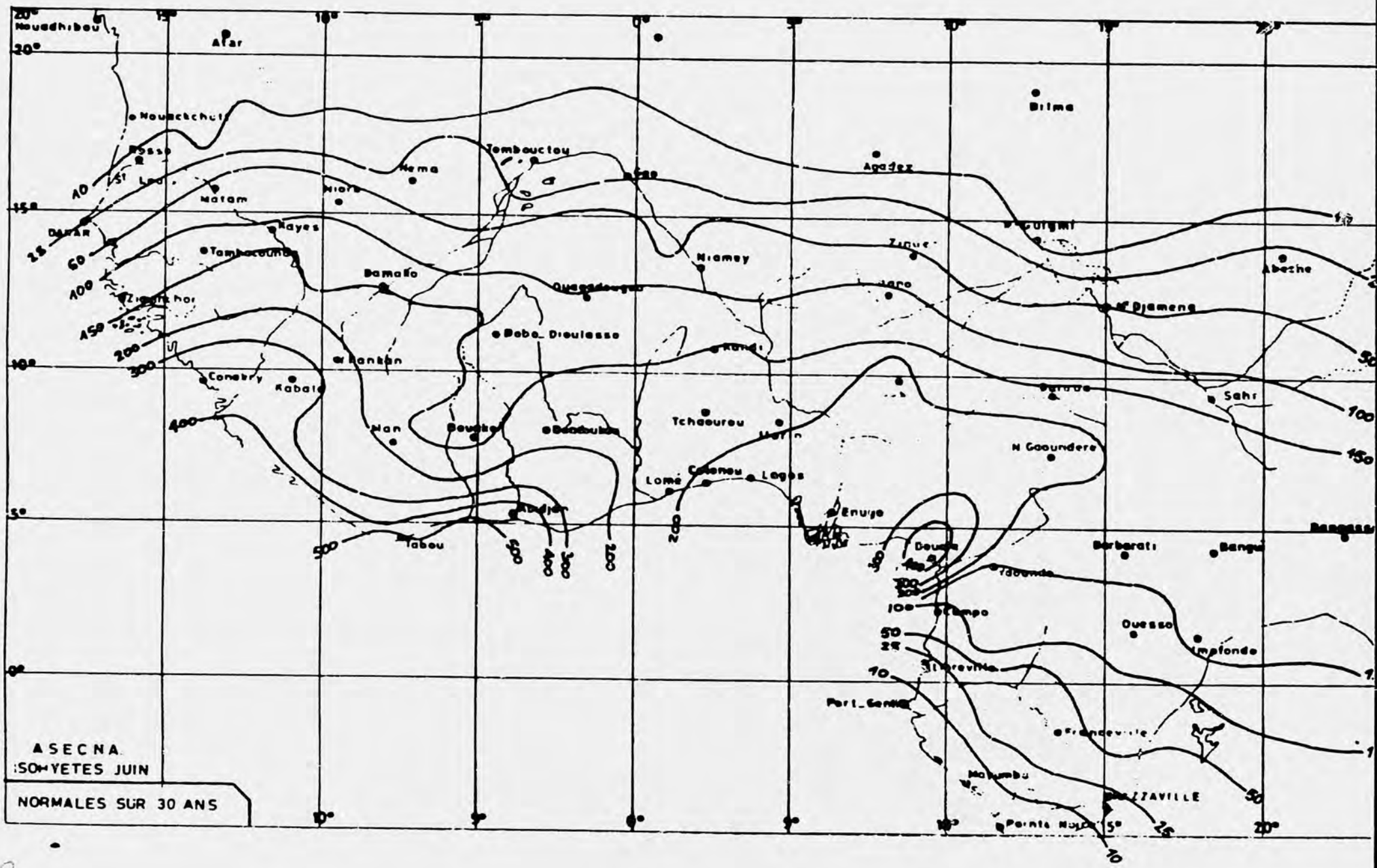


Annex - Figure 3.1.4.1 (F)

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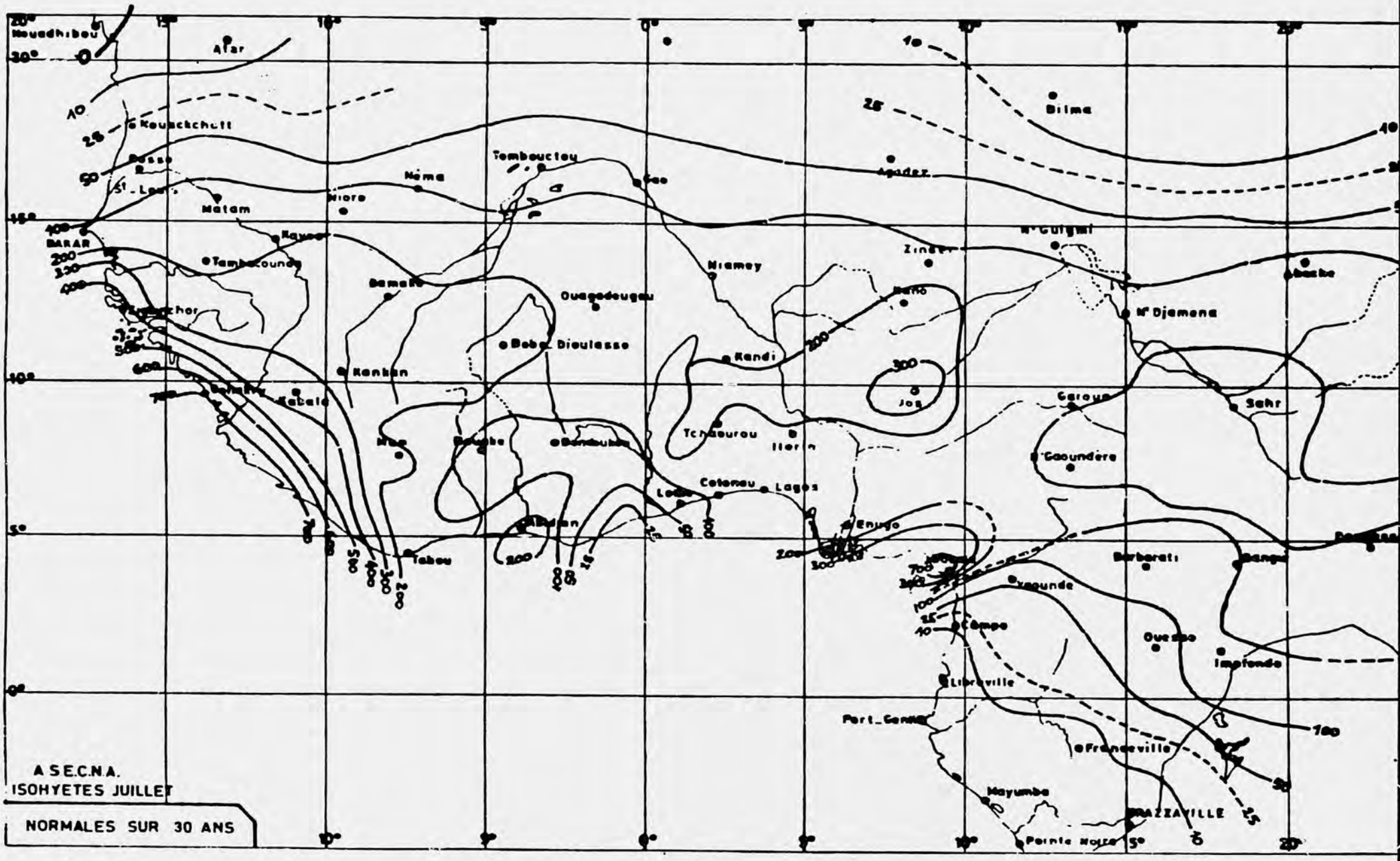


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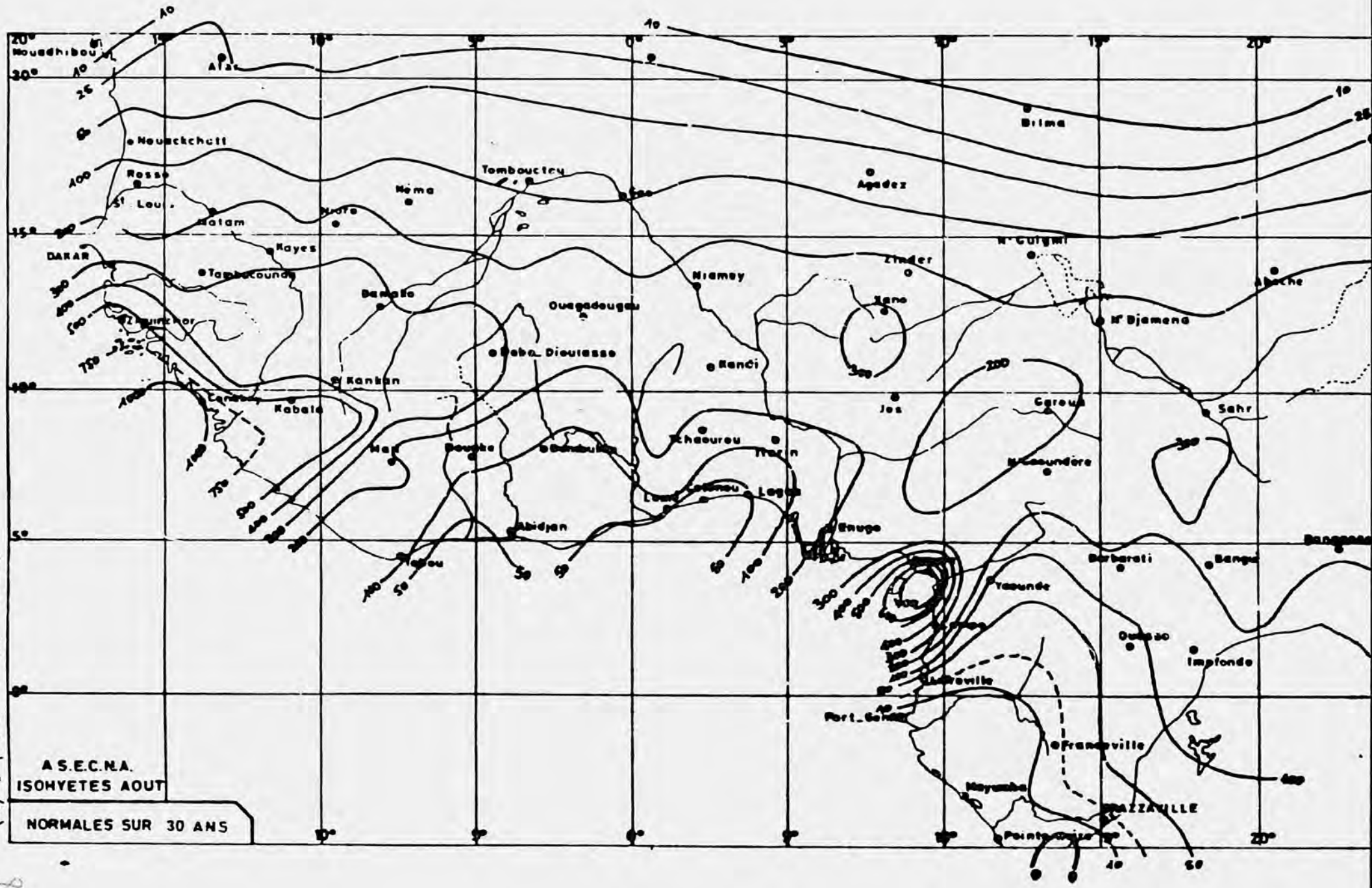
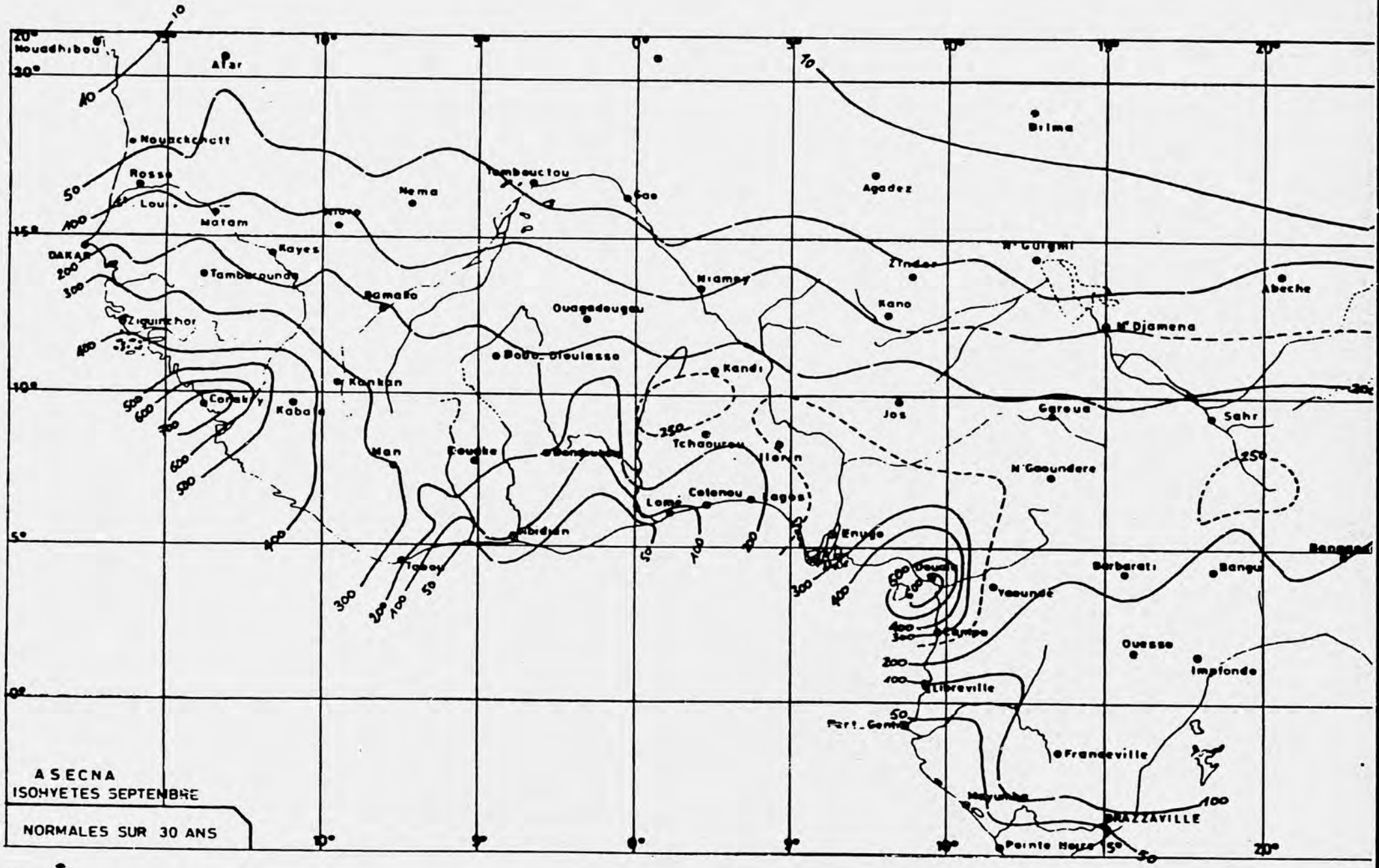



Annex - Figure 3.1.4.1 (H)

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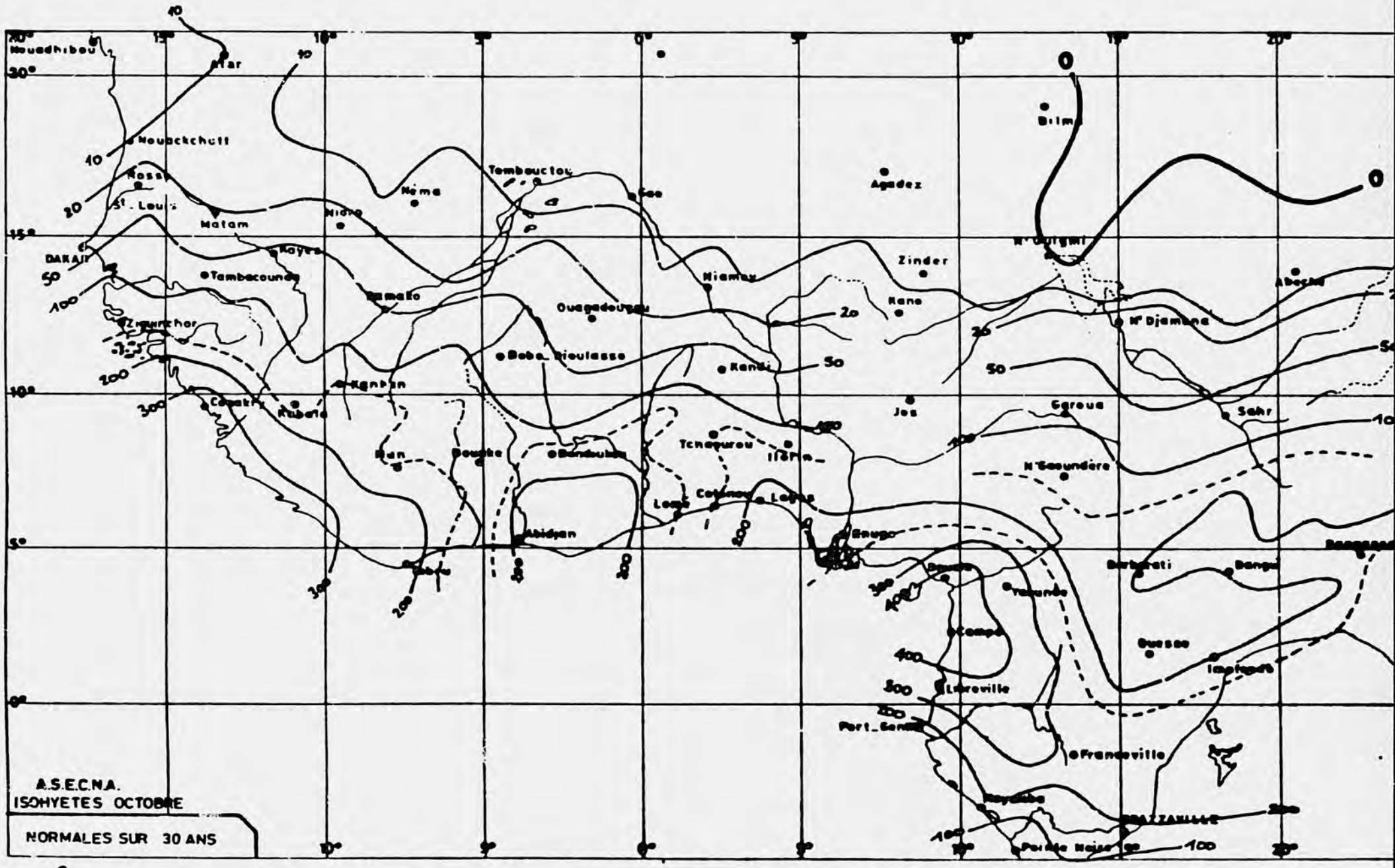


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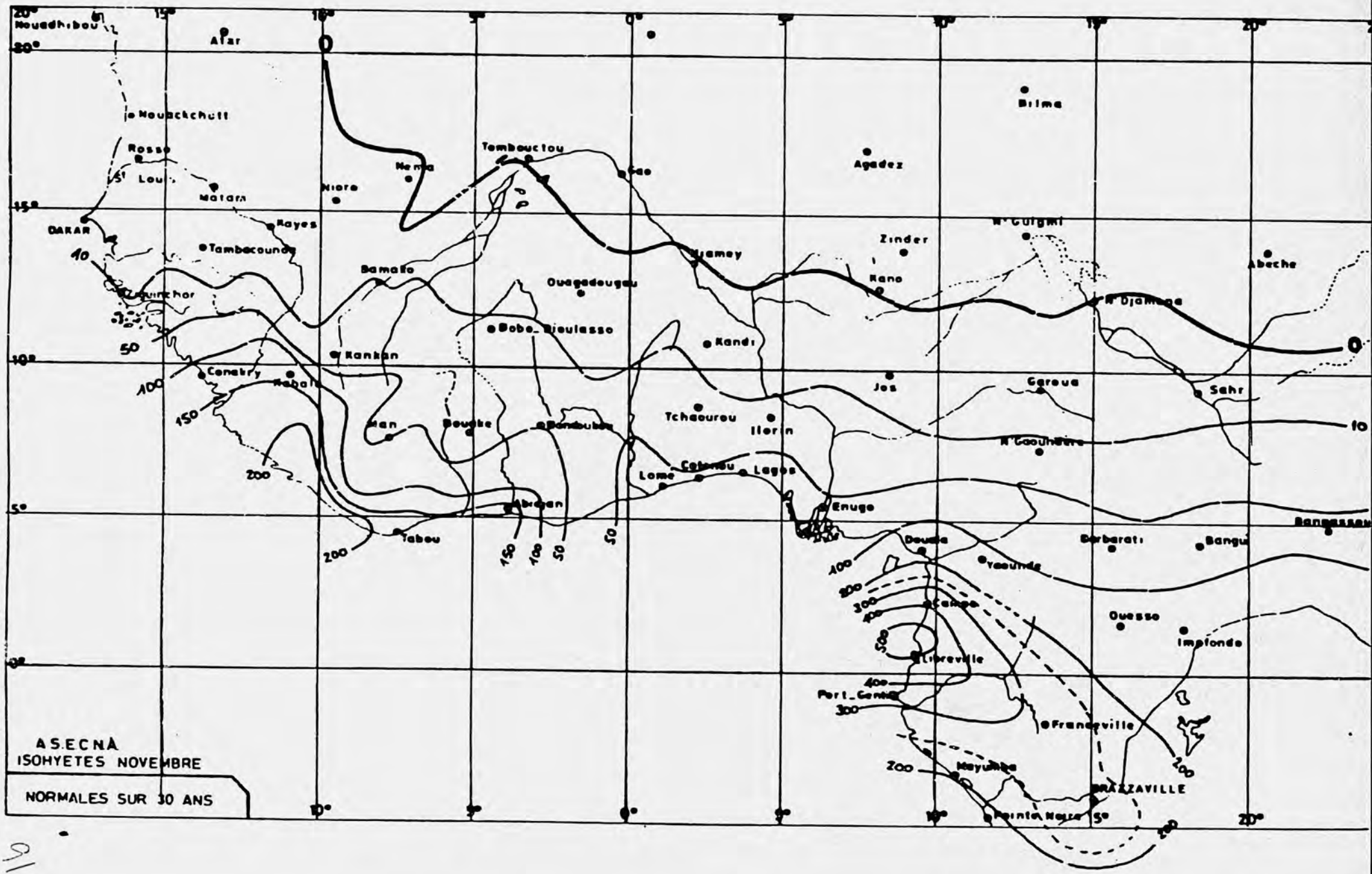
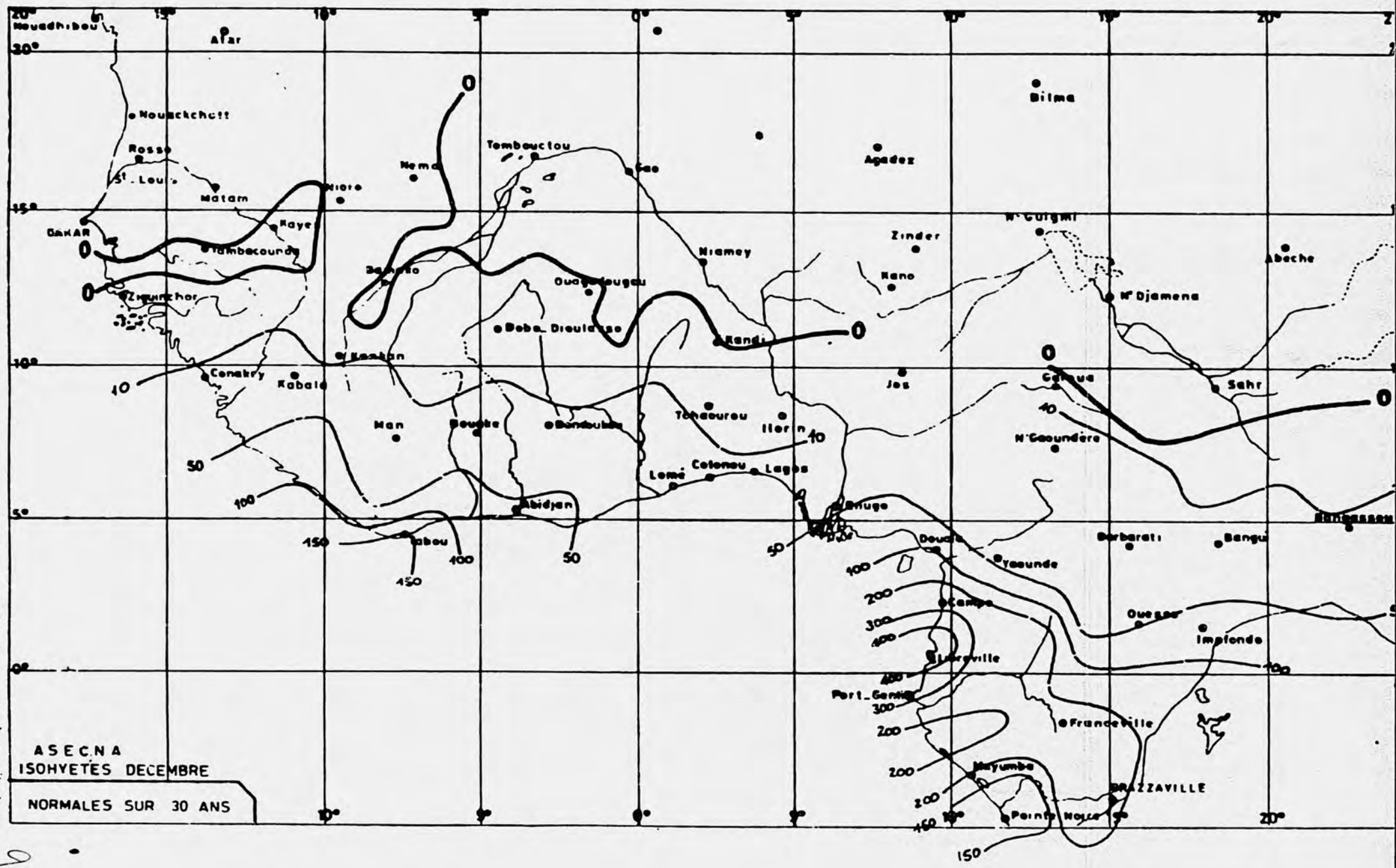



Annex - Figure 3.1.4.1 (f.)




Annex - Figure 3.1.4.1 (L)

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- CHAPTER 4 -

# AGRONOMIC AND SOILS CONSIDERATION


4.0. INTRODUCTION

4.1. SOILS INVENTORY

4.2. LABORATORY ANALYSIS OF SOILS SAMPLES

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2.2. Commentary and Conclusions on Soils Samples from Zone 2.
2.3. Commentary and Conclusions on Soils Samples from Zone 4.
2.4. Commentary and Conclusions on Soils Samples from Zone 5.
2.5. Commentary and Conclusions on Soils Samples from Zone 6.
2.6. Commentary and Conclusions on Soils Samples from Zone 7.
2.7. Commentary and Conclusions on Soils Samples from Zone 8.
2.8. General Observations on the Laboratory Analysis.

4.3. ADAPTATION AND AVAILABILITY OF SOILS

3.1. An Improved Soils Map
3.2. Zones Amenable to Rice culture
3.3. Availability for Development

4.4. AGRICULTURE IN THE ANAMBE BASIN

4.1. Crops and Yields
4.2. General crop production practices
4.3. Rice culture
4.4. Rice Research
4.5. Limitations in Land Productivity

4.5. SUMMARY OF AGRONOMIC AND SOILS CONSTRAINTS.

# AGROMOMIC AND SOILS CONSIDERATIONS

## 4.0. INTRODUCTION.

The SENERIZ project in the Anambe basin originally in the conceptualisation phase planned for the development of 30,000 hectares of cropland, of which the major portion would be devoted to rice cultivation.

Can this ambitious goal be achieved ? An answer to this question based only on the results of this soils study would be premature. The answer, on the basis of the different observations and data gathered, would seem to depend more on the hydraulic and human possibilities than on other factors.

From a strictly pedological viewpoint, constraints exist but in most cases they are not impossible to correct. Once corrections have been made, it is potentially possible to develop for the different proposed uses an area approching the planned 30,000 hectares. Naturally, these proposed uses are conceived in relation to soils-related, ecological, and other characteristics. The potentialities of the different zones and the agricultural practices and techniques for their optimum use are discussed in this chapter.

## 4.1. SOILS INVENTORY.

A general soil map published in the GERCA report Amenagements Hydro-Agricoles en Casamance et Haute Gambia (SCET -ILACO 1967) was the best source found for general soil group delineation and it was used as a basis for soil observations and sampling. Based on these observations and laboratory analysis of the samples, the GERCA soils map was revisal and corrected. This map is presented in annex 1. Description of the soil profiles are presented in annex 1 chapter.

Nine soil groups are shown on the SODAGRI soils map. Their descriptions are as follows :

Group 1. Leached tropical ferruginous soils with patches of precipitated free iron oxides.

Group 2. Soils with partial hydromorphia at lower levels : located on the lower glacis of the upland soils of the basin.

Group 3. Soils evolving to gley soils : located on the sandy lower glacis.

Group4a. Soils evolving to gley soils, coaser-textured.

Group4b. Soils evolving to gley soils, finer-textured.

Group 5. Pseudo-gley soils with a permanent deep underground water table.

Group 6. Pseudo-gley soils, with coarse surface texture.

Group 7. Pseudo-gley soils, with fine surface texture.

.../...

## 4.2. LABORATORY ANALYSIS OF SOILS SAMPLES

Samples taken from these various areas were analyzed in the laboratories of ORSTOM and ISRA. Analytical results are presented by soils group in the following section, with commentary and conclusions of the pedologists.

TABLE 1. Analytical Results of Soil

Samples from Zone 1. A : GRANULOMETRY

GRANULOMETRY IN %

| SAMPLE NUMBER AND HORIZON | Clay | Fine Silt | Coarse Silt | Fine Sand | Coarse Sand |
|---|---|---|---|---|---|
| 1A | 6.0 | 4.4 | 11.3 | 47.8 | 29.2 |
| 1B | 7.3 | 4.1 | 11.6 | 48.0 | 27.5 |
| 8A | 7.0 | 7.4 | 4.1 | 37.0 | 43.1 |
| 9A | 19.8 | 6.0 | 3.0 | 29.5 | 39.4 |
| 9A | 23 | 7.6 | 9.0 | 37.5 | 36.5 |
| 9B | 28.4 | 6.4 | 7.0 | 28.4 | 26.3 |
| 10A | 7.5 | 6.3 | 6.0 | 38.4 | 39.7 |
| 10B | 21.0 | 6.1 | 2.7 | 28.8 | 39.0 |
| 14A | 12.1 | 7.1 | 7.5 | 26.9 | 34.0 |

.../...

TABLE 1, continued (Zone 1)

B : PHYSICAL CHARACTERISTICS.

| Sample No. and Horizon | Moisture in % | Porosity in % | Permeability cm/h | Wilting Point 3[1] | Wilting Point 4.2 | Wilting Point 2.5 |
|---|---|---|---|---|---|---|
| 1A | 0.6 | - | 2.9 | 4.0 | 2.5 | 6.2 |
| 1B | 0.6 | - | 2.4 | 3.4 | 2.5 | 5.2 |
| 8A | 0.6 | 34.7 | 1.2 | 4.9 | 3.0 | 7.3 |
| 8B | 1.0 | 28.8 | 2.2 | 8.3 | 6.3 | 11.1 |
| 9A | 0.8 | 40.5 | 3.8 | 5.9 | 3.8 | 9.1 |
| 9B | 1.6 | 36.7 | 2.0 | 11.1 | 8.6 | 14.1 |
| 10A | 0.7 | 37.3 | 1.6 | 4.9 | 3.2 | 7.6 |
| 10B | 1.2 | 37.2 | 1.3 | 8.4 | 6.5 | 11.0 |
| 14A | 0.6 | 36.7 | 1.7 | 4.7 | 3.2 | 7.2 |
| 14B | 1.2 | 41.7 | 3.2 | 9.5 | 7.5 | 12.2 |

1 The values corresponding to the wilting points (p or point fletrissement) are the rates of available moisture in %, and thus represent field capacity.

TABLE 1, continued (Zone 1)

C : ORGANIC MATTER, PHOSPHORUS, IRON

| Sample No. and Horizon | Organic matter | Carbon : C | Nitrogen : N | C/N relationship |
|---|---|---|---|---|
| 1A | 0.9 | 5.00 | 0.36 | 14.2 |
| 1B | 0.3 | 1.56 | 0.13 | 12.0 |
| 8A | 1.1 | 6.20 | 0.47 | 13.2 |
| 8B | 0.5 | 2.92 | 0.26 | 11.2 |
| 9A | 1.3 | 7.30 | 0.46 | 15.9 |
| 9B | 0.9 | 5.40 | 0.40 | 13.5 |
| 10A | 1.0 | 6.00 | 0.38 | 15.8 |
| 10B | 0.9 | 5.32 | 0.37 | 14,4 |
| 14A | 0.9 | 5.00 | 0.32 | 15.6 |
| 14B | 0.6 | 3.32 | 0.28 | 11.9 |

| | Total Phosphorus | Total $P_2O_5$ | Available $P_2O_5$ |
|---|---|---|---|
| 1A | | 0.100 | 0.009 |
| 1B | | 0.120 | 0.009 |
| 8A | | 0.260 | 0.007 |
| 8B | | 0.150 | 0.004 |
| 9A | | 0.235 | 0.041 |
| 9B | | 0.180 | 0.09 |
| 10A | | 0.135 | 0.047 |
| 10B | | 0.205 | 0.006 |
| 14A | | 0.165 | 0.039 |
| 14B | | 0.085 | 0.009 |

| | Total Iron | Total $Fe_2O_3$ | Free $Fe_2O_3$ |
|---|---|---|---|
| 1A | | 0.46 | 0.21 |
| 1B | | 0.39 | 0.19 |
| 8A | | 0.78 | 0.38 |
| 8B | | 1.00 | 0.58 |
| 9A | | 1.05 | 0.89 |
| 9B | | 1.9[illegible] | 1.64 |
| 10A | | 1.48 | 1.22 |
| 10B | | 2.12 | 1.67 |
| 14A | | 0.95 | 0.49 |
| 14B | | 1.24 | 0.72 |

.../...

TABLE 1, concluded (Zone 1)

D : EXCHANGEABLE CATIONS, CATIONIC EXCHANGE

| Sample Number and Horizon | EXCHANGEABLE CATIONS: Ca ++ | Mg ++ | K + | Na+ | Sum : S |
|---|---|---|---|---|---|
| 1A | 1.33 | 0.23 | 0.02 | 0.03 | 1.61 |
| 1B | 0.93 | 0.18 | 0.01 | 0.02 | 1.14 |
| 8A | 1.85 | 0.33 | 0.05 | 0.03 | 2.26 |
| 8B | 1.00 | 0.80 | 0.05 | 0.01 | 1.86 |
| 9A | 1.94 | 0.93 | 0.18 | 0.02 | 3.07 |
| 9B | 1.50 | 0.75 | 0.5 | 0.03 | 2.78 |
| 10A | 1.00 | 0.50 | 0.27 | 0.03 | 1.80 |
| 10B | 0.78 | 0.70 | 0.19 | 0.04 | 1.71 |
| 14A | 0.48 | 0.35 | 0.09 | 0.03 | 0.35 |
| 14B | 0.40 | 0.38 | 0.03 | 0.03 | 0.92 |

| | T: Exchange capacity | % S/T | pH water | pH KCl |
|---|---|---|---|---|
| 1A | 2.70 | 60 | 5.3 | 4.5 |
| 1B | 3.80 | 30 | 5.8 | 4.6 |
| 8A | 2.30 | 78 | 6.4 | 5.6 |
| 8B | 4.00 | 47 | 7.1 | 5.6 |
| 9A | 5.50 | 56 | 7.0 | 5.9 |
| 9B | 4.20 | 66 | 6.7 | 5.1 |
| 10A | 2.90 | 62 | 6.6 | 5.3 |
| 10B | 3.70 | 46 | 5.6 | 4.4 |
| 14A | 3.20 | 30 | 5.6 | 4.6 |
| 14B | 3.60 | 36 | 5.1 | 4.2 |

.../...

4.2.1.. Commentary and Conclusions on Soil Samples from Zone 1.

The examination of the different characteristics of these soils which appear in Table 1A through 1B reveals the following :

1- Their texture is essentially silty to clayey sand. The surface texture is silty sand, where the clay present does not exceed 8%. But once into B horizon (between 40 and 60 cm in depth), the amount of clay present reaches 20 to 30%.Differences (without, however, statistical value) do exist between the textural classes, according to whether the samples were taken in millet fields, in peanut fields, or in cotton fields.

Thus, the sample which was taken from a millet field appears to be richer in clay : almost 28.4% in the B horizon.

2- In conformity with their nature as described above,these soils are fairly permeable, with average porosity. Both of proporties diminish at deeper levels. It should be noted as well that the field capacity, the usable (or available) moisture, and the permanent wilting point exhibit the pattern expected from the more clayey nature of the B horizon, which at the same W.P. (wilting point - same suction) retains more water than the A horizon.

3- The soils of Zone 1 are not fundamantally lacking biochemical influences. Thus, in comparison to the "dior" and beige soils of Senegal studied by Nicou in 1975,[1] the amounts of carbon(C) and Nitrogen (N) present are fairly great.

1. Nicou, R. "Caracteristiques principales des sols sableux et sablo-argileux du Senegal : problemes agronomiques de leur mise en valeur" D.G.R.S.T. - C.N.R.A., 1975, p.9.

At the surface level, the amount of carbon varies from 8 to 5%, and the amount of nitrogen varies from 0.47 to 0.36%. Nicou gives values which range from 0.12 to less than 2% for carbon, and from 0.82 to 0.15% for nitrogen.

Naturally, these values decrease at deeper levels, due to the lessened influence of the organic matter.

The carbon/nitrogen relationship, which varies from 16 to 12 for the different samples tested, may be considerd as average, considering the rapid decomposition of organic matter in tropical soils.

On the other hand, the amount of phosphororus presnt bears witness to the reputation of these soils for being extremely poor in this element. Thus, the values found for available $P_2O_5$ less than (0.05%) are clearly lower than average values mentioned by Nicou[1], although Nicou somestimes shows which are less than 50%.

The values obtained for potassium are comparable to the values shown by Nicou (between 0.03 and 0.20 meq/100 g).

Elsewhere, the weakness of the cationic exchange capacity, which barely reaches 5.5 meq/100 g, reflects the relative poverty of these soils in clay, whose kaolinitic nature accentuate this property.

The relatively high amount of exchangeable calcium, about 2 meq/100 g, respects the general tendency of neutral-pH soils with an average saturation rate of generally less than 80% but greater than 25%.

1. R. Nicou, op. cit., p.9.

.../...

As for the values shown for the amount of iron present, they seem to be normal for these soils, but are rather high in relation to the very small plant needs for this element.

Conclusions on the soils of Zone 1

The characteristics surveyed for these soils, which are essentially sandy-silt in nature, show their relative poverty from both the hydraulic and the chemical viewpoints. These two faults constitute two limiting factors, which, however, are not impossible to correct. This topic will be taken up in the section on agronomic recommendations.

~~TABLE 2: ANALYTICAL RESULTS OF SOILS~~ SAMPLES FROM ZONE 2.

~~A : GRANULOMETRY.~~

GRANULOMETRY IN %

| Sample Number And Horizon | Clay 2 | Silt 2-20 | Sand 20-50 | Sand 50-200 | Sand 200-2000 |
|---|---|---|---|---|---|
| 32A | 7.8 | 3.8 | 13.0 | 44.7 | 30.2 |
| 32B | 14.8 | 6.8 | 11.9 | 36.5 | 30.0 |
| 33A | 11.3 | 5.5 | 25.6 | 39.4 | 17.4 |
| 33B | 12.5 | 6.0 | 12.2 | 31.1 | 38 |
| 34A | 22.5 | 10.8 | 22.3 | 29.7 | 14.0 |
| 34B | 21.5 | 10.3 | 17.9 | 31.0 | 19.2 |
| 35A | 6.8 | 3.3 | 15.9 | 41.9 | 31.8 |
| 35B | 9.5 | 4.8 | 15.1 | 43.9 | 26.6 |
| 36A | 8.8 | 3.8 | 15.6 | 40.3 | 32.0 |
| 36B | 11.8 | 5.8 | 16.4 | 37.9 | 28.0 |

TABLE 2.,continued (Zone2)

B : PHYSICAL CARACTERISTICS.

| Sample Number And Horizon | Moisture | Porosity | Permeability | Wilting point 4.2 | Wilting point 3.0 | Wilting point 2.5 |
|---|---|---|---|---|---|---|
| 32A | | | | 1.9 | 5.7 | 8.3 |
| 32B | | | | 4.6 | 9.1 | 11.4 |
| 33A | | | | 2.5 | 9.6 | 14.4 |
| 33B | | | | 3.7 | 9.2 | 10.7 |
| 34A | | | | 5.7 | 17.4 | 20.5 |
| 34B | | | | 5.8 | 14.1 | 17.2 |
| 35A | | | | 1.8 | 4.7 | 7.7 |
| 35B | | | | 2.7 | 5.7 | 8.7 |
| 36A | | | | 2.0 | 5.5 | 9.2 |
| 36B | | | | 3.2 | 6.8 | 10.4 |

.../...

TABLE 2. continued (Zone 2)

C : ORGANIC MATTER, PHOSPHORUS, IRON.

| Sample Number And Horizon | Organic matter Carbon : C | Nitrogen : N | C/N relationship |
|---|---|---|---|
| 32A | 3.68 | 0.48 | 12 |
| 32B | 1.50 | 0.26 | 6 |
| 33A | 6.54 | 0.59 | 11 |
| 33B | 1.39 | 0.23 | 6 |
| 34A | 8.09 | 0.73 | 11 |
| 34B | 1.37 | 0.27 | 5 |
| 35A | 4.97 | 0.43 | 12 |
| 35B | 1.28 | 0.11 | 8 |
| 36A | 6.18 | 0.54 | 11 |
| 36B | 2.17 | 0.23 | 9 |

| Sample Number And Horizon | Total Phosphorus Total $P_2O_5$ | Available $P_2O_5$ (ppm) |
|---|---|---|
| 32A | 0.17 | 4 |
| 32B | 0.15 | 5 |
| 33A | 0.15 | 8 |
| 33B | 0.17 | 6 |
| 34A | 0.15 | 9 |
| 34B | 0.15 | 4 |
| 35A | 0.17 | 4 |
| 35B | 0.07 | 4 |
| 36A | 0.17 | 6 |
| 36B | 0.12 | 2 |

| Sample Number And Horizon | Total Iron Total $Fe_2O_3$ | Free $Fe_2O_3$ |
|---|---|---|
| 32A | 4.[illegible] | 1.4 |
| 32B | 5.8 | 1.8 |
| 33A | 3.6 | 1.0 |
| 33B | 8.3 | 4.1 |
| 34A | 7.2 | 2.4 |
| 34B | 9.7 | 3.8 |
| 35A | 3.6 | 1.8 |
| 35B | 3.8 | 1.4 |
| 36A | 3.8 | 2.2 |
| 36B | 5.3 | 2.8 |

.../...

TABLE 2., concluded (Zone 2)

D : EXCHANGEABLE CATIONS, CATIONIC EXCHANGE CAPACITY, pH.

| Sample Number And Horizon | Exchangeable cations : Ca ++ | Mg ++ | K + | Na + | Sum : S |
|---|---|---|---|---|---|
| 32A | 1.36 | 0.18 | 0.03 | 0.006 | 1.58 |
| 32B | 0.64 | 0.46 | 0.02 | 0.06 | 1.18 |
| 33A | 1.64 | 0.28 | 0.06 | 0.06 | 2.04 |
| 33B | 1.56 | 0.54 | 0.03 | 0.02 | 2.15 |
| 34A | 3.98 | 0.90 | 0.08 | 0.04 | 5.00 |
| 34B | 2.46 | 0.52 | 0.03 | 0.08 | 1.09 |
| 35A | 1.42 | 0.38 | 0.004 | 0.05 | 1.85 |
| 35B | 0.58 | 0.12 | 0.004 | 0.02 | 0.72 |
| 36A | 0.98 | 0.28 | 0.04 | 0.14 | 1.44 |
| 36B | 0.62 | 0.22 | 0.09 | 0.04 | 0.89 |

| | Exchange cap. : T | % S/T | pH water | pH Kcl |
|---|---|---|---|---|
| 32A | 2.2 | 72 | 6.3 | 5.4 |
| 32B | 2.0 | 89 | 5.8 | 4.5 |
| 33A | 2.70 | 76 | 5.8 | 4.9 |
| 33B | 2.60 | 83 | 6.2 | 4.8 |
| 34A | 7.0 | 71 | 6.0 | 4.8 |
| 34B | 6.30 | 58 | 6.0 | 4.3 |
| 35A | 2.20 | 84 | 6.3 | 5.5 |
| 35B | 1.80 | 40 | 5.5 | 4.3 |
| 36A | 2.0 | 72 | 6.2 | 5.3 |
| 36B | 2.20 | 40 | 5.1 | 4.3 |

.../...

4.2.2. Commentary of Soil Samples from Zone 2.

The soils of Zone 2, from the study of the analytical results, present essentially a slightly clayey sand texture, except for Sample 34, which has a good amount of clay present.

The available moisture at the different Wilting Points (W.P.) conforms to the fairly coarse of the soil, with moderatly good water retention.

The cationic exchange capacity, which fluctuates around 2 to 3 and is never higher than 7, is consistent with the small clay content and probably also with the nature of the soil.

These soils of Zone 2 show an average amount of carbon present at the surface level, and a very small amount at the deeper level. As to the amount of potassium and phosphorus present, they are both very small for these soils.

The pH remains comparable to the pH values presented by the other soils, that is, acidic soils with a neutral tendency.

.../...

TABLE 3 . ANALYTICAL RESULTS OF SOIL SAMPLES FROM ZONE 4.

A : GRANULOMETRY.

GRANULOMETRY IN %

| Sample Number And Horizon | Clay | Fine silt | Coarse silt | Fine sand | Coarse sand |
|---|---|---|---|---|---|
| 4A | 7.5 | 24.0 | 20.6 | 34.4 | 10.2 |
| 4B | 31.5 | 19.4 | 5.9 | 22.3 | 20.0 |
| 5A | 8.0 | 18.3 | 19.6 | 31.6 | 21.4 |
| 5B | 19.1 | 17.4 | 9.1 | 30.8 | 20.5 |
| 15A | 7.0 | 12.0 | 13.7 | 42.9 | 22.2 |
| 15B | 8.8 | 14.1 | 13.9 | 40.3 | 20.9 |
| 16A | 10.5 | 12.3 | 10.0 | 38.2 | 28.0 |
| 16B | 27.9 | 11.1 | 9.7 | 22.6 | 25.2 |

TABLE 3. Continued. (Zone 4A)

B. : PHYSICAL CHARACTERISTICS.

| Sample Number And Horizon | Moisture in % | Porosity in 5 | Permeability in cm/h | Wilting point:3 | Wilting point.4.2 | Wilting point 2.5 |
|---|---|---|---|---|---|---|
| 4A | 1.1 | - | 0.7 | 12.8 | 3.0 | 19.7 |
| 4B | 0.9 | 19.0 | 0.2 | 15.2 | 11.3 | 20.6 |
| 5A | 0.8 | 30.5 | 0.5 | 8.9 | 3.5 | 13.5 |
| 5B | 1.4 | - | 1.0 | 10.1 | 5.7 | 14.5 |
| 15A | 0.9 | 39.0 | 1.3 | 6.6 | 3.4 | 11.2 |
| 15B | 0.8 | 35.7 | 0.8 | 6.1 | 3.5 | 10.9 |
| 16A | 0.9 | 34.7 | 1.0 | 6.6 | 3.5 | 10.5 |
| 16B | 2.6 | 33.2 | 1.3 | 11.3 | 8.0 | 15.5 |

.../...

TABLE 3, Continued (Zone 4).

C : ORGANIC MATTER, PHOSPHORUS, IRON.

%

| Sample Number And Horizon | Organic matter | Carbon C | Nitrogen N | C/N relationship |
|---|---|---|---|---|
| 4A | 1.7 | 9.60 | 0.67 | 14.3 |
| 4B | 0.4 | 2,40 | 0.20 | 12.0 |
| 5A | 1.4 | 8.10 | 0.46 | 17.6 |
| 5B | 0.5 | 2.88 | 0.26 | 11.1 |
| 15A | 1.3 | 7.4 | 0.46 | 16.1 |
| 15B | 0.3 | 2.00 | 0.19 | 10.5 |
| 16A | 1.0 | 5.70 | 0.43 | 13.3 |
| 16B | 0.5 | 3.08 | 0.27 | 11.4 |

| | Total Phosphorus | Total $P_2O_5$ | Available $P_2O_5$ |
|---|---|---|---|
| 4A | | 0.105 | 0.17 |
| 4B | | 0.070 | 0.007 |
| 5A | | 0.105 | 0.010 |
| 5B | | 0.090 | 0.014 |
| 15A | | 0.120 | 0.009 |
| 15B | | 0.885 | 0.001 |
| 16A | | 0.115 | 0.009 |
| 16B | | 0.050 | 0.001 |

| | Total Iron | Total $Fe_2O_3$ | Free $Fe_2O_3$ |
|---|---|---|---|
| 4A | | 0.48 | 0.09 |
| 4B | | 1.62 | 0.67 |
| 5A | | 0.43 | 0.12 |
| 5B | | 0.67 | 0.27 |
| 15A | | 0.74 | 0.07 |
| 15B | | 0.31 | 0.10 |
| 16A | | 0.40 | 0.15 |
| 16B | | 0.93 | 0.61 |

.../...

TABLE 3. Concluded. (Zone 4)

D : EXCHANGEABLE CATIONS, CATIONIC EXCHANGE CAPACITY, pH

| Sample Number And Horizon | Exchangeable cations : Ca + + | Mg + + | K + | Na + | Sum : S |
|---|---|---|---|---|---|
| 4A | 2.28 | 0.50 | 0.09 | 0.04 | 2.91 |
| 4B | 5.90 | 1.80 | 0.09 | 0.17 | 8.96 |
| 5A | 1.41 | 0.44 | 0.06 | 0.03 | 1.94 |
| 5B | 1.08 | 0.48 | 0.05 | 0.03 | 1.64 |
| 15A | 3.34 | 0.69 | 0.05 | 0.06 | 4.14 |
| 15B | 0.92 | 0.44 | 0.06 | 0.03 | 1.45 |
| 16A | 1.77 | 0.65 | 0.04 | 0.04 | 0.06 |
| 16B | 2.30 | 1.15 | 0.02 | 0.06 | 4.13 |

| Sample Number And Horizon | Exchange cap. : T | % S/T | pH water | pH KCl |
|---|---|---|---|---|
| 4A | 3.30 | 88 | 6.1 | 4.9 |
| 4B | 10.00 | 90 | 6.4 | 4.5 |
| 5A | 3.00 | 65 | 5.9 | 4.8 |
| 5B | 3.00 | 55 | 5.4 | 4.2 |
| 15A | 4.50 | 92 | 7.1 | 6.1 |
| 15B | 1.70 | 85 | 6.5 | 5.0 |
| 16A | 3.30 | 64 | 6.2 | 5.0 |
| 16B | 5.10 | 48 | 6.5 | 4.0 |

.../...

### 4.2.3. Commentary and Conclusions on Soil Samples from Zone 4.

The soils of Zone 4 like the soils of Zone 1, have more clay in the B horizon than in the A horizon. Although the percentage of clay at both levels is practically the same as the percentage found for the soils of Zone 1, the percentage of fine and coarse silt appears to be much higher for the soils of Zone 4. Thus, there is an evolution of the texture here to sandy-to-clayey silt.

This texture does not seem to affect very much the porosity of these soils in comparison to the soils of Zone 1. The porosity remains practically the same, that is to say, average - between about 20 and 40%. Nevertheless, as the texture here is less sandy, the permeability of the soils of Zone 4 drops, and varies between 0.2 and 1.3 cm/h.

This finer nature of the soil texture also means better water retention by these soils. Thus, field capacity almost never drops below 10%, while the wilting point of these soils varies between a minimum of 3.0% and a maximum of 11%. However, these results, even if they do show the general tendency, are not perfectly homogenous.

Thus, differences of 10% may exist between the A horizons of two different samples from the same zone.

Elswhere, it must be noted that the soils of Zone 4 seem to be richer in surface organic matter than those of Zone 1. Thus, the amount of carbon present here varies from about 10% to 6%, whereas it did not reach 8% in Zone 1.

.../...

The amounts of carbon and nitrogen present and the C/N relationship, however, remain comparable to the amounts found for the beige and "dior" soils of Senegal which were already mentioned.

Iron, just as in the soils of Zone 1, is present in larger quantities in the B horizon than in the A horizon, with the relationship between them from 1.5 to 7.5.

Considering the amount of cations present, the soils of Zone 4, like those of Zone 1, are comparable to other soils, without changes in the acidic tendency of the soils. The values for exchangeable calcium (Ca) vary between 3.34 meq/100 g and almost .meq/100 g, whereas for certain profiles, the cationic exchange capacity reaches 10 meq/100 g. This factor should be placed in the context of the greater influence of organic matter on these soils. As far as the nature of clay present is concerned, its influence is certainly less marked.

Conclusions on the Soils of Zone 4.

Compared to the soils of Zone 1, the soils of Zone 4 seem to be potentially more productive. Their finer texture, their water retention properties, and their richer chemical composition are all factors whith work together in favor of this greater potential productivity.

.../...

TABLE 4. ANALYTICAL RESULTS OF SOILS SAMPLES FROM ZONE 5 -

A : GRANULOMETRY.

| Sample Number And Horizon | Clay | Fine silt | Coarse silt | Fine sand | Coarse sand |
|---|---|---|---|---|---|
| 11A | 10.5 | 9.8 | 12.5 | 43.5 | 21.2 |
| 11B | 43.5 | 10.0 | 10.5 | 20.8 | 10.1 |
| 12A | 6.9 | 8.9 | 13.5 | 49.8 | 18.6 |
| 12B | 1.59 | 8.6 | 13,6 | 41.9 | 17.6 |

TABLE 4, continued (Zone 5)

B : PHYSICAL CHARACTERISTICS.

| Sample Number And Horizon | Moisture in % | Porosity in % | Permeability in cm/h | Wilting point 3 | Wilting point4.2 | Wilting point2.5 |
|---|---|---|---|---|---|---|
| 11A | 1.0 | 30.2 | 0.7 | 7.2 | 3.9 | 10.4 |
| 11B | 4.0 | 38.4 | 3.4 | 16.3 | 12.4 | 20.2 |
| 12A | 0.7 | 32.8 | 2.1 | 5.6 | 3.2 | 9.7 |
| 12B | 1.3 | 37.5 | 2.5 | 7.9 | 5.5 | 11.6 |

1. Wilting point : Field capacity

TABLE 4, Continued (Zone 5).

C : ORGANIC MATTER, PHOSPHORUS, IRON.

| Sample Number And Horizon | Organic matter | % Carbon C | Nitogen N | C/N relationship |
|---|---|---|---|---|
| 11A | 1.4 | 8.10 | 0.48 | 16.9 |
| 11B | 0.7 | 4.24 | 0.46 | 9.2 |
| 12A | 1.4 | 8.00 | 0.46 | 17.4 |
| 12B | 1.1 | 6.10 | 0.41 | 14.9 |

| | Total Phosphorus | Total $P_2O_5$ | Available $P_2O_5$ |
|---|---|---|---|
| 11A | | 0.115 | 0.006 |
| 11B | | 0.140 | 0.003 |
| 12A | | 0.080 | 0.009 |
| 12B | | 0.110 | 0.004 |

| | Total Iron | Total $Fe_2O_3$ | Free $Fe_2O_3$ |
|---|---|---|---|
| 11A | | 0.50 | 0.25 |
| 11B | | 0.20 | 0.90 |
| 12A | | 0.49 | 0.20 |
| 12B | | 0.75 | 0.38 |

TABLE 4, Concluded (Zone 5).

D : EXCHANGEABLE CATIONS, CATIONIC EXCHANGE CAPACITY, pH

| Sample Number And Horizon | Exchangeable cations : Ca ++ | Mg ++ | K + | Na + | Sum : S |
|---|---|---|---|---|---|
| 11A | 1.33 | 0.59 | 0.05 | 0.04 | 2.01 |
| 11B | 2.28 | 0.15 | 0.04 | 0.11 | 2.58 |
| 12A | 1.33 | 0.62 | 0.26 | 0.03 | 2.24 |
| 12B | 0.78 | 0.12 | 0.12 | 0.04 | 0.38 |

| | Exchange cap. : T | %S/T | pH water | pH KCL |
|---|---|---|---|---|
| 11A | 3.40 | 59 | 6.0 | 4.7 |
| 11B | 5.30 | 49 | 5.6 | 4.1 |
| 12A | 2.70 | 83 | 6.4 | 5.3 |
| 12B | 3.10 | 32 | 5.4 | 4.1 |

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### 4.2.4. Commentary and Conclusions on Soil Samples from Zone 5.

The examination of the mechanical analysis for Zone 5 Table 4 shows that these soils contain large quantities of silty or clayey fine sand, even if the results are not homogenous at the level of the two profiles examined. The phenomenon of increasing clay with increasing depth is also present here.

We have here a case of soils of average porosity (37% on the average) . However, that this permeability should in some cases be greater than the permeability of Zone 1 does not appear to be consistent with reality.

As far as the water retention properties of these soils at the different wilting points is concerned, they are consistent with the fine sand texture of these soils.

Otherwise, in relation to the beige and "dior" soils already mentioned, there is a high level of organic matter, as the amount present is never less than 4%, and at the maximum reaches 8.10%. Nitrogen is also at a high level, being present in amounts never below 0.40%, with a maximum of 0.48%.

The same observations made for the soils of Zone 1 and 4 concerning the presence of phosphorus are valid here. This is also true for the presence of iron.

In these soils, the calcium present is preponderant among the exchangeable elememts, with an average rate of 1.20 meq/100 g, whereas the amount of potassium present varies from around 0 05 to 0.15 meq/100 g according to the profile.

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The tendency of the soils to be neutral in pH is maintained for the surface horizons. Acidity appears to be more marked at deeper levels.

The cationic exchange capacity, considering the textural nature of these soils, remains within the norm. It fluctuates around 3 meq/100 g. The effect of organic material on this exchange capacity does not seem to prevail over the effect of the clay content, as the values found for the cationic exchange capacity at deeper levels remain slightly higher than those for the surface levels.

As for as base saturation is concerned, it is average.

Conclusions on the Soils of Zone 5.

The two profiles sampled from Zone 5 do not show homogeneity as to the different characteristics examined. Additional study probably would reveal different sub-zones in Zone 5.

However, the agricultural possibilities of this zone as we know it are very real. It remains to assure the means of optimizing these posibilities.

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TABLE 5. ANALYTICAL RESULTS OF SOIL SAMPLES FROM ZONE 6.

A : GRANULOMETRY.

GRANULOMETRY IN %

| Sample Number And Horizon | Clay | Fine silt | Coarse silt | Fine sand | Coarse sand |
|---|---|---|---|---|---|
| 6A | 11.3 | 18.0 | 20.2 | 31.7 | 16.4 |
| 6B | 28.8 | 15.3 | 16.3 | 23.9 | 12.7 |
| 7A | 8.0 | 9.4 | 5.3 | 37.3 | 38.5 |
| 7B | 48.9 | 10.6 | 3.9 | 18.4 | 14.3 |

TABLE 5. Continued (ZONE 6)

B : PHYSICAL CHARACTERISTICS.

| Sample Number And Horizon | Moisture in % | Porosity in % | Permeability in cm/h | Wilting point 3 | Wilting point 4.2 | Wilting point 2.5 |
|---|---|---|---|---|---|---|
| 6A | 1.1 | - | 0.8 | 8.8 | 4.7 | 15.3 |
| 6B | 2.0 | - | 2.1 | 12.4 | 8.6 | 17.1 |
| 7A | 0.7 | 29.7 | 0.6 | 6.1 | 3.2 | 9.0 |
| 7B | 3.1 | - | 2.7 | 18.1 | 14.4 | 21.7 |

.../...

TABLE 5. Continued (Zone 6)

C : ORGANIC MATTER, PHOSPHORUS, IRON.

| Sample Number And Horizon | Organic matter % | Carbon C % | Nitrogen N % | C/N relationship |
|---|---|---|---|---|
| 6A | 1.5 | 8.70 | 0.61 | 14.3 |
| 6B | 0.9 | 5.04 | 0.43 | 11.7 |
| 7A | 1.1 | 6.40 | 0.45 | 14.2 |
| 7B | 0.8 | 4.60 | 0.49 | 9.4 |

| | Total Phosphorus | |
|---|---|---|
| | Total $P_2O_5$ | Available $P_2O_5$ |
| 6A | 0.120 | 0.014 |
| 6B | 0.085 | 0.009 |
| 7A | 0.155 | 0.009 |
| 7B | 0.160 | 0.006 |

| | Total Iron | |
|---|---|---|
| | Total $Fe_2O_3$ | Free $Fe_2O_3$ |
| 6A | 0.58 | 0.25 |
| 6B | 0.91 | 0.37 |
| 7A | 0.59 | 0.29 |
| 7B | 1.36 | 0.63 |

TABLE 5. Concluded. Zone 6.

D : EXCHANGEABLE CATIONS, CATIONIC EXCHANGE CAPACITY , pH.

| Sample Number And Horizon | Exchangeable Cations : Ca ++ | Mg ++ | K + | Na + | Sum : S |
|---|---|---|---|---|---|
| 6A | 2.05 | 0.69 | 0.10 | 0.03 | 2.87 |
| 6B | 1.78 | 0.18 | 0.06 | 0.08 | 2.10 |
| 7A | 1.00 | 0.55 | 0.11 | 0.02 | 1.68 |
| 7B | 0.78 | 0.38 | 0.06 | 0.04 | 1.26 |

| | Cationic exc. cap. :T | %S/T | pH water | pH KCl |
|---|---|---|---|---|
| 6A | 4.60 | 62 | 6.1 | 5.0 |
| 6B | 3.90 | 54 | 5.4 | 4.8 |
| 7A | 4.40 | 38 | 6.0 | 4.8 |
| 7B | 7.30 | 17 | 5.0 | 3.9 |

.../...

### 4.2.5. Commentary and Conclusions on Soil Samples from Zone 6.

Granulometric analysis of the soils of Zone 6 shows that they have a clayey-silt texture.

Their permeability is practically the same as that for the soils of Zone 5. The same is true for the possibilities of water retention or drainage. The observations made previously concerning these subjects are also valid here.

As for as the chemical characteristics are concerned, these soils fail within the range of the values found and commented on for the soils of Zone 5. From this point of view, it must be said that the soils of Zone 6 show just about the same potentialities as those of Zone 5.

#### Conclusions on the Soils of Zone 6.

The chemical analyses done on more than two samples certainly reveal the great differences that exist between the two zones. It seems that at this stage, the reason that there is a longer period of standing water in Zone 6 is due to its toppographical location and its less permeable texture, especially at the surface level.

.../...

TABLE 6. ANALYTICAL RESULTS OF SOIL

A : GRANULOMETRY

| Sample Number And Horizon | GRANULOMETRY IN % Clay | Fine silt | Coarse silt | Fine sand | Coarse sand |
|---|---|---|---|---|---|
| 17A | 49.3 | 14.9 | 15.7 | 10.4 | 3.4 |
| 17B | 51.3 | 14.9 | 13.3 | 9.8 | 3.6 |

TABLE 6. Continued (Zone 7).

B : PHYSICAL CHARACTERISTICS.

| Sample Number And Horizon | Moisture in % | Porosity in % | Permeability in cm/h | Wilting point 3 | Wilting point4.2 | Wilting point2.5 |
|---|---|---|---|---|---|---|
| 17A | 4.6 | 39.5 | 1.0 | 19.3 | 14.5 | 25.4 |
| 17B | 5.0 | 35.2 | 2.1 | 15.2 | 15.2 | 26.2 |

TABLE 6. Continued

C : ORGANIC MATTER, PHOSPHORUS, IRON.

| Sample Number And Horizon | % Organic matter | Carbon | Nitogen N | C/N relationship |
|---|---|---|---|---|
| 17A | 1.6 | 9.00 | 0.72 | 12.5 |
| 17B | 1.1 | 6.50 | 0.50 | 13.0 |

Total Phosphorus

| | Total $P_2O_5$ | Available $P_2O_5$ |
|---|---|---|
| 17A | 0.190 | 0.015 |
| 17B | 0.125 | 0.006 |

Total Iron

| | Total $Fe_2O_3$ | Free $Fe_2O_3$ |
|---|---|---|
| 17A | 0.66 | 0.34 |
| 17B | 0.74 | 0.38 |

.../...

TABLE.6- Concluded
D : Exchangeable Cations, Cationic Exchange Capacity, pH.

| Sample Number And Horizon | Exchangeable cations : Ca ++ | Mg ++ | K + | Na + | Sum : S |
|---|---|---|---|---|---|
| 17A | 6.34 | 1.73 | 0.09 | 0.10 | 8.26 |
| 17B | 5.40 | 1.06 | 0.05 | 0.11 | 6.62 |

| | Exchange cap. : T | % S/T | p water | p KC |
|---|---|---|---|---|
| 17A | 12.20 | 68 | 5.8 | 4.2 |
| 17B | 14.80 | 45 | 5.5 | 3. |

4.2.6. Commentary and Conclusions on Soils Samples from Zone 7.

The mechanical analysis done on the soils of Zone 7 shows them to be essentially clayey soils; the percentage of clay is 50%. The texture can thus be characterized as being very clayey silt.

The texture favors good water retention with field capacity of 15%. The permeability does not appear to be diminished in comparison to the soils of Zones 4 and 6.

Elsewhere, although the amount of carbon present does not appear to have greatly changed in comparison to the soils already examined, the amount of nitrogen present, on the other hand, is slightly higher, and at the surface level reaches 0.72%, against 0.50% in the B horizon.

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The amount of available phosphorus is not significantly changed, and remains low, between 0.006 and 0.15%.

The observations already made concerning the iron content remain valid here as well.

In terms of exchangeable cations, the soils of Zone 7 are relatively rich in exchangeable calcium ($Ca^{++}$). The amount of exchangeable calcium present fluctuates around 6 meq/100 g.

The cationic exchange capacity (C.E.C.) is also relatively high, falling between 12 and 15 meq/100 g. This high level of exchange capacity is more due to the nature of the clay than to the organic matter. In effect, from a morphological point of view, this clay seems to have a different aspect and seems more rich.

Paradoxically, these soils have a pH which tends to be more acidic.

Conclusions on the Soils of Zone 7.

All the factors - texture, nitrogen content, exchangeable cations and the C.E.C. - indicate that these soils are relatively more fertile than those already examined. Other limiting factors, if they exist, will be treated further on in the text.

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TABLE 7. ANALYTICAL RESULTS OF SOIL SAMPLES FROM ZONE 8.
A : GRANULOMETRY.

| Sample Number And Horizon | Clay | Fine silt | Coarse silt | Fine sand | Coarse sand |
|---|---|---|---|---|---|
| 13A | 38.9 | 15.4 | 9.3 | 15.6 | 12.8 |
| 13B | 33.0 | 9.8 | 12.6 | 20.3 | 18.9 |

TABLE 7. Continued (Zone 8).
B : PHYSICAL CHARACTERISTICS.

| Sample Number And Horizon | Moisture in % | Porosity in % | Permeability in cm/h | Wilting point 3 | Wilting point4.2 | Wilting point2.5 |
|---|---|---|---|---|---|---|
| 13A | 5.3 | 33.8 | 0.8 | 21.1 | 25.1 | 29.8 |
| 13B | 4.2 | 21.0 | 0.9 | 15.4 | 11.9 | 19.8 |

TABLE 7. Continued.
C : ORGANIC MATTER, PHOSPHORUS, IRON.

| Sample Number And Horizon | Organic matter | Carbon C | Nitrogen N | C/N relationship |
|---|---|---|---|---|
| 13A | 2.8 | 16.20 | 1.28 | 12.7 |
| 13B | 0.4 | 2.50 | 0.26 | 9.6 |

Total Phosphorus

| | Total $P_2O_5$ | Available $P_2O_5$ |
|---|---|---|
| 13A | 0.220 | 0.025 |
| 13B | 0.070 | 0.009 |

Total Iron

| | Total $Fe_2O_3$ | Free $Fe_2$ |
|---|---|---|
| 13A | 0.86 | 0.46 |
| 13B | 1.17 | 0.56 |

.../...

TABLE 7. Concluded.

D : EXCHANGEABLE CATIONS, CATIONIC EXCHANGE CAPACITY , pH.

| Sample Number And Horizon | Exchangeable cations : Ca + + | Mg ++ | K + | Na + + | Sum : S |
|---|---|---|---|---|---|
| 13 A | 5.90 | 1.00 | 0.14 | 0.15 | 7.19 |
| 13B | 6.78 | 0.63 | 0.07 | 0.24 | 7.78 |

| | Exchange cap. : T | % S/T | pH water | pH KCL |
|---|---|---|---|---|
| 13A | 13.90 | 52 | 5.6 | 4.1 |
| 13B | 11.10 | 70 | 6.0 | 4.2 |

4.2.7. Commentary and Conclusions on Soil Samples from Zone 8.

The soils of Zone 8 are also characterized by a clayey to very clayey silt texture. However, the quantity of clay present seems to be less. It was even observed that this layer of clay rests on a layer of coarser-textured material at a deeper level.

This clay, from a morphological viewpoint, behaves like montmorillonite- expanding clay which cracks as it dries out.

The possibilities of water retention are comparable to the values given for Zone 7, with a field capacity which fluctuates around 29 and 20% according to horizon.

As far as permeability is concerned, the values found, 0.8 cm/h and 0.9 cm/h according to the different horizons, lead to the conclusion that the permeability conforms to the clayey nature of the soil as defined above.

The amount of surface organic matter present in these soils is the highest seen so far, reaching 16.20% for carbon and 2.8% for organic matter.

The amount of nitrogen present at the surface level, 1.28% also bears witness to the influence exercised by the organic matter, which in this zone is essentially composed of Graminaceae,

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These soils remain deficient in phosphorus, like the others. As far as the iron content is concerned, the values are normal for these soils but are nonetheless relatively high when plant needs in iron are considered.

The cationic exchange capacity is also fairly high, with exchangeable calcium present at a rate of around 6 meq/100g.

The increase in the exchange capacity at surface (2.14 as compared to 11 meq/100 g) may be due to the higher amounts of organic matter present at the surface.

However, it was also observed that the texture at lower levels is coarser than the surface texture. This may also explain the higher cationic exchange capacity at the surface.

The pH is close to the value for neutrality, with a slightly acidic tendency.

Conclusions on the Soils of Zone 8.

The soils of Zone 8 are just as promising as the soils of Zone 7. Their characteristics closely approximate each other in real value. The problem in eventual development of these soils lies in the difficulty of draining them.

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### 4.2.8. General Observations on Laboratory Analyses.

The examination of the whole of the results of laboratory analysis of soil samples from the different zones should be made in the light of the following general observations :

Firstly, it was impossible to take the same number of samples in all zones. The zones do not have the same possibilities nor the same facility of access. For certain zones, such as 7 and 8, which are practically inaccessible, it was not possible to take more than two representative samples.

Secondly, variation in the different characteristics examined is often evident from the analyses themselves.

This variability supports the need for precision in establishing a more detailed soils map than is currently available, because of the need for accuracy in development program.

## 4.3. ADAPTATION AND AVAILABILITY OF SOILS.

### 4.3.1. An Improved Soils Map.

Based on observations of the field and a study and comparison of the laboratory analysis of numerous samples, certain corrections and improvments of the basic soils map were found to be necessary.

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The indicated changes produced the map presented in Figure 4.3.1.

The modifications suggested on the attached map are in no way definitive nor complete. They are, however, soundly based.

To clarify the meaning of the map, a symbolic legend is included which gives an indication of the developmental possibilities of the different zones. This legend, which draws on the Belgian classification, takes into account the texture, the drainage class, and the profile development of the soils. These three factors are the ones which most affect hydro-agricultural development, especially drainage and irrigation.

4.3.2. Zones Amenable to Rice Culture.

The map shows those zones are more amenable to irrigation for rice cultivation, in the order of their importance :

1 - Zone 4b (Ec x - Ed x - 18 000 hectares) has light clayey texture and moderate permeability. This zone has fairly deep soils whose compactness, however, does not permit their effective exploitation by traditional equipment. The solution to this situation lies in the use of more sophisticated plowing equipment.

2 - Zone 6 (A ex - E dx - 5,500 hectares). This zone has a fairly clayey texture, with rather poor drainage for a certain period of the year, becoming well enough drained later on.

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These are deep soils which would need development before the installation of an irrigation network. The development needs would include preparation of the soils for better water evacuation.

3 - Zone 7 (Ed x - E ex)1,800 hectares. This zone, with its very clayey texture, is flooded for a good portion of the year. The development needed would essentially concern the possibilities for draining this zone in order to undertake the preparation of cropland for cultivation. The installation of a drainage network should certainly be envisaged.

4 - Zone 8 (Ud x - Ue x) 1,100 hectares. This zone has heavy clay at the surface level. The development required would be the same as that for Zone 7.

For both of these zones, the major limiting factor is the fact that they are flooded during a part of the year, and parts of Zone 8 are almost continually under water.

5 - Zone 2 (Sd x - Ad x) 5,200 hectares. Parts of this zone particularly downstream from the villages, could lend themselves to rice cultivation. In these areas, the texture of the soil is very close to that of Zone 4b. Other parts of Zone 2 are too coarse - textured and would require excessive amounts of water for irrigation of rice.

6 - Zones 4 and 5 (Lex) totalling 7,800 hectares are similar in their sandy-silt texture, They could be used for irrigation for rice cultivation, with greater water requirements, and proper choice of the irrigation method.

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It can be seen from this brief examination of the different zones that most of them do present possibilities for irrigation for rice cultivation. However, certain major limiting factors do exist, notably the presence of semipermanent water in certain zones.

Nonetheless, from the point of view of both the texture and the richness of these soils and from the possibilities of improving this richness, we have here zones which do lend themselves to rice cultivation, if good varieties are chosen and proper cultural practices followed.

### 4.3.3. Availability for Development.

In the Anambe Basin, as in any area of comparable extent, there are scattered areas that for various reasons are not available for development as agricultural land. Such areas include unusual topographic features, geologic or pedological oddities, and areas already claimed for higher uses : villages, roads, etc. No attempt has been made to estimate these areas because their proportion of the total surface is small, and in view of the imprecision in overall measurements, can be disregarded.

However, one parcel of land of significant size is unavailable for agricultural use : the Anambe National Forest. For reasons presented and discussed in chapter 3, section 3.3.8. SODAGRI choses not to press for declassification of this forest land at the present time.

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The forest contains 6,200 hectares. Estimated area by soil group is shown in Table 4.3.3.A. About 5.700 hectares - 90 percent of the total - is in soil groups 4b, 5, 6 and 7 that are suitable for rice cultivation. Subtraction of the forests' 6.200 hectares leaves available 103.800 hectares in the basin.

Current and potential use of the land in the Anambe Basin is shown in Table 4.3.3.B. Assuming that the peasants will continue to cultivate the lighter, more easily tilled soils, adequate scope is available for expansion of their fields by 40 percent or more, while improving their practices and their yields. Assuming that the heavier soils, not suited cultivation by the local farmers with hand or animal-powered tillage, will be reserved for use by the Seneriz project and mechanized cultivation ; some 25.000 hectares remain suitable and available for incorporation in an agro-industrial complex focussing on rice production.

TABLE 4.3.3.A. Anambe Basin and Classified Forest Areas by Soil Groups.

| Soil Group | Area in Basin | Area in Classif.Forests | Balance non-Classif. area |
|---|---|---|---|
| 1 | 68.000 | - | 68.000 |
| 2 | 5.200 | 100 | 5.100 |
| 3 | 2.600 | - | 2.600 |
| 4a | 2.200 | 200 | 2.000 |
| 4b | 18.000 | 1.500 | 16.500 |
| 5 | 5.600 | 1.500 | 4.100 |
| 6 | 5.500 | 1.700 | 3.300 |
| 7 | 1.800 | 1.200 | 600 |
| 8 | 1.100 | - | 1.100 |
| TOTAL | 110.000 | 6.200 | 103.800 |

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TABLE 4.3.3.B. Current and Potential Land Use in Anambe Basin by Soil Groups.

( Excluding 6 200 hectares of Classified Forest)

Area in Hectares

| Soils Group | Area | Current use | Potential use | Projet Target (Area) |
|---|---|---|---|---|
| 1<br>5<br>2 | 68 000<br>4 100<br>5 100 | Shifting Cultivation 21 000 ha crops | Stabilized and improved culture by peasants | 30 000 |
| | 77 200 | | | |
| 3<br>4a<br>4b | 2 600<br>2 000<br>16 500 | Little Used | Mechanized Cultivation | 20 600 |
| | 21 100 | | | |
| 6<br>7 | 3 800<br>600 | Seasonal flooding Cattle pasture | Mechanized Cultivation | 4 400 |
| | 4 400 | | | |
| 8 | 1 100 | Seasonal flooding pasture and water storage | Occasional flooding and cattle pasture | 1 100 |
| | 1 100 | | | |
| Total | 103 800 | Total available for Mechanized Cultivation : | | 25 000 |

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## 4.4. AGRICULTURE IN THE ANAMBE BASIN.

### 4.4.1. Crops and Yields.

A report on the major crops grown in the department of Velingara follows ; official data for the Anambe Basin, a geographic rather than administrative region, are not available, but the distribution of land area among the crops and the yields of crops may be assumed to apply to the Basin.

| Crop | Area Ha | % | Yields Kgs/ha | Production M.T. |
|---|---|---|---|---|
| Sorghum | 13.300 | 24.6 | 1.210 | 16.093 |
| Peanuts | 12.800 | 23.7 | 990 | 12.672 |
| Cotton | 11.500 | 21.2 | 1.200 | 13.800 |
| Millet | 9.400 | 17.4 | 900 | 8.460 |
| Maïze | 4.138 | 7.6 | 1.185 | 4.904 |
| Rice | 2.970 | 5.5 | 1.070 | 3.178 |
| TOTAL | 54.108 | 100.0 | | |

### 4.4.2. General Crop Production Practices.

In the Anambe Basin, the largest concentration of villages and cropland is located around the upper edge of the basin on soils of group 1, with a very modest sprinkling of villages and agriculture in a relatively narrow band at an intermediate level around the basin (Soils group 5).

About the same emphasis is given to the same crops in the basin as in the department of Velingara as a whole, and the cropping pattern is relatively uniform throughout the basin. Apart from rice culture, about equal emphasis is given to cash crops (cotton and peanuts) and food crops (sorghum, millet and maize).

The seasonality of rainfall dominates the climates picture and controls the agriculture of the region. The growing of crops is limited to the rainy season. Except for very limited areas of lowland (swamp) rice and a few irrigated vegetables, there is no crop grown during the dry season.

Most of the land preparation is carried out by using oxen. Plowing can be done only after the first rains have provided enough moisture to allow penetration and turning of the soil. The depth of plowing is very shallow, estimated at 7 to 10 cm., plowing is fallowed by harrowing in some cases, but mostly for cotton.

A general agricultural calendar for four crops is shown as follows :

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Agricultural Calendar.

| Dates | Cotton | Rice | Millet | Peanuts |
|---|---|---|---|---|
| March to May | Burning, brush clearing, layout | Layout. | Soil preparation, grading plowing | Soil preparation. |
| May and June | Sowing | Plowing basal fertilizer appl. harrowing. | Dry sowing. of | Sowing |
| June and July | End of Sowing<br>Fertilizer | Sowing<br>Weeding | Replanting of missing hills, weedings.<br>Fertilizer | Fertilizer after weeding |
| August and September | Insecticide treatments | Fertilizer Insecticide, when needed. | | |
| September and October | Insecticide treatments. | Harvest and sale | Beginning of harvest. | |
| October and November | Harvest and sale. | | Harvest and sale. | Harvest |

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- Weeds and their control : Certain prevalent weeds, which are comment to all crops, have been identified. They are :

- Striga Senegalensis : A perennial, Striga Senegalensis reproduces asexually by stolons (runners) as well as by sexual reproduction. This a very serious competitor to all crops.

- Cenchrus Biflorus : This annual grass, one of the Graminaceae, is very difficult to control because of its close resemblance to rice when it is at an early stage of development.

- Andropogan Gayanus :Another member of the Graminaceae species, this grass compètes with lowland rice. It has a greater access to light than rice because of its superior height.

- Oryza Barthii and Oriza Breviligulata :Respectively a perennial and an annual, this weed has been identified in certain rice paddies.

- Water lilies ; Found only in aquatic rice paddies, these do not constitute a serious problem.

None of the Cyperacea (the sedge family) have been identified, although in certain ponds Scirpus Maritimus is found.

- Weed control : Striga is normally rooted up and burned. Other weeds are simply rooted and by hand or hoed with a daba.

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Chemical herbicides are not yet used, except for cotton ; SODEFITEX uses Cotoran. However, it would seem that Stamf 34T and Avirosan (C 288) are appropriate herbicides for future use in rice paddies.

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### 4.4.3. Rice Culture.

Three varieties of rice are planted. They are : TS 123, 302b and I Kong Pao.

Characteristics of these rice varieties are shown in the following table :

TABLE 4.4.3. Agronomic characteristics of rice varieties TS 123, 3o2 G, and I Kong Pao (Source : SODEFITEX, Velingara).

| Characteristics | TS 123 | 302 G | I Kong Pao |
|---|---|---|---|
| Origin | Taiwan | Sefa 1970 | Taiwan |
| Selection | - | TN1 x Tunsart | - |
| Classification | Japonica | Indica | Indica |
| Duration | 100 days | 100 days | 110 days |
| Photoperiod sensitivity | - | Low | - |
| Height | 115 cm | 85 cm | 85 cm |
| Plant type | Upright | Upright | Slightly curved |
| Panicle aspect | Curved compact | Semi -curved | Curved-compact |
| Tillering ability | - | Good | Good |
| Drought resistance | - | Low | Low |
| Lodging | Susceptible | Resistant | Resistant |
| Hardiness | Fairly good | Poor | Medium |
| Grain characteristics | | | |
| - length | 9.1 mm | 8.8 mm | 7.1 mm |
| - width | 3.9 mm | 2.9 mm | 3.3 mm |
| Weight of 1000 grains | 34.5 grams | 25 grams | 28 grams |
| Milled rice | 62% | - | - |
| - translucency | - | high | medium |
| - cooking quality | - | good | good |
| - gelatinization temperature | - | low | low |
| Blast resistance | Low | good | good |
| Fertilizer response | Good | - | good |
| Potential yield t/ha. | 3.5 t/ha | Irr. 8t/ha rain-fed, 5 t/ha | Irr. 6.9 t/ha. rain-fed, 5,5 t/ha |

Source : SODEFITEX, Velingara.

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Rice fertilization practices recommended by SODEFITEX are as follows : 150 kgs per hectare of 8-18-27 as a basal fertilizer, to be applied before or at seeding ; an application of 50 kgs. of urea 40 days after sowing and 1.5 units of sulphur applied 8-10 days after sowing. It was reported that farmers do not like to use fertilizer on rice and that for the Casamance region, an average of only 6 Kgs./ha. of 8-18-27 is used. Thus, the typical rice crop does not receive fertilizer.

Seeding of rice is usually done by hand seeding in rows with 20-25 cm. spacing and at the rate of 100kgs./ha. of seed.

Weeding is usually done by hand pulling and in some instances by hoeing between the rows.

The major insect pest reported is a stem borer (sesamia). Damage to rice grains by what appeared to be stink-bugs was observed in rough rice samples. It was also reported that a species of cricket attacks rice during the vegetative stage. An insecticide, HCH, is recommended for control of insect pests.

Blast or pericularia oryzae was the only disease of rice reported prevalent in the area. As this disease is frequently mentioned in several reports and is known locally, it is likely to be a major importance in rice production.

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Rice is grown in the Anambe basin only as a rainfed crop ; full irrigation with addition of water when needed is not practised. The greatest single problem associated with rice production in the department of Velingara and the Anambe basin was reported to be the absence of a dependable rainfall pattern during the growing season which would provide the high levels of soil moisture throughout the period necessary for a rice crop. There was some indication from verbal reports that in years when rainfall was satisfactory for rice, the yields of rice were higher, while the yields of cotton, peanuts, sorghum, and some other crops were lower than usual, and that during years with good yields of cotton, peanuts, sorghum, etc., the yield of rice was lower than normal. This reflects the higher moisture requirement for rice compared to most other crops.

### 4.4.4. Rice Research.

Current situation :ISRA (Institut Senegalais de Recherches Agronomiques), with headquqrters in Bambey, is responsible for agronomic research in Senegal. ISRA has a small unsophisticated experimental station, a PAPEM (Point d'Appui d'Etudes Multilocales), located approximately 2 km. southeast of Velingara. No permanent buildings exist and a very minimum of equipment is available. The staff consists of one general agriculturalist who carries out work plans designed in Bambey. Occasional visits are made by technicians from Bambey who supervise the experiments, assess the data, etc. In 1976, the rice experiment consisted of different methods and depths of land preparation

plots. The yields of rice under the various treatments during 1976 varied between 450 and 1800 kgs./ha. It was reported that a period of low rainfall occured out on some other crops including peanuts, corn, and cotton. In the peanut experiment, yields ranged from 2200 to 2700 kgs/ha. in the different treatments.

No experiments on rice were carried out at other locations in the Anambe basin.

The major part of the rice research for the Casamance region is carried out at Djibilor and Sefa which are located long distances from the Anambe basin. The general environment and the soils are quite different from the situation existing in the Anambe basin, and the results of research work from these two centers cannot be applied directly to the Anambe basin. An attempt was made to gather sufficient research-based information to assess the potential of rice production in the Anambe basin, and it was determined that the needed information does not exist.

Research program needs :To provide research-based answers to many questions and problems in production of rice and other crops in the Anambe Basin, a program of applied research is needed, Desirable components of a research program to support rice production are given below.

A. Soil moisture.

Optimum soil moisture or its lack appears to be the single

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greatest limitation to higher yields of rice. Investigations should be made as follows :

1- Methods of land preparation and cultural practices that would increase the water holding capacity of the soil.

2- Construction of levees or dikes in and around rice fields to trap rain and drainage water.

3- Impoundment of water in non-cultivated areas that could be used for supplemental irrigation during extended periods without rainfall.

4- Testing a large number of drought-resistant lines of rice that have been developed by IRI,IITA, and elsewhere for the possibility of selection of varieties that could endure longer periods of no rainfall than the presently grown varieties. WARDA (West African Rice Development Association) would be a good source of material for testing.

B. Fertilizers.

Insignificant amounts of fertilizer are currently applied to rice. The soils of the Anambe basin are low in the major elements N, P, and K, and it is reasonable to expect a profitable return from the use of optimum rates and rations of commercial fertilizer. The following investigations should be made :

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1- Influence on yield of different rates and ratios of N, P, and K.

2- Influence on yield by different times of application of fertilizer elements, especially N and K.

3- Economic analysis of the results of the above studies for rain-fed rice and for irrigated rice.

C. Insect Pests and Diseases of Rice.

Investigation is needed to identify the major insect pests and diseases of rice and to determinate to what extent they are limiting to the production of rice. The following studies are needed :

1- Identification of the major insects and diseases.

2- Determination of the extent of damage.

3- Methods of control, including varietal resistance.

4- Economic analysis of using chemicals or other methods for controlling insects and diseases.

D. Varieties.

Tremendous advances have been made in development of rice varieties adapted to a wide range of conditions, resulting in varieties

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with cold tolerance, high temperature tolerance, drought resistance, tolerance to above-normal amounts of iron, aluminium, etc., resistance to specific insects and diseases, and other special characteristics. To obtain the best possible varieties of rice for the Anambe basin area, it will be necessary to obtain pertinent lines and varieties and to test them for adaptibility. The best source of varieties for testing would W.A.R.D.A. (West African Rice Development Association); as Senegal is a member of W.A.R.D.A., it should be easy to get their assistance. W.A.R.D.A. is continuously obtaining material from IRRI, ITTA, other contries of the world and from research programs in different contries in West Africa where they are involved in rice breeding and testing programs. This organization is in a strong position to assist in establishing investigations needed to assess the potential of viable rice production in the Anambe basin.

Research station :To carry out a good research program that will backstop the project and sustain long term production of rice at good levels will require the establishment of a research station in the Anambe basin. A location should be chosen that is representative of the major soil areas on which rice is to be grown, The outstanding requirements will be :

A- Land - Approximately 25 hectares.

B- Buildings - for offices, laboratories, storage for seed, fertilizers, insecticides, and equipment.

.../...

C- Water for irrigation from one or more wells and for reservoirs, with pumps, pipes, canals, etc., for delivery.

D- Equipment - 1. Laboratory equipment. 2. Vehicles. 3. Tractors or animals for power. 4. Farm implements, including plows, harrows, threshers, etc.

E- Trained personnel :

1. Rice Varietal Improvement Specialist.
2. Rice Agronomist
3. Rice Entomologist.
4. Rice Pathologist.

At least one of the first two listed should be full time and in residence. If necessary, part time or shared personnel in the other cases would be preferable to their omission.

F- Non-Scientific personnel such as farm manager, tractor drivers, laborers, etc.

Trained personnel are usually scarce in developing countries but several international agencies have facilities and offer assistance in training in rice research and production at different levels. Three of these organizations are W.A.R.D.A. with headquarters in Liberia, ITTA and IRRI.

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4.4.5. Limitations in Land Productivity.

The characteristics of agriculture that appear to be most important in fixing limits on land productivity can be summarized as follows :

Methods of Cultivation-: There is no mechanized farming in the basin ; the soil preparation and cultivation is carried out by hand methods and by animals with limited implements. This situation limits the land areas that can be farmed to the lighter soil types that can be more easily tilled.

A long established custom in the Agriculture in the area is shifting cultivation, which consists of cultivating a given area of land for a few years and then abandoning this area for a long period of time before cultivating it again. Reasons for this practice are probably related to the inherent low fertility of the soils, erosion susceptibility, noxious weed competition and possibly compaction problems.

Surface and internal drainage :Flooding and poor drainage of certain areas of the basin precludes crops that will not tolerate high moisture conditions, whereas, these areas may be better adapted to the production of rice. On the other hand, areas of the basin that have good surface and internal drainage resulting in drought susceptability during periods of low rainfall are not be well adapted for rice production but would be well adapted for low moisture tolerant crops such as sorghum.

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Fertility : In general the soils of the Anambe basin would be classified as low in fertility . This indicates that for sustained production of good crop yields, relatively high rates of fertilizers will have to be applied. At the same time, due to the low base exchange capacity of the soils, there will be a limit to the amount of commercial fertilizers applied that will give an economic return. The actual limitation can be determined only through research.

Organic matter : Maintenance of an adequate level of organic matter under intense cultivation will be a continuing problem. Every effort possible should be made to incorporate all available organic material into the soil at the earliest possible stage. In addition to the incorporation of crop residues, it may be necessary and desirable to make certain crop rotations. The actual crops and their sequences should be determined by applied research.

Erosion : Soil erosion is a major problem in agriculture around the world. It will also be a major problem in agricultural development of the Anambe basin, due to periods of very intense rainfall which result in vast quantities of water moving toward lower elevations. during a short period of time.

Soil erosion cannot be eliminated but it can be slowed to a large extent by the use of soil conservation practices such as terracing, contour row cropping, strip cropping, vegetated drainageways and maintaining good soil structure. Insofar as possible, the land should be convered with some type of vegetation during the rainy season.

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The soils of the Anambe basin can be classed as fragile soils in that a high percentage are light textured in the surface, low in organic matter with poor structure. These factors, along with the fact that most of the soil makes it necessary to give serious consideration to utilizing every known practice to minimize soil erosion.

The practices used for prevention of soil erosion will also assist in improving moisture retention in soils during periods of low rainfall and in irrigation of crops during the dry season.

## 4.5. SUMMARY OF AGRONOMIC AND SOILS CONSTRAINTS.

The major constraints on project design from the point of view of agronomy and pedology are as follows :

1-Absence of sufficient information on the occurance of different soil types and the production potential of the soils. This will require a more detailed soil survey and agronomic research including yield tests on the different soil types.

It can be assumed that the soils in the lower part of the basin, soils group 6 and 7, approximately 7,300 hectares, would be best adapted to irrigated rice production, if flooding can be controlled.

It can also be assumed that approximately 80,000 has. of land in soils group 1 and 3 would not be adapted to irrigated rice due to the very permeable, light textured soils.

.../...

A sizable area of soil groups 4 and 5 appears to be adapted to irrigated rice production on the basis of topography, texture, and permeability. Exact area can be determined only by more accurate surveys and level of yields can be only estimated in the absence of yield tests.

Low soil fertility is an important constraint that has to be considered in project design, especially in projecting yields and intensity of cropping. Applications of fertilizers can correct low fertility to varying degrees, depending on the individual soil. It may not be economically practical to attempt high yield production based on application of commercial fertilizers, This point can be resolved only by intensive experimentation.

3. The present methods of cultivation by man and animal power limit the soil types that can be worked, the depth of tillage. Even in the light textured soil areas that are presently cultivated, the present depth of plowing is quite shallow. This constraint can be overcome by machinery and proper implements, which would present new contraints such as maintenance, costs, trained operators, etc. The desirability and economics of available methods of cultivation can be determined through experimentation.

Erosion and its control should be given consideration in all agricultural operations, regardless of location. Most of the land in the Anambe basin occurs on relatively gentle slopes and the problem of erosion would not be as severe as on steeper slopes, but due to the physical and chemical characteristics of the soils and the very intense

rainfall that occurs occasionally, erosion control should be kept in mind in the project design.

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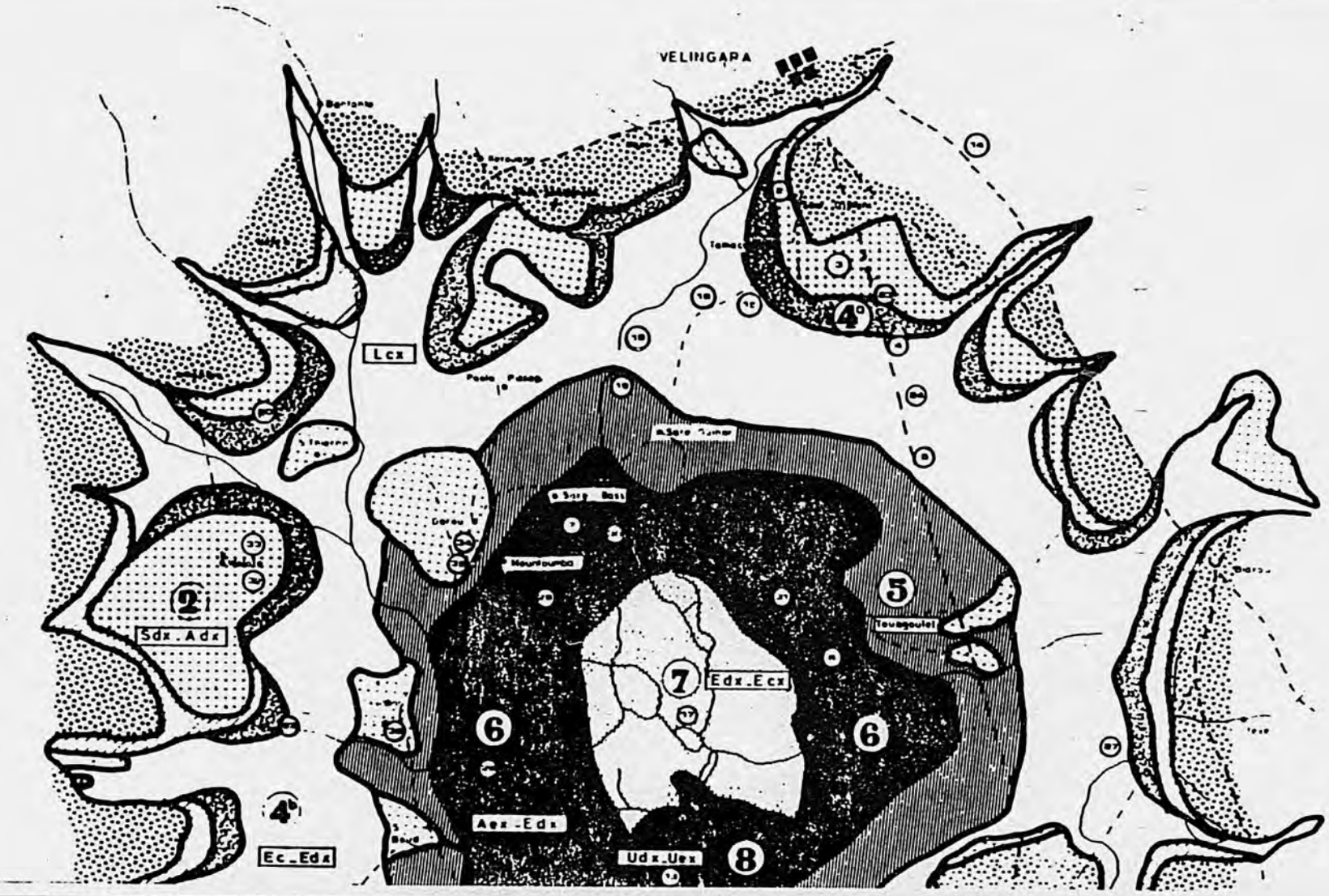
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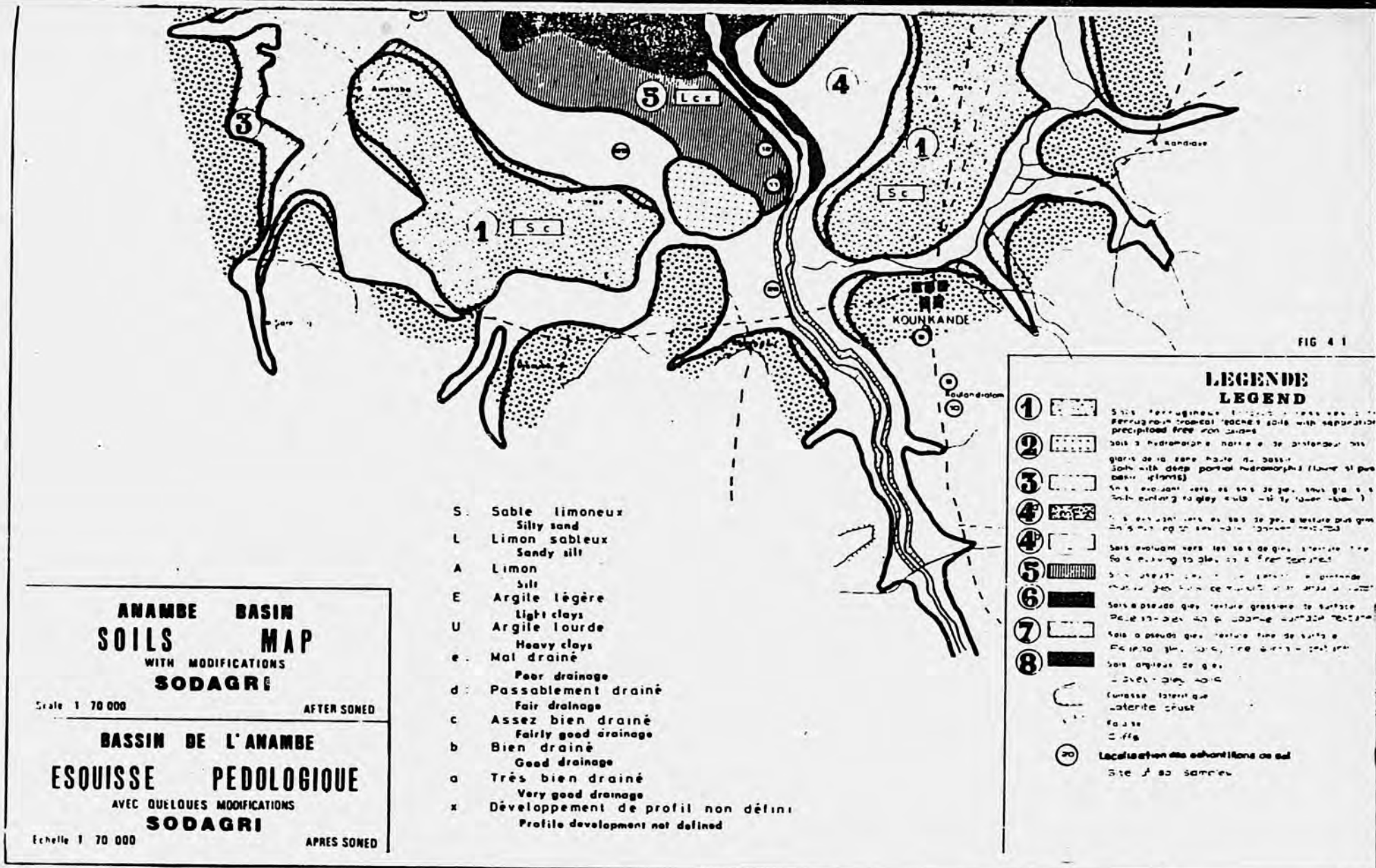
KOUNKANDE
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FIG 4 1
LEGENDE
LEGEND
Localisation des échantillons de sol
Site of soil samples
Cuirasse latéritique
Laterite crust
Falaise
Cliffs
S. Sable limoneux
Silty sand
L Limon sableux
Sandy silt
A Limon
Silt
E Argile légère
Light clays
U Argile lourde
Heavy clays
e. Mal drainé
Poor drainage
d Passablement drainé
Fair drainage
c Assez bien drainé
Fairly good drainage
b Bien drainé
Good drainage
a Très bien drainé
Very good drainage
x Développement de profil non défini
Profile development not defined
ANAMBE BASIN
SOILS MAP
WITH MODIFICATIONS
SODAGRI
Scale 1 70 000
AFTER SONED
BASSIN DE L'ANAMBE
ESQUISSE PEDOLOGIQUE
AVEC QUELQUES MODIFICATIONS
SODAGRI
Echelle 1 70 000
APRES SONED

TABLEAU RECAPITULATIF : Analyses Physiques et Chimiques de 17 Echantillons des Sols du Bassin de l'Anambé.

TABULAR SUMMARY : Physical and Cheminal Analysis of 17 Soil Samples Taken in the Anambé Basin.

| GROUPE DE SOL NO. / SOIL GROUP NO. * | 1 | | 1 | |
|---|---|---|---|---|
| Profile No./Horizon | 8A | 8B | 9A | 9B |
| Profondeur/Depth cm | 0-15 | 15-50 | 0-15 | 15-45 |
| **GRANULOMETRY / GRANULOMETRIE %** | | | | |
| Humidité/Moisture | 0.6 | 1.0 | 0.8 | 1.6 |
| Argile/Clay | 7.0 | 19.8 | 8.3 | 28.4 |
| Limon fin/Fine silt | 7.4 | 6.0 | 7.6 | 6.4 |
| " grossier/Coarse " | 4.1 | 3.0 | 9.0 | 7.0 |
| Sable fin/Fine sand | 37.0 | 29.5 | 37.5 | 28.7 |
| " grossier/Coarse " | 43.1 | 39.4 | 36.5 | 26.3 |
| Matière Organique/Org.matter | 1.1 | 0.5 | 1.3 | 0.9 |
| Total | 100.3 | 99.2 | 101.0 | 99.3 |
| **MATTERE ORGANIQUE / ORGANIC MATTER %** | | | | |
| Carbone:Carbon C | 6.20 | 2.92 | 7.30 | 5.40 |
| Azote Nitrogen N | 0.47 | 0.26 | 0.46 | 0.40 |
| C/N | 13.2 | 11.2 | 15.9 | 13.5 |
| Total % $P_2O_5$ | 0.260 | 0.150 | 0.235 | 0.180 |
| Ass./avlble $P_2O_5$ | 0.007 | 0.004 | 0.041 | 0.009 |
| pH eau/water 1/2,5 | 6.4 | 7.1 | 7.0 | 6.7 |
| pH KCl | 3.6 | 5.6 | 5.9 | 5.1 |
| **CATIONS ECHANGEABLES / EXCH. CATIONS** | | | | |
| Calcium Ca+ | 1.85 | 1.00 | 1.94 | 1.50 |
| Magnesium Mg+ | 0.33 | 0.80 | 0.93 | 0.75 |
| Potassium K+ | 0.05 | 0.05 | 0.18 | 0.50 |
| Sodium Na+ | 0.03 | 0.01 | 0.02 | 0.03 |
| Total (S) | 2.26 | 1.86 | 3.07 | 2.78 |
| C.E.C. (T) | 2.90 | 4.00 | 5.50 | 4.20 |
| S/T % | 78 | 47 | 56 | 66 |
| **CARAC.PHYSIQUES/PHYS.CHARAC. / PHYS CHARACTERISTICS** | | | | |
| Porosity/Porosité % | 34.7 | 28.8 | 40.5 | 36.7 |
| Field Capacity/pF 3 | 4.9 | 8.3 | 5.9 | 11.1 |
| Field Capacity/pF 4,2 | 3.0 | 6.3 | 3.8 | 8.6 |
| Field Capacity/pF 2,5 | 7.3 | [illegible] | 9.1 | 14.1 |
| Perméabilité cm/h | 1.2 | 2.2 | 3.8 | 2.0 |
| Fer/Iron $Fe_2O_3$ Total | 0.78 | 1.00 | 1.05 | 1.96 |
| $Fe_2O_3$ Libre | 0.38 | 0.58 | 0.89 | 1.64 |

* Numerotés selon la carte pédologique GERCA à l'échelle 1:70.000
Soil group numbers according to the 1:70,000 soils map of the GERCA Report.

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[illegible] : (suite)

TABULAR SUMMARY : (Continued)

| GROUPE DE SOL NO. / SOIL GROUP NO. * | 1 | | 1 | |
|---|---|---|---|---|
| Profile No./Horizon | 10A | 10B | 14A | 14B |
| Profondeur/Depth cm | 0-15 | 15-50 | 0-15 | 15-50 |
| **GRANULOMETRIE / GRANULOMETRY %** | | | | |
| Humidité/Moisture | 0.7 | 1.2 | 0.6 | 1.2 |
| Argile/Clay | 7.5 | 21.0 | 7.8 | 22.1 |
| Limon fin/Fine silt | 6.3 | 6.1 | 6.4 | 7.1 |
| " grossier/Coarse " | 6.0 | 2.7 | 7.9 | 7.5 |
| Sable fin/Fine sand | 38.4 | 28.8 | 40.1 | 26.9 |
| " grossier/Coarse" | 39.7 | 29.0 | 37.1 | 34.0 |
| Mtr.organique/Org.matter | I.0 | 0.9 | 0.9 | 0.6 |
| Total | 99.6 | 99.7 | 100.8 | 99.4 |
| **MATIERE ORGANIQUE / ORGANIC MATTER %** | | | | |
| Carbone/Carbon C | 6.00 | 5.32 | 5.00 | 3.32 |
| Azote/Nitrogen N | 0.38 | 0.37 | 0.32 | 0.28 |
| C/N | 15.8 | 14.4 | 15.6 | 11.9 |
| Total % $P_2O_5$ | 0.135 | 0.205 | 0.165 | 0.085 |
| Assim./avibl. $P_2O_5$ | 0.047 | 0.006 | 0.[illegible] | 0.009 |
| [illegible] eau/water 1/2,5 | 6.6 | 5.6 | 5.6 | 5.1 |
| pH kcl | 5.3 | 4.4 | 4.6 | 4.2 |
| **CATIONS ECHANGEABLES / EXCH. CATIONS** | | | | |
| Calcium $Ca^{++}$ | 1.00 | 0.78 | 0.48 | 0.48 |
| Magnesium $Mg^{++}$ | 0.50 | 0.70 | 0.35 | 0.38 |
| Potassium $K^{+}$ | 0.27 | 0.19 | 0.09 | 0.03 |
| Sodium $Na^{+}$ | 0.03 | 0.04 | 0.03 | 0.03 |
| Total (S) | 1.80 | 1.71 | 0.95 | 0.92 |
| C.E.C. (T) | 2.90 | 3.70 | 3.20 | 3.60 |
| S/T % | 62 | 46 | 30 | 26 |
| **CARAC.PHYSIQUES/PHYS.CHARAC. / PHYS CHARACTERISTICS** | | | | |
| Porosity/Porosité % | 37.3 | 37.2 | 36.7 | 41.7 |
| Field Capacity/pF 3 | 4.9 | 8.4 | 4.7 | 9.5 |
| Field Capacity/pF 4,2 | 3.2 | 6.5 | 3.2 | 7.5 |
| Field Capacity/pF 2,5 | 7.6 | 11.0 | 7.2 | 12.2 |
| Perméabilité cm/h | 1.6 | 1.3 | 1.7 | 3.2 |
| Fer/Iron $Fe_2O_3$ Total | 1.48 | 2.12 | 0.95 | 1.24 |
| $Fe_2O_3$ Libre | 1.22 | 1.67 | 0.49 | 0.72 |

* Numerotés selon la carte pédologique GERCA à l'échelle 1.70.000
Soil group numbers according to the 1:70,000 soils map of the GERCA Report.

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TABLEAU RECAPITULATIF :

TABULAR SUMMARY :

| GROUPE DE SOL No. / SOIL GROUP No. * | 2 | | 4 | |
|---|---|---|---|---|
| Profile No./Horizon | 2A | 2B | 3A | 3B |
| Profondeur/Depth cm | 0-20 | 20-40 | 0-30 | 30-60 |
| **GRANULOMETRIE / GRANULOMETRIE %** | | | | |
| Humidité/Moisture | 2.0 | 0.9 | 0.5 | 0.2 |
| Argile/Clay | 5.6 | 16.6 | 3.9 | 1.3 |
| Limon fin/Fine silt | 4.3 | 4.6 | 15.4 | 6.0 |
| " grossier/Coarse " | 3.7 | 4.4 | 11.1 | 9.0 |
| Sable fin/Fine sand | 36.8 | 30.0 | 43.0 | 50.2 |
| " grossier/Coarse " | 46.6 | 42.8 | 25.2 | 32.3 |
| Mtr. organique/Org. matter | 0.6 | 0.4 | 0.6 | 0.1 |
| Total | 99.6 | 99.7 | 100.7 | 99.1 |
| **MATIERE ORGANIQUE / ORGANIC MATTER %** | | | | |
| Carbone/Carbon C | 3.30 | 2.32 | 3.40 | 0.32 |
| Azote/Nitrogen N | 0.23 | 0.20 | 0.26 | 0.03 |
| C/N | 14.3 | [illegible] | [illegible] | 10.7 |
| Total % $P_2O_5$ | 0.165 | 0.195 | 0.075 | 0.040 |
| Assi./avibl. $P_2O_5$ | 0.039 | 0.053 | 0.006 | 0.004 |
| pH eau/water 1/2,5 | 7.3 | 7.0 | 6.4 | 6.8 |
| pH KCl | 6.1 | 5.3 | 5.2 | 5.6 |
| **CATIONS ECHANGEABLES / EXCH. CATIONS** | | | | |
| Calcium $Ca^{++}$ | 1.33 | 0.78 | 0.78 | 0.05 |
| Magnesium $Mg^{++}$ | 0.50 | 0.55 | 0.20 | 0.05 |
| Potassium $K^{+}$ | 0.17 | 0.32 | 0.06 | 0.01 |
| Sodium $Na^{+}$ | 0.03 | 0.03 | 0.03 | 0.04 |
| Total (S) | 2.03 | 1.68 | 1.07 | 0.15 |
| C.E.C. (T) | 3.30 | 3.60 | 2.60 | 1.50 |
| S/T % | 62 | 47 | 41 | 10 |
| **CARAC. PHYSIQUES / PHYS. CHARAC. / PHYS. CHARACTERISTICS** | | | | |
| Porosity/Porosité % | | | | |
| Field Capacity/pF | 3.3 | 6.9 | | 1.9 |
| Field Capacity/pF 4,2 | 2.4 | 5.6 | 2.3 | 1.3 |
| Field Capacity/pF 2,5 | 4.8 | 9.1 | 10.0 | 3.3 |
| Perméabilité cm/h | 2.2 | 0.7 | 1.1 | 1.2 |
| Fer/Iron $Fe_2O_3$ Total | 0.85 | 1.17 | 0.36 | 0.22 |
| $Fe_2O_3$ Libre | 0.57 | 0.54 | 0.10 | 0.06 |

* Numérotation selon la carte pédologique GERCA à l'échelle 1:70,000
Soil group numbers according to the 1:70,000 soils map of the GERCA Report.

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TABLEAU RECAPITULATIF

TABULAR SUMMARY :

| | | | | |
|---|---|---|---|---|
| [illegible] DE SOL No. | 4 | | 4 | |
| SOIL GROUP NO. * | | | | |
| Profile No./Horizon | 4A | 4B | 5A | 5B |
| Profondeur/Depth cm | 0-30 | 30-40 | 0-20 | 20-35 |
| **GRANULOMETRY** | | | | |
| **GRANULOMETRIE %** | | | | |
| Humidité/Moisture | 1.1 | 0.9 | 0.8 | 1.4 |
| Argile/Clay | 7.5 | 31.5 | 8.0 | 19.1 |
| Limon fin/Fine silt | 24.0 | 18.4 | 18.3 | 17.4 |
| " grossier/Coarse " | 20.6 | 5.9 | 19.6 | 9.1 |
| Sable fin/Fine sand | 34.4 | 22.3 | 31.6 | 30.8 |
| " grossier/Coarse " | 10.2 | 20.0 | 21.4 | 20.5 |
| Mtr.organique/Org.matter | 1.7 | 0.4 | 1.4 | 0.5 |
| Total | 99.5 | 99.4 | 101.1 | 98.8 |
| **MATIERE ORGANIQUE** | | | | |
| **ORGANIC MATTER %** | | | | |
| Carbone:Carbon C | 9.60 | 2.40 | 8.10 | 2.88 |
| Azote/Nitrogen N | 0.67 | 0.[illegible] | 0.46 | 0.26 |
| C/N | 14.3 | 12.0 | 17.6 | 11.1 |
| Total % $P_2O_5$ | 0.105 | 0.070 | 0.105 | 0.09 |
| Ass./avlbl. $P_2O_5$ | 0.017 | 0.007 | 0.010 | 0.014 |
| pH eau/water 1/2,5 | 6.1 | 6.4 | 5.9 | 5.4 |
| PH KCl | 4.9 | 4.5 | 4.8 | 4.2 |
| **CATIONS ECHANGEABLES** | | | | |
| **EXCH. CATIONS** | | | | |
| Calcium $Ca^{++}$ | 2.28 | 6.90 | 1.41 | 1.08 |
| Magnesium $Mg^{++}$ | 0.50 | 1.80 | 0.44 | 0.48 |
| Potassium $K^{+}$ | 0.09 | 0.09 | 0.06 | 0.05 |
| Sodium $Na^{+}$ | 0.04 | 0.[illegible]7 | 0.03 | 0.03 |
| Total (S) | 2.91 | 8.96 | 1.94 | 1.64 |
| C.E.C. (T) | 3.30 | 10.00 | 3.00 | 3.00 |
| S/T % | 88 | 90 | 65 | 55 |
| **CARAC. PHYSIQUES/PHYS.CHARAC.** | | | | |
| **PHYS CHARACTERISTICS** | | | | |
| Porosity/Porosité % | | 19.0 | 30.5 | |
| Field Capacity/pF 3 | 12.8 | 15.2 | 8.9 | 10.1 |
| Field Capacity/pF 4,2 | 5.0 | 11.5 | 3.5 | 5.7 |
| Field Capacity/pF 2,5 | 19.7 | 20.6 | 13.5 | 14.5 |
| Perméabilité cm/h | 0.7 | 0.2 | 0.5 | 1.0 |
| Fer/Iron $Fe_2O_3$ Total | 0.48 | 1.62 | 0.43 | 0.67 |
| $Fe_2O_3$ Libre | 0.09 | 0.67 | 0.12 | 0.27 |

* Numérotés selon la carte pédologique GERCA à l'échelle 1.70.000
Soil group numbers according to the 1.70,000 soils map of the GERCA Report.

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TABLEAU RECAPITULATIF

TABULAR SUMMARY :

| GROUPE DE SOL No. / SOIL GROUP NO. * | 4 | | 4 | |
|---|---|---|---|---|
| Profile No./Horizon | 15A | 15B | 16A | 16B |
| Profondeur/Depth cm | 0-15 | 15-40 | 0-15 | 15-35 |
| **GRANULOMETRY / GRANULOMETRIE %** | | | | |
| Humidité/Moisture | | | | 2.6 |
| Argile/Clay | | | | 27.9 |
| Limon fin/Fine silt | | | | 11.1 |
| " grossier/Coarse " | | | | 9.7 |
| Sable fin/Fine sand | | | | 22.6 |
| " grossier/Coarse" | | | | 25.2 |
| Mtr.organique/Org.matter | | | | 0.5 |
| Total | | | | 99.6 |
| **MATTERE ORGANIQUE / ORGANIC MATTER %** | | | | |
| Carbone:Carbon C | 7.40 | 2.00 | 5.70 | 3.08 |
| Azote/Nitrogen N | 0.46 | 0.19 | 0.43 | 0.27 |
| C/N | 16.1 | 10.5 | 13.3 | 11.4 |
| Total % $P_2O_5$ | 0.120 | 0.08 | 0.115 | 0.050 |
| Ass./avlbl. $P_2O_5$ | 0.009 | 0.001 | 0.009 | 0.001 |
| pH eau/water 1/2,5 | 7.1 | 6.5 | 6.2 | 6.5 |
| PH KGL | 6.1 | 5.0 | 5.0 | 4.9 |
| **CATIONS ECHANGEABLES / EXCH. CATIONS** | | | | |
| Calcium Ca+ | 3.34 | 0.92 | 1.77 | 2.90 |
| Magnesium Mg+ | 0.69 | 0.44 | 0.65 | 1.15 |
| Potassium K+ | 0.05 | 0.06 | 0.04 | 0.02 |
| Sodium Na+ | 0.06 | 0.03 | 0.04 | 0.06 |
| Total (S) | 4.14 | 1.45 | 2.50 | 4.13 |
| C.E.C. (T) | 4.50 | 1.70 | 3.90 | 8.60 |
| S/T % | 92 | 85 | 64 | 48 |
| **CARAC. PHYSIQUES/PHYS.CHARAC. / PHYS CHARACTERISTICS** | | | | |
| Porosity/Porosité % | 39.0 | 35.7 | 34.7 | 33.2 |
| Field Capacity/pF 3 | 6.6 | 6.1 | 6.6 | 11.3 |
| Field Capacity/pF 4,2 | 3.4 | 3.5 | 3.5 | 8.0 |
| Field Capacity/pF 2,5 | 11.2 | 10.9 | 10.5 | 15.5 |
| Perméabilité cm/h | 1.3 | 0.8 | 1.0 | 1.3 |
| Fer/Iron $Fe_2O_3$ Total | 0.34 | 0.31 | 0.40 | 0.93 |
| $Fe_2O_3$ Libre | 0.07 | 0.10 | 0.15 | 0.61 |

* Numérotés selon la carte pédologique GERCA à l'échelle 1.70.000
Soil group numbers according to the 1.70.000 soils map of the GERCA Report.

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TABLEAU RECAPITULATIF

TABULAR SUMMARY :

| GROUPE DE SOL N: / SOIL GROUP NO. * | 5 | | 5 | |
|---|---|---|---|---|
| Profile No./Horizon | 1A | 1B | 11A | 11B |
| Profondeur/Depth cm | 0-27 | 27-50 | 0-15 | 15-40 |
| **GRANULOMETRY / GRANULOMETRY %** | | | | |
| Humidité/Moisture | 0.6 | 0.6 | 1.0 | 4.0 |
| Argile/Clay | 6.0 | 7.3 | 10.5 | 43.5 |
| Limon fin/Fine silt | 4.4 | 4.1 | 9.8 | 10.0 |
| " grossier/Coarse " | 11.3 | 11.6 | 12.5 | 10.5 |
| Sable fin/Fine sand | 47.8 | 48.0 | 43.5 | 20.8 |
| " grossier/Coarse" | 29.2 | 27.5 | 21.2 | 10.1 |
| Mtr.organique/Org. matter | 0.9 | 0.3 | 1.4 | 0.7 |
| Total | 100.2 | 99.4 | 99.9 | 99.6 |
| **MATTIERE ORGANIQUE / ORGANIC MATTER %** | | | | |
| Carbone:Carbon C | 5.10 | 1.56 | 8.10 | 4.24 |
| Azote/Nitrogen N | 0.36 | 0.13 | 0.48 | 0.46 |
| C/N | 14.2 | 12.0 | 16.9 | 9.2 |
| Total % $P_2O_5$ | 0.100 | 0.120 | 0.115 | 0.140 |
| Ass./avlb. $P_2O_5$ | 0.009 | 0.009 | 0.006 | 0.003 |
| pH eau/water 1/2,5 | 5.3 | 5.8 | 6.0 | 5.6 |
| PH KCL | 4.5 | 4.6 | 4.7 | 4.1 |
| **CATIONS ECHANGEABLES / EXCH. CATIONS** | | | | |
| Calcium Ca+ | 1.33 | 0.93 | 1.33 | 2.28 |
| Magnesium Mg+ | 0.23 | 0.18 | 0.59 | 0.15 |
| Potassium K+ | 0.02 | 0.01 | 0.05 | 0.04 |
| Sodium Na+ | 0.03 | 0.02 | 0.04 | 0.11 |
| Total (S) | 1.61 | 1.14 | 2.01 | 2.58 |
| C.E.C. | 2.70 | 3.80 | 3.40 | 5.30 |
| S/T % | 60 | 30 | 59 | 49 |
| **CARC. PHYSIQUES/PHYS. CHARAC. / PHYS CHARACTERISTICS** | | | | |
| Porosity/Porosité % | [illegible] | | 30.2 | 38.4 |
| Field Capacity/pF 3 | 4.0 | 3.4 | 7.2 | 16.3 |
| Field Capacity/pF 4,2 | 2.5 | 2.5 | 3.9 | 12.4 |
| Field Capacity/pF 2,5 | 6.2 | 5.6 | 10.4 | 20.2 |
| Perméabilité cm/h | 2.9 | 2.4 | 0.7 | 3.4 |
| Fer/Iron $Fe_2O_3$ Total | 0.46 | 0.39 | 0.50 | 1.20 |
| $Fe_2O_3$ Libre | 0.21 | 0.19 | 0.25 | 0.90 |

* Numérotés selon la carte pédologique GERCA à l'échelle I.70,000
Soil group numbers according to the 1.70,000 soils map of the GERCA Report.

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TABLEAU RECAPITULATIF

TABULAR SUMMARY :

| GROUPE DE SOL No<br>SOIL GROUP NO. * | 5 | | 6 | |
|---|---|---|---|---|
| Profile No./Horizon | 12A | 12B | 6A | 6B |
| Profondeur/Depth cm | | | 0-15 | 15-30 |
| **GRANULOMETRY**<br>**GRANULOMETRIE %** | | | | |
| Humidité/Moisture | 0.7 | 1.3 | 1.1 | 2.0 |
| Argile/Clay | 6.9 | 15.9 | 11.3 | 28.8 |
| Limon fin/Fine silt | 8.9 | 8.6 | 18.0 | 15.3 |
| " grossier/Coarse " | 13.5 | 13.6 | 20.2 | 16.3 |
| Sable fin/Fine sand | 49.8 | 41.9 | 31.7 | 23.9 |
| " grossier/Coarse " | 18.6 | 17.6 | 16.4 | 12.7 |
| Mtr. organique/Org. matter | 1.4 | 1.1 | 1.5 | 0.9 |
| Total | 99.8 | 100.0 | 100.2 | 99.9 |
| **MATTERE ORGANIQUE**<br>**ORGANIC MATTER %** | | | | |
| Carbone : Carbon C | 8.00 | 6.10 | 8.70 | 5.04 |
| Azote/Nitrogen N | 0.46 | 0.41 | 0.61 | 0.43 |
| C/N | 17.4 | 14.9 | 14.3 | 11.7 |
| Total % $P_2O_5$ | 0.08 | 0.11 | 0.12 | 0.085 |
| | 0.009 | 0.004 | 0.014 | 0.009 |
| pH eau/water 1/2,5 | 6.4 | 5.4 | 6.1 | 5.4 |
| PH KCL | 5.3 | 4.1 | 5.0 | 4.8 |
| **CATIONS ECHANGEABLES**<br>**EXCH. CATIONS** | | | | |
| Calcium Ca+ | 1.33 | 0.70 | 2.05 | 1.78 |
| Magnesium Mg+ | 0.62 | 0.12 | 0.63 | 1.18 |
| Potassium K+ | 0.26 | 0.12 | 0.10 | 0.06 |
| Sodium Na+ | 0.03 | 0.04 | 0.03 | 0.08 |
| Total (S) | 2.24 | 0.98 | 2.87 | 2.10 |
| C.E.C. (T) | 2.70 | 3.10 | 4.60 | 3.90 |
| S/T % | 83 | 32 | 62 | 54 |
| **CAR. PHYSIQUES/PHYS. CHARAC.**<br>**PHYS CHARACTERISTICS.** | | | | |
| Porosity/Porosité % | 32.8 | 37.5 | | |
| Field Capacity/pF 3 | 5.6 | 7.9 | 8.8 | 12.4 |
| Field Capacity/pF 4,2 | 3.2 | 5.5 | 4.7 | 8.6 |
| Field Capacity/pF 2,5 | 9.7 | 11.6 | 15.3 | 17.1 |
| Perméabilité cm/h | 2.1 | 2.5 | 0.8 | 2.1 |
| Fer/Iron $Fe_2O_3$ Total | 0.49 | 0.75 | 0.58 | 0.91 |
| $Fe_2O_3$ Libre | 0.20 | 0.38 | 0.25 | 0.37 |

* Numérotés selon la carte pédologique GERCA à l'échelle 1.70.000
Soil group numbers according to the 1.70,000 soils map of the GERCA Report.

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TABLEAU RECAPITULATIF

TABULAR SUMMARY :

| GROUPE DE SOL No / SOIL GROUP NO. * | 6 | | 7 | |
|---|---|---|---|---|
| Profile No./Horizon | 7A | 7B | 17A | 17B |
| Profondeur/Depth cm | 0-20 | 20-40 | 0-15 | 15-40 |
| **GRANULOMETRY / GRANULOMETRIE %** | | | | |
| Humidité/Moisture | 0.7 | 3.1 | 4.6 | 5.0 |
| Argile/Clay | 8.0 | 48.9 | 49.3 | 51.3 |
| Limon fin/Fine silt | 9.4 | 10.6 | 14.9 | 14.9 |
| " grossier/Coarse " | 5.3 | 3.9 | 15.7 | 13.3 |
| Sable fin/Fine sand | 37.3 | 18.4 | 10.4 | 9.8 |
| " grossier/Coarse " | 38.5 | 14.3 | 3.4 | 3.6 |
| Mtr. organique/Org. matter | 1.1 | 0.8 | 1.6 | 1.1 |
| Total | 100.3 | 100.0 | 99.9 | 99.0 |
| **MATTERE ORGANIQUE / ORGANIC MATTER %** | | | | |
| Carbone:Carbon C | 6.40 | 4.60 | 9.00 | 6.50 |
| Azote/Nitrogen N | 0.45 | 0.49 | 0.72 | 0.50 |
| C/N | 14.2 | 9.4 | 12.5 | 13.0 |
| Total % $P_2O_5$ | 0.155 | 0.160 | 0.19 | 0.125 |
| Ass./avlb. $P_2O_5$ | 0.009 | 0.006 | 0.015 | 0.006 |
| pH eau/water 1/2,5 | 6.0 | 5.0 | 5.8 | 5.5 |
| PH KCL | 4.8 | 3.9 | 4.2 | 3.9 |
| **CATIONS ECHANGEABLES / EXCH. CATIONS** | | | | |
| Calcium Ca+ | 1.00 | 0.70 | 6.34 | 5.40 |
| Magnesium Mg+ | 0.55 | 0.38 | 1.73 | 1.06 |
| Potassium M+ | 0.11 | 0.06 | 0.09 | 0.05 |
| Sodium Na+ | 0.02 | 0.04 | 0.10 | 0.11 |
| Total (S) | 1.68 | 1.26 | 8.26 | 6.62 |
| C.E.C. (T) | 4.40 | 7.30 | 12.20 | 14.80 |
| S/T % | 38 | 17 | 68 | 45 |
| **CARC. PHYSIQUES/PHYS. CHARAC. / PHYS CHARACTERISTICS** | | | | |
| Porosity/Porosité % | 29.7 | | 39.5 | 35.2 |
| Field Capacity/pF 3 | 6.1 | 18.1 | 19.3 | 19.7 |
| Field Capacity/pF 4,2 | 3.2 | 14.4 | 14.5 | 15.2 |
| Field Capacity/pF 2,5 | 9.0 | 21.7 | 25.4 | 26.4 |
| Perméabilité cm/h | 0.6 | 2.7 | 1.0 | 2.1 |
| Fer/Iron $Fe_2O_3$ Total | 0.59 | 1.36 | 0.66 | 0.74 |
| $Fe_2O_3$ Libre | 0.29 | 0.63 | 0.34 | 0.38 |

* Numérotés selon la carte pédologique GERCA à l'échelle 1.70.000
Soil group numbers according to the 1.70,000 soils map of the GERCA Report.

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TAB.LEAU RECAPITULATIF

TABULAR SUMMARY :

| GROUPE DE SOL No / SOIL GROUP NO. * | 8 | |
|---|---|---|
| Profile No./Horizon | 13A | 13B |
| Profondeur/Depth cm | 0-20 | 20-50 |
| **GRANULOMETRY / GRANULOMETRIE %** | | |
| Humidité/Moisture | 5.3 | 4.2 |
| Argile/Clay | 38.9 | 33.0 |
| Limon fin/Fine silt | 15.4 | 9.8 |
| " grossier/Coarse " | 9.3 | 12.6 |
| Sable fin/Fine sand | 15.6 | 20.3 |
| " grossier/Coarse " | 12.8 | 18.9 |
| Mtr. organique/Org.matter | 2.8 | 0.4 |
| Total | 100.1 | 99.2 |
| **MATIERE ORGANIQUE / ORGANIC MATTER %** | | |
| Carbone:Carbon C | 16.20 | 2.50 |
| Azote/Nitrogen N | 1.28 | 0.66 |
| C/N | 12.7 | 9.6 |
| Total % $P_2O_5$ | 0.220 | 0.070 |
| Ass./avlb. $P_2O_5$ | 0.025 | 0.009 |
| pH eau/water 1/2,5 | 5.6 | 6.0 |
| PH KCL | 4.1 | 4.2 |
| **CATIONS ECHANGEABLES / EXCH. CATIONS** | | |
| Calcium Ca+ | 5.90 | 6.78 |
| Magnesium Mg+ | 1.00 | 0.69 |
| Potassium K+ | 0.14 | 0.07 |
| Sodium Na+ | 0.15 | 0.24 |
| Total (S) | 7.19 | 7.78 |
| C.E.C. (T) | 13.90 | 11.10 |
| S/T % | 52 | 70 |
| **CAR. PHYSIQUES/PHYS. CHARAC. / PHYS CHARACTERISTICS** | | |
| Porosity/Porosité % | 33.8 | 21.0 |
| Field Capacity/pF 3 | 21.1 | 15.4 |
| Field Capacity/pF 4,2 | 15.1 | 11.9 |
| Field Capacity/pF 2,5 | 29.8 | 19.8 |
| Perméabilité cm/h | 0.8 | 0.9 |
| Fer/Iron $Fe_2O_3$ Total | 0.86 | 1.17 |
| $Fe_2O_3$ Libre | 0.46 | 0.54 |

* Numérotés selon la carte pédologique GERCA à l'échelle 1.70.000
Soil group numbers according to the 1.70.000 soils map of the GERCA Report.

## Annex 1 : Description of Soil Samples.

### SOIL PROFILE NO. 1

LOCATION : Approximately 4.5 km. south of Kerevane a long road from Kerevane to Kedougoudikor.

HISTORY : It was reported that rice had been planted by villagers several years ago but was abandoned.

VEGETATION : Intermittant low-growing trees. All grasses and young plants had been destroyed by fire.

SOIL DESCRIPTION :

0-27 cm Light greyish very fine sand, or fine sand, with some evidence of organic matter in the surface.

27-50 cm Very light color of whitish-yellow fine sand with some moisture present.

### SOIL PROFILE NO. 2.

LOCATION : Approximately 2.5 km. south of Velingara in a cultivated area of the village Saré Djimini. This location was near the 35 m contour line.

HISTORY : Land had been cropped for several years and was planted in corn during 1976. Yield estimates could not be obtained.

VEGETATION : Dried cornstalk residue left from cattle grazing.

SOIL DESCRIPTION :

0-20 cm Very compact dark grey very fine sand.

20-40 cm Very compact yellowish sand.

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COMMENTS : This location is in the Soil Group 2 shown on the soils map. This village plants peanuts for seed multiplication for the department of Agriculture.

SOIL PROFILE NO. 3.

LOCATION : Approximately 1.5 km. south of Sare Djimini along old road from Velingara to Kounkane.

HISTORY : Rice was grown in this area in 1973 with yields of about 0.95t/ha. It was reported to have standing water intermittently during the rainy season and that during periods of no rain (in July, August, and September) the soil remains saturated.

VEGETATION : Low-growing trees. All grass and other vegetation had been destroyed by fire.

SOIL DESCRIPTION

0-30 cm Whitish fine sand with no profile development.

30-60 cm Whitish fine sand grading to slightly more coarse material. A modest amount of moisture was observed beginning at about the 30 cm depth.

SOIL PROFILE NO.4.

LOCATION : Approximately 2.5 km. south of Sare Djimini along old road from Velingara to Kounkane.

HISTORY : According to the best information available, this area has never been in cultivation due to very heavy soil that cannot be plowed with the oxen that farmers have and due to weed control being too difficult. The excessive weed problem was said to be due to very poor land preparaion.

VEGETATION : Low-growing trees with only an occasional tuft of tall Andropogan-type grass.



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SOIL DESCRIPTION

0-30 cm Grey sandy or silty clay, very compact. Thes surface was characterized by numerous small mounds somewhat conical but irregular in shape, approximately 22-25 cm in diameter at the base and 15-25 cm high. At first glance, it appeared that the land had been roughly plowed but closer observation showed that the mounds were a natural phenomen.

30-40 cm Greyish silty clay, extremely compact, impervious.

COMMENTS : It was reported that this area has stagnant water standing on it throughout the rainy season. The soil area may have been a slight depression in relation to the surrounding soil areas. It was located in the center of a large area of Soil Group 4 on the soils map.

SOIL PROFILE NO. 5.

LOCATION : Approximately 4.5 km. south of Sare Djimini along old road from Velingara to Kounkane.

VEGETATION : Low-growing trees. All grass and other vegetation had been destroyed by fire.

SOIL DESCRIPTION :

0-20 cm Light grey silt with some clay material, compact.

20-35 cm Greyish silty clay with traces of yellow mottling.

COMMENTS : This soil location is in an area shown in the soil map as Group 4. If this sample is a good representation of Soil Group 4 and if it extends more of less on a contour around the Anambe basin as indicated on the soils map, it would represent the largest single soil area in the basin.

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SOIL PROFILE NO. 6

LOCATION : Approximately 1 km. south-southwest of the Village Toungoulel (the village was abandoned at the time of this visit).

HISTORY : No signs of past cultivation were observed. A villager at Sare Djimini stated that this area was flooded during the rainy season and that fish could be seen jumping in the water where the village is located, and that the people had all moved to a location near Velingara.

VEGETATION : Low-growing trees with very little other types of vegetation. There had been no fire, but cattle-grazing had been so intense that the ground was almost bare.

In the process of digging a hole for this soil sample, several fleshy tubers about the size and shape of an onion were observed. Even though the soil was very compact and dry, the tubers were full of moisture and would probably emerge with the first rains, and due to density in number of tubers, might be a dominant species of vegetation during the rainy season.

SOIL DESCRIPTION :

0-15 cm- Grey silty clay, extremely compact.

15-30 cm- Lighter grey silty clay with a considerable amount of yellowish mottling and containing a few small iron concretions. Some moisture was observed at the 25 cm depth.

COMMENTS : It is determined that this location was below the 25 meter contour level and estimated to be approximately at the 23.5 meter level. According to the soils map, this soil was located in Group 6.

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SOIL PROFILE NO. 7

LOCATION : 2 km. southest of Sare Quinor along the road from Sare Quinor to Darou and 1 km. south of road down the major drainageway shown on all maps.

HISTORY : This area showed no indication of having ever been cultivated. A villager reported that this area did not flood continously during the rainy season.

VEGETATION ; Low-growing trees with considerable amount of different thorny bushes.

SOIL DESCRIPTION :

0-20 cm - Light grey sandy or silty clay.

20-40 cm - Lighter grey silty clay with a small amount of red mottling and very compact

COMMENTS : This location was in the Soil Group 6 according to the soils map. The onion-like bulbs observed at the location of Soil Sample NO. 6 were also observed at this location.

Numerous termite tunnels were observed on the ground surface which gave a crust-like appearance.

SOIL PROFILE NO. 8

LOCATION : 200 m from the crossway Kounkande Koulandialan. At the edge of the road to Koulandialan. Peanuts cultivated this year.

DESCRIPTION :

0-15 cm - Texture : silt-sandy

Structure : not very developed

Permeability : permeable enough.

Colour : grey

Organic matter : great influence of humus

15-20 cm - Texture : silt clay

Structure : not very developed - with some concretions

Colour : grey yellowish

Organic matter : little influence of humus.

SOIL PROFILE NO. 9.

LOCATION : In Koulandialan, under millet and corn field at the end of the road.

HISTORY : The farmer reported that this field had been cultivated with millet and corn for more than 20 years.

DESCRIPTION :

0-15 cm - Texture : silt sandy.

Structure : structure not developed

Colour : grey

Permeability : quite permeable

Organic matter : great influence of humus with small roots in this horizon.

15-45 cm - Texture : silt clay

Structure : developed - more compact with few concretions

Colour : yellowish red

Permeability : permeable

Organic matter : some influence of roots but little humus.

SOIL PROFILE NO. 10.

LOCATION : Under cotton field -from 50 m of millet field. (profile 11) in 1976 it was millet field.

DESCRIPTION :

0-15 cm Texture : silty clay

Structure : not well developed

Colour : reddish grey or yellowish

Organic matter : low

Permeability : permeable

SOIL PROFILE NO. 11.

LOCATION : 2 km. from Anambe in the direction N N E

CONDITIONS : Local inhabitants report that during rainy season this area is flooded to a depth of 80 cm.

VEGETATION : Very tall grasses (1 m 50 - 1 m 70)

DESCRIPTION :

0-15 cm Texture : silty clay to clay

Structure : well developed enough

Colour : grey

Permeability : not permeable, very little organic matter, presence of some onion - like tubers.

15-40 cm Texture : silt clay

Structure : developed

Permeability : more permeable

Organic matter : little influence

Moisture : below 30 cm

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SOIL PROFILE NO. 12.

LOCATION ; 1 km. distant from NO.11. The same physical characteristics as NO. 11 were found except that the surface (A) horizon was not so thick.

SOIL PROFILE NO. 13.

LOCATION : 5 km. from Anambe N N E direction - in the deep valley.

CONDITIONS : Highly organic soils - with some water. After dessication, Polygonal soils with 3 cm wide cracks.

High grasses - 1m70cm to 2 m.

DESCRIPTION :

0-20 cm - Texture : silty clay

Structure : good structure

Permeability : impermeable

Colour : grayish black.

Organic matter : great influence of partially decomposed organic matter.

20-50 cm - Texture : sandy silt

Colour : reddish with light spots

Structure : not very developed

Permeability : very permeable

Organic matter : some small roots

SOIL PROFILE NO. 14.

LOCATION : PAPEM (ISRA research station), about 2 km SE from Vélingara.

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DESCRIPTION :

0-15 cm - Texture : sandy

Colour : gray

Organic matter : fragments of roots

15-50 cm - Texture : sandy clay

Colour : yellowish - reddish

Organic matter : root fragments.

SOIL PROFILE NO. 15.

LOCATION : 200 m from Tamacounda at the right edge of the road in a cotton field.

DESCRIPTION :

0-15 cm - Texture : silt clay

Structure : good structure

Permeability : permeable

Depth : deep soil

Moisture : dry soil on the surface

Colour : gray

Organic matter : presence of rootlets

15-40 cm - Texture : sandy silt

Structure : good structure

Permeability : permeable

Colour : gray reddish gleyification spots not very evident

Organic matter : very few rootlets.

GENERALITIES : According to the inhabitants of the village of Tamacounda has only existed since 12 years ago. The inhabitants came from the village of Sare Bessel, which still exists.

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The agricultural products are : rice, peanut, millet, corn, etc ...
The problems are the rapid infiltration of water. Some rivers did not have enough water this year (1976) because after about 5 or 10 days the water infiltrates completely ;
A well-digger has told us that whwn digging the wells at the beginning of the rainy season he finds water at 7m deep.
The inhabitants say that apart from the problem of water, their soils show a good fertility.

SOIL PROFILE NO. 16

LOCATION : About 1500 m from Tamacounda under a rice-field, at the right edge of the road.

DESCRIPTION :

0-15 cm - Texture : silt clay
Structure : very compact on the surface
Permeability : low permeability
Colour gray
Organic matter : presence of numerous rootlets

15-35 cm + Texture : silt clay, more sand
Structure : moderately well developed
Colour : spots of gleyfication very neat
Organic matter : low

GENERALITIES : According to the farmers, the standing-water in this area reaches a depth of 15 to 20 cm and stays at that level 5 to 10 days ; it infiltrates after that.

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SOIL PROFILE NO. 17.

LOCATION : 6 km. from Mountoumba in the S.E. direction.

DESCRIPTION :

0-15 cm : Texture : clay - heavy soil

Structure : a good structure due to the presence of organic matter in humus.

Permeability : less permeable - soil with partial hydromophia.

Colour : gray, dark gray. Gray soil at the bottom of the slope.

15-40 cm Texture : clay

Structure : good structure

Colour : ochre gleyification spots

Permeability : poor permeability

Organic matter : presence of numerous roots at lower depth.

GENERALITIES : We took this sample at 50 mm of the shallow standing water which remains at this level and extends up to Teyel.

This soil is characterized by the presence of large clefts and break-ups on the surface. Probably these clefts are due to the presence of swelling clay. (montmorillonite).

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# CHAPTER 5 - CLIMATOLOGY AND HYDROLOGY

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7.1. Climatic Dictates
7.2. Hydrology Dictates.

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## 5.1. CLIMATE

### 5.1.1. Climatological Stations

Three third-class weather stations of importance are currently in operation within the project area, but they record only daily rainfall data. These stations are as follows :

| Station | Elevation | Coordinates | Recording Period |
|---|---|---|---|
| Velingara | 40 m | 13°9'N - 14°7'W | 1932 to present |
| Kounkande | 32 m | 12°56'N -14°1'W | 1965 to present |
| Kerevane | 44 m | 13°8'N - 14°10'W | 1971 to present |

Three first-class weather stations operate near the basin and are important to the study. These synoptic stations record data on rainfall, wind, temperature, radiation, sunlight hours and evaporation. They are as follows :

| Station | Distance from Basin Center (km) | Elev. (m) | Location Coordinates | Data Obtained for Periods of Observation |
|---|---|---|---|---|
| Kolda | 87 | 35 | 12°53' N 14°58'W | 1922 intermittently to present |
| Tambacounda | 92 | 49 | 13°46'N 13°41'W | 1919 intermittently to present |
| Kedougou | 20 | 178 | 12°37'N 12°13'W | 1918 intermittently to present |

Data from these stations are sent to the National Meteorological Service (ASECNA) at Yoff Airport in Dakar, from which source most of the information used in this report was obtained.

.../...

The Velingara station is of primary importance to the projet studies due to its location at the northern edge of the basin and its length of rainfall records. Kounkande station is of importance due to its location near the southern edge of the basin, for its period of record in common with that of Velingara (12 years), and as it reflects the increased rainfall received by the southern portion of the basin as compared to the Velingara area of influence. Data from the Kerevane station, located approximately 7.5 kilometers due east of Velingara, is important as its values when compared to daily and monthly recordings in common with Velingara demonstrate the variations in point rainfall as compared to mean areal precipitation.

Data from Kolda and Tambacounda stations, and to a lesser extent from the Kedougou station, were utilized to construct synthetic values representing average meteorological conditions, except for rainfall, within the study basin.

5.1.2. Velingara Precipitation

Daily precipitation data from 1932 through 1976 are available on computer print-outs from ASECNA. Most years are complete; however, there is a gap in recordings for the period between July, 1959 and June, 1961. Table 5.1.2., which follows, shows monthly and annual totals for the official Velingara station which is maintained by the Sector Agricole office. Averages for months of records have been assumed for the missing months (with the exception of entire 1960) in order to compute long term averages and probabilities of precipitation. Based on 44 years of records, the average rainfall in mm for Velingara is as follows :

.../...

**Table 5.1.2. : Velingara Rainfall (mm)**
**Tableau 5.1.2. Pluviométrie de Vélingara (mm)**

| Year Année | J-A J-A | May Mai | Jun Juin | Jul Juil | Aug Août | Sep Sept | Oct Oct | N-D N-D | Annual Total Total Annuel | % of Normal % de la normale |
|---|---|---|---|---|---|---|---|---|---|---|
| 1932 | 2.0 | 59.3 | 115.5 | 210.3 | 352.8 | 318.5 | 9.5 | 0.0 | 1067.9 | 99.6 |
| 1933 | 0.0 | 4.0 | (130.8) | (214.3) | 270.0 | 411.5 | 23.1 | 26.0 | 1079.7 | 100.7 |
| 1934 | 0.0 | 0.0 | 185.0 | 351.7 | 782.5 | 781.5 | 204.6 | 0.0 | 2305.8 | 215.0 |
| 1935 | 0.0 | 0.0 | 260.8 | 187.8 | 287.8 | 253.3 | 50.3 | 15.8 | 1055.8 | 98.4 |
| 1936 | 0.0 | 127.3 | 152.8 | 171.6 | 515.5 | 177.4 | 72.5 | 1.4 | 1218.5 | 113.6 |
| 1937 | 0.0 | 0.0 | 77.4 | 128.3 | 284.7 | 175.3 | 103.8 | 0.0 | 769.5 | 71.7 |
| 1938 | 21.0 | 8.2 | 78.1 | 135.4 | 334.9 | 293.2 | 14.2 | 0.0 | 885.1 | 82.5 |
| 1939 | 0.0 | 12.9 | [illegible] | 193.4 | 310.3 | 326.1 | 136.9 | 0.0 | 1140.8 | 106.4 |
| 1940 | 0.0 | 4.4 | 148.6 | 159.8 | 274.6 | [illegible] | 215.8 | 0.0 | 1151.7 | 107.4 |
| 1941 | 0.0 | 152.7 | 191.5 | 320.9 | 360.9 | 240.1 | 21.6 | 0.0 | 1287.7 | 120.1 |
| 1942 | 3.5 | 25.0 | 133.1 | 253.8 | 250.0 | 299.0 | 121.0 | 18.5 | 1103.9 | 102.9 |
| 1943 | 0.0 | 28.0 | 98.0 | 153.0 | 297.5 | 428.0 | 131.0 | 0.0 | 1135.5 | 105.9 |
| 1944 | 0.0 | 4.0 | 213.0 | 152.0 | 145.0 | 261.0 | 95.0 | 25.0 | 895.0 | 83.4 |
| 1945 | 2.0 | 8.0 | 66.9 | 167.2 | 392.6 | 240.0 | 65.4 | 6.2 | 948.3 | 88.4 |
| 1946 | 0.5 | 0.0 | 170.2 | 276.0 | 359.1 | 231.0 | 96.3 | 0.0 | 1133.1 | 105.6 |
| 1947 | 0.0 | 0.0 | 106.0 | 236.9 | 338.8 | 247.6 | 73.2 | 2.2 | 1004.7 | 93.7 |
| 1948 | 0.0 | 5.6 | 189.4 | 169.2 | 242.5 | 264.3 | 101.4 | 0.0 | 972.4 | 90.7 |
| 1949 | 0.0 | 15.3 | 229.2 | 194.9 | 317.6 | 183.4 | 52.7 | 8.0 | 901.1 | 84.1 |
| 1950 | 0.0 | 28.2 | 71.9 | 177.3 | 568.0 | 210.4 | 148.5 | 19.0 | 1223.3 | 114.0 |
| 1951 | 0.0 | 38.2 | 97.7 | 287.9 | 394.9 | 353.0 | 224.2 | 32.0 | 1428.1 | 133.1 |
| 1952 | 0.0 | 104.0 | 126.5 | 293.5 | 77.5 | 373.2 | 188.1 | 0.0 | 1162.8 | 108.4 |
| 1953 | 0.0 | 0.0 | 110.2 | 374.6 | 204.3 | 197.4 | 93.7 | 0.0 | 980.2 | 91.4 |

(suite)

**Table 5.1.2. : Vélingara Rainfall (mm)**

**Tableau 5.1.2. : Pluviométrie de Vélingara (mm)**

| Year<br>Année | J-A<br>J-A | May<br>Mai | Jun<br>Juin | Jul.<br>Juil. | Aug<br>Août | Sep<br>Sept | Oct<br>Oct | N-D<br>N D | Annual Total<br>Total Annuel | % of Normal<br>% de la normale |
|---|---|---|---|---|---|---|---|---|---|---|
| 1954 | 4.0 | 2.0 | 82.5 | 141.1 | 289.4 | 204.0 | 36.3 | 18.6 | 777.9 | 72.6 |
| 1955 | 29.0 | 43.1 | [illegible].6 | 448.7 | 283.2 | 258.4 | 88.6 | 0.0 | 1256.6 | 117.2 |
| 1956 | 0.0 | 24.4 | 148.6 | 223.4 | 295.4 | 203.1 | 63.2 | 5.3 | 963.4 | 89.8 |
| 1957 | 0.0 | 0.0 | 136.9 | 154.4 | 468.0 | 456.4 | 198.5 | 4.5 | 1410.7 | 132.3 |
| 1958 | ( 2.6 ) | (25.5) | 196.5 | 175.0 | 608.2 | 234.1 | 41.9 | 37.0 | 1320.8 | 123.1 |
| 1959 | 0.5 | 44.0 | 93.5 | (214.3) | (319.7) | (281.9) | (90.8) | (5.7) | 1050.0 | 97.9 |
| 1960 (1) | NA/ND | NA/ND | NA/ND | NA/ND | NA/ND | NA/ND | NA/ND | NA/ND | NA/ND | NA/ND |
| 1961 | (2.6) | (25.5) | 152.3 | 277.2 | 663.6 | 342.2 | 76.0 | (9.1) | 1551.4 | 145.0 |
| 1962 | 0.0 | 26.5 | 152.8 | 239.4 | 305.8 | 216.5 | 112.3 | 1.5 | 1055.8 | 98.4 |
| 1963 | 0.0 | 10.7 | 66.1 | 173.7 | 331.3 | 203.0 | 149.2 | 0.0 | 934.9 | 87.2 |
| 1964 | 67.4 | 108.7 | 230.6 | 329.8 | 310.2 | 451.4 | 56.0 | 0.0 | 1554.1 | 147.9 |
| 1965 | 0.0 | 3.7 | 49.4 | 238.2 | 239.1 | 207.6 | 87.4 | 19.0 | 924.4 | 86.2 |
| 1966 | 0.0 | 19.6 | 218.2 | 160.0 | 148.0 | 295.9 | 192.2 | 0.0 | 1034.8 | 96.5 |
| 1967 | 0.0 | 24.8 | 192.7 | 190.7 | 255.4 | 357.1 | 74.8 | ( 5.7 ) | 1101.2 | 102.7 |
| 1968 | 11.9 | 20.7 | 142.6 | 148.1 | 159.1 | 287.1 | 46.8 | 0.0 | 816.3 | 76.1 |
| 1969 | 3.6. | 6.7. | 47.9 | 106.6 | 360.5 | 181.9 | [illegible] | 0.0 | 866.3 | 80.8 |
| 1970 | 0.0 | 16.5 | 120.5 | 153.5 | 257.5 | 199.8 | 26.4 | 0.0 | 774.3 | 72.2 |
| 1971 | 0.0 | 6.9 | 182.0 | 135.2 | 247.3 | 225.7 | 13.6 | 0.0 | 810.7 | 75.6 |
| 1972 | 0.0 | 10.8 | 84.9 | 220.7 | 175.6 | 125.6 | 82.8 | 0.0 | 700.4 | 65.3 |
| 1973 | 0.0 | 56.3 | 126.7 | 242.9 | 279.2 | 130.1 | 34.7 | 0.0 | 869.9 | 81.1 |

..../....

(suite)

**Table 5.1.2. : Vélingara Rainfall (mm)**
**Tableau 5.1.2. : Pluviométrie de Vélingara (mm)**

| Year Année | J-A J-A | May Mai | Jun Juin | Jul. Juil. | Aug Août | Sep Sept. | Oct Oct. | N-D N-D | Annual Total Total Annuel | % of Normal % de la normale |
|---|---|---|---|---|---|---|---|---|---|---|
| 1974 | 0.0 | 2.1 | 46.7 | 222.9 | 206.3 | 166.7 | 55.4 | 3.6 | 703.7 | 65.6 |
| 1975 | 0.2 | 3.8 | 61.4 | 238.8 | 332.7 | 392.2 | 12.0 | 0.0 | 1041.1 | 97.1 |
| 1976 | 12.9 | 14.5 | 101.5 | 184.1 | 164.9 | 286.9 | 52.1 | 0.0 | 816.9 | 76.2 |
| AV. | 3.7 | 25.5 | 130.8 | 214.3 | 319.7 | 281.9 | 90.8 | 5.8 | 1072.5 | 100.0 |

Notes : ( ) Amounts shown in paranthesis, indicating the absence of data, are assumed as the average of other years of records.

( 1 ) No data is available for 1960

( ) Les chiffres entre parantheses (qui indiquent le manque de données) sont estimés comme étant la moyenne des autres années des données.

(1) Les données pour 1960 ne sont pas disponibles.

..../....

Velingara Station Rainfall (mm)

| Jan - Apr | May | June | July | August | Sept. | Oct. | Nov-Dec. | Annual |
|---|---|---|---|---|---|---|---|---|
| 3.7 | 25.5 | 130.8 | 214.3 | 319.7 | 281.9 | 90.8 | 5.8 | 1072.5 |

Averages of rainfall by decades are shown below and indicate the depressing effect of the prolonged period of drought during the last decade.

Velingara Rainfall By Decades of Years:

| Decade | Aver. for Decade | % of 44-year Average |
|---|---|---|
| 1976 - 1967 | 850.1 | 79.3 |
| 1966 - 1957 (1) | 1205.0 | 112.3 |
| 1956 - 1947 | 1067.1 | 99.5 |
| 1946 - 1937 | 1045.1 | 97.4 |
| 1936 - 1932 (2) | 1345.4 | 125.4 |

(1) less 1960 (2) 5-year average

From 1968 through 1974, rainfall in Velingara averaged 791.7mm per year which is 74% of normal, for an average deficit of 281 mm. 1972 and 1974 recorded 700.4 mm and 703.7 mm respectively, or about 65% of the average.

Approximately 88% of annual rainfall occurs during the four-month period June through September. By including the transitional months of May and October into a six - month wet season, over 99% of annual rainfall is accounted for . The very infrequent showers

.../...

which occur during the dry season (November through April) are agriculturally unimportant and are usually less than daily evaporation.

5.1.3. Kounkandé Precipitation.

Regular rainfall recordings were begun in Kounkande by the Centre d'Expansion Rurale in August, 1963. They were discontinued during 1964, but have been continuous since January, 1965, until the present time. Discounting the partial year of 1963, 12 complete years of data exist . Table 5.1.3., which follows, shows monthly and annual totals and averages for the period of record. This data is summarized as follows :

Kounkande Station Rainfall (mm)

| Jan-Apr. | May | June | July | August | Sept. | Oct. | Nov-Dec. | Total |
|---|---|---|---|---|---|---|---|---|
| 0.9 | 23.5 | 119.2 | 218.6 | 232.7 | 272.0 | 86.6 | 4.9 | 958.4 |

Average annual totals for the period in common with Velingara are shown below for 1965 - 1976.

| | Annual Average |
|---|---|
| Kounkande | 958.4 mm |
| Velingara | 823.7 mm |

It can be assumed from this comparison, which covers the recent droughty years, that Kounkande which lies 32 kilometers south of Velingara, on the average will receive at least 100 mm more total annual precipitation than Velingara. Conversely, the northern half

.../...

**Table 5.1.3. : Kounkande Rainfall ( mm)**
**Tableau 5.1.3. : Pluviométrie de Kounkandé (mm ).**

| Year Année | J-A J-A | May Mai | Jun Juin | Jul Juil. | Aug Août | Sep Sept. | Oct Oct | N-D N-D | Annual Total Total Annuel | % of Normal % de la normale |
|---|---|---|---|---|---|---|---|---|---|---|
| 1965 | 0.0 | 8.1 | 34.1 | 215.0 | 387.3 | 211.[illegible] | 94.7 | 4[illegible].7 | 997.4 | 104.1 |
| 1966 | 0.0 | 26.0 | 203.0 | 113.5 | 136.1 | 326.[illegible] | 204.4 | 0.6 | 1010.5 | 105.5 |
| 1967 | 0.0 | 11.6 | 144.3 | 291.4 | 240.3 | 308.6 | 132.[illegible] | 0.0 | 1133.5 | 118.3 |
| 1968 | 5.0 | 7.9 | 187.6 | 121.8 | 133.9 | 247.9 | 86.5 | 1.4 | 792.0 | 82.7 |
| 1969 | 0.0 | [illegible].3 | 96.8 | 243.3 | 217.8 | 278.9 | 140.4 | 0.0 | 992.5 | 103.6 |
| 1970 | 0.0 | 36.0 | 95.4 | 197.9 | 227.8 | 332.4 | 24.5 | 0.0 | 914.0 | 95.4 |
| 1971 | 0.2 | 2.8 | 194.0 | 149.5 | 331.3 | 328.3 | 39.7 | 0.0 | 1045.8 | 109.1 |
| 1972 | 0.0 | 34.9 | 93.9 | 211.0 | 183.3 | 165.3 | 125.6 | 0.0 | 814.0 | 85.0 |
| 1973 | 0.0 | 10[illegible].1 | 82.1 | 172.7 | 336.2 | 126.0 | 8.5 | 0.0 | 827.6 | 86.4 |
| 1974 | 0.0 | 25.1 | 43.3 | 350.2 | 193.9 | 178.2 | 67.1 | [illegible] | 867.1 | 90.5 |
| 1975 | [illegible] | 0.2 | 14[illegible].2 | 385.6 | 221.0 | 462.4 | 55.7 | 0.0 | 1268.6 | 132.4 |
| 1976 | 4.9 | 12.1 | 112.3 | 170.5 | 182.9 | 297.5 | 59.8 | 0.0 | 840.0 | 87.7 |
| Average Moyennes | 0.9 | 23.5 | 119.2 | 218.5 | 232.7 | 272.0 | 86.6 | 4.9 | 958.4 | 100.0 |

of the Anambe Basin normally receives notably less rainfall than the southern half of the study area. This conclusion is further supported by previously mentioned isohyetal lines shown on Figure 3.1.4. B, which represent 30-year precipitation averages. Koundande area experiences an average of 80 days per year of recordable rainfall, and thus has a slightly longer growing season for rainfed crops than Velingara which averages 75 wet days per year.

5.1.4. Kerevane Precipitation.

In 1971, the Centre de Perfectionnement Agricole in Kerevane, located 7.5 kilometers due west of Velingara, began recording rainfall data using a standard gauge. The gauge does not function from December through April as rainfall in excess of daily evaporation is extremely infrequent during these months. For the purpose of this analysis, rainfall values for the missing months were assumed to be zero. With the exception of the dry months, records are complete and are continuing.

Monthly and annual totals and averages for the six-year period are given on table 5.1.4. The averages are summarized and compared to Velingara and Kounkande records for the same period (1971 through 1976) as follows :

Anambe Basin Rainfall Averages for 6-year Period (1971 - 76) (mm)

| Station | J-A | M | J | J | A | S | O | N-D | Total |
|---|---|---|---|---|---|---|---|---|---|
| Kounkande | 0.9 | 29.5 | 111.5 | 239.9 | 241.4 | 259.6 | 59.4 | 1.6 | 943. 8 |
| Velingara | 2.2. | 15.7 | 100.5 | 207.4 | 234.3 | 221.2 | 41.8 | 0.6 | 823. 7 |
| Kerevane | 0.0. | 3.1 | 117.1 | 177.1 | 198.1 | 237.2 | 48.2 | 1.8 | 782. 6 |

.../...

Table 5.1.4. : Kérévane Rainfall (mm).

Tableau 5.1.4. : Pluviométrie de Kounkandé (mm)

| Year<br>Année | J-A<br>J-A | May<br>Mai | Jun<br>Juin | Jul<br>Juil. | Aug<br>Août | Sep<br>Sept. | Oct<br>Oct | N-D<br>N-D | Annual Total<br>Total Annuel | % of normal<br>% de la normale |
|---|---|---|---|---|---|---|---|---|---|---|
| 1971 | 0.0 | 0.0 | 219.8 | 105.0 | 250.5 | 224.5 | 10.0 | 0.0 | 809.8 | 103.5 |
| 1972 | 0.0 | 0.0 | 52.5 | 213.5 | 140.9 | 125.5 | 88.7 | 0.0 | 621.1 | 79.4 |
| 1973 | 0.0 | 15.8 | 131.7 | 166.0 | 290.4 | 111.0 | 28.0 | 0.0 | 742.9 | 94.9 |
| 1974 | 0.0 | 0.0 | 61.0 | 166.0 | 163.0 | 162.0 | 57.0 | 4.0 | 613.0 | 78.3 |
| 1975 | 0.0 | 3.0 | 91.0 | 233.0 | 235.5 | 544.0 | 29.0 | 0.0 | 1135.5 | 145.1 |
| 1976 | 0.0 | 0.0 | 146.5 | 179.0 | 108.5 | 256.0 | 76.5 | 7.0 | 773.5 | 98.8 |
| Averages<br>Moyennes. | 0.0 | 3.1 | 117.1 | 127.1 | 198.1 | 237.2 | 48.2 | 1.8 | 782.6 | 100.0 |

Table 5.1.4B gives a breakdown on the above totals to indicate the vagarities of the monthly distributions.

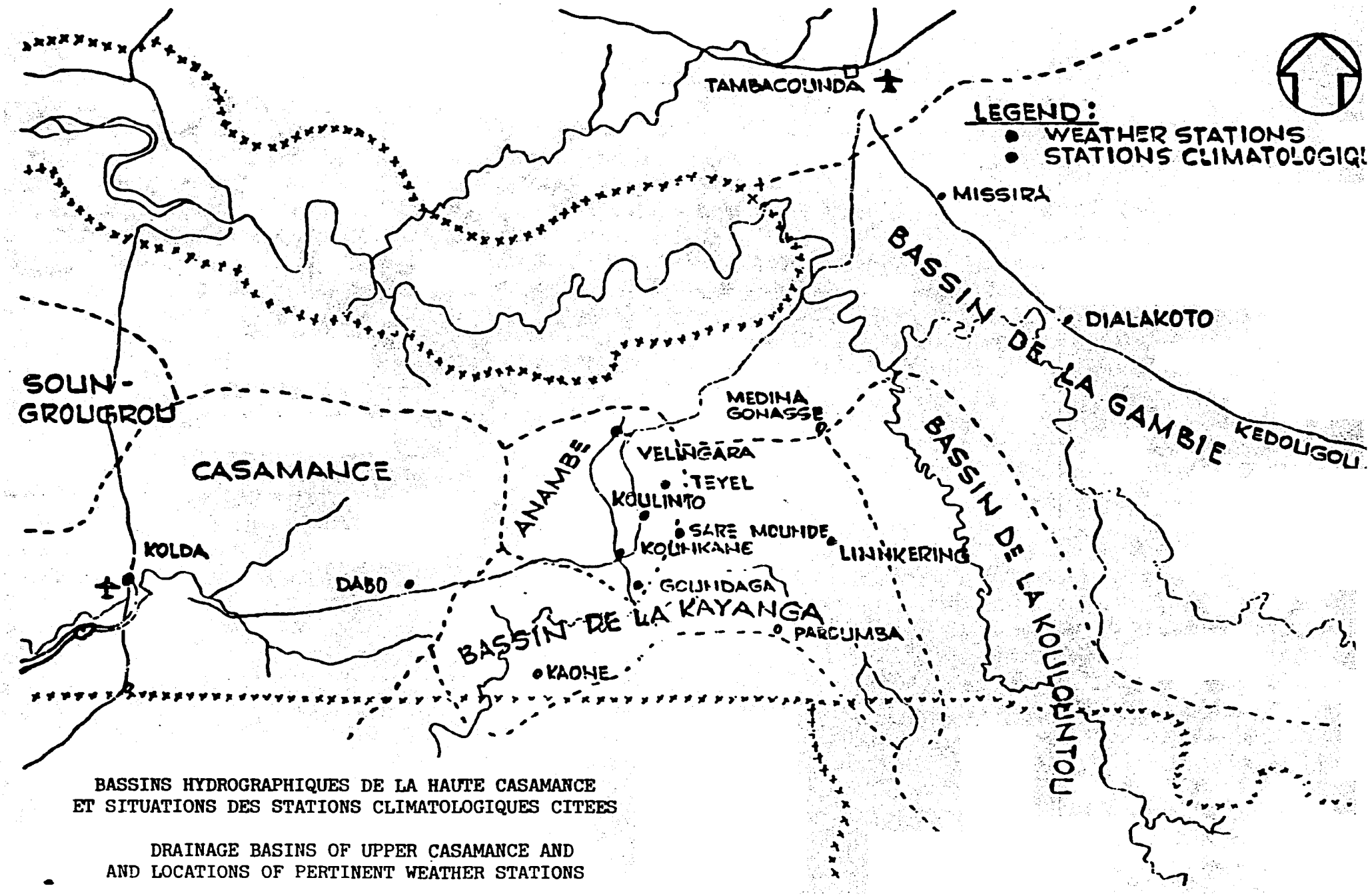
5.1.5. Additional Rainfall Data.

In addition to the official weather stations previously mentioned, rainfall data at locations within, or immediately adjacent to, the Anambe Basin have been recorded by SODEFITEX and published in their "Rapports Annuaires sur la Culture Cottonnière au Senegal". The SODEFITEX cotton ginning complex is located approximately one kilometer north of the Velingara Station and has intermittent rainfall data since 1964. Short-term data is available from Link ring, Kounkande, Pakour, Dabo, and Kolda.

During 1962, GERCA, as part of their "Study into the Hydro-Agricultural Developpement in the Casamance and Upper Gambie Regions", conducted a pluviometric survey in the Anambe, Gambia, Koulountou, Kayanga, Casamance and Sougrougrou Basins. Temporary rainfall gauges were installed in several pertinent locations to supplement existing information in each basin and to provide a basis for estimating run-off coefficients and stream flows. This additional data has been collected and analyzed to illustrate the variances in spacial distribution and point as compared to areal precipitation, but has not been included in the report. It is available in the documents referred to above.

Figure 5.1.5. shows the location of most of the stations utilized for this report and partially defines the approximate limits of the

.../...




BASSINS HYDROGRAPHIQUES DE LA HAUTE CASAMANCE
ET SITUATIONS DES STATIONS CLIMATOLOGIQUES CITEES

DRAINAGE BASINS OF UPPER CASAMANCE AND
AND LOCATIONS OF PERTINENT WEATHER STATIONS

Figure 5.1.5

**Table 5.1.4.B. : Monthly and Annual Precipitation in mm for common Period Velingara, Kounkande and K[illegible] Stations.**

**Tableau 5.1.4.B. : Pluviométrie Mensuelle et Annuelle en mm de Vélingara, Kounkandé, et Kérévane pour la même Pé[illegible]ode.**

| Year Année | Station Station | J-A J-A | May Mai | Jun Juin | Jul Juil | Aug Août | Sep Sep | Oct Oct | N-D N-D | Annual Total Total Annuel |
|---|---|---|---|---|---|---|---|---|---|---|
| 1971 | Kounkande | 0.2 | 2.8 | 194.0 | 149.5 | 331.3 | 328.3 | 39.7 | 0.0 | 1045.8 |
| | Velingara | 0.0 | 6.9 | 182.0 | 135.2 | 247.3 | 225.7 | 13.6 | 0.0 | 810.7 |
| | Kerevane | (0.0) | 0.0 | 219.8 | 105.0 | 250.5 | 224.5 | 10.0 | (0.0) | 809.8 |
| 1972 | Kounkande | 0.0 | 34.9 | 93.9 | 211.0 | 183.3 | 165.3 | 125.6 | 0.0 | 814.0 |
| | Velingara | 0.0 | 16.3 | 84.9 | 220.7 | 175.6 | 125.6 | 82.8 | 0.0 | 700.4 |
| | Kerevane | (0.0) | 0.0 | 52.5 | 213.5 | 140.9 | 125.5 | 88.7 | (0.0) | 621.1 |
| 1973 | Kounkande | 0.0 | 102.1 | 82.1 | 172.7 | 336.2 | 126.0 | 8.5 | 0.0 | 827.6 |
| | Velingara | 0.0 | 56.3 | 126.7 | 242.9 | 279.2 | 130.1 | 34.7 | 0.0 | 869.9 |
| | Kerevane | (0.0) | 15.8 | 131.7 | 166.0 | 290.4 | 111.0 | 28.0 | (0.0) | 742.9 |
| 1974 | Kounkande | 0.0 | 25.1 | 43.3 | 350.2 | 193.9 | 178.2 | 67.1 | 9.3 | 867.1 |
| | Velingara | 0.0 | 2.1 | 46.7 | 222.9 | 205.3 | 166.7 | 55.4 | 3.6 | 703.7 |
| | Kerevane | (0.0) | 0.0 | 61.0 | 166.0 | 163.0 | 162.0 | 57.0 | 4.0 | 613.0 |
| 1975 | Kounkande | 0.5 | 0.2 | 143.2 | 385.6 | 221.0 | 462.4 | 55.7 | 0.0 | 1268.6 |
| | Velingara | 0.2 | 3.8 | 61.4 | 238.8 | 332.7 | 393.2 | 12.0 | 0.0 | 1041.1 |
| | Kerevane | (0.0) | 3.0 | 91.0 | 233.0 | 235.5 | 544.0 | 29.0 | (0.0) | 1135.5 |
| 1976 | Kounkande | 4.9 | 12.1 | 146.5 | 170.5 | 182.9 | 297.5 | 59.8 | 0.0 | 840.0 |
| | Velingara | 12.9 | 14.5 | 101.5 | 184.1 | 164.9 | 286.9 | 52.1 | 0.0 | 816.9 |
| | Kerevane | (0.0) | 0.0 | 146.5 | 179.0 | 108.5 | 256.0 | 76.5 | 7.0 | 773.5 |
| Aver. Moyenne | Kounkande | 0.9 | 29.5 | 111.5 | 239.9 | 241.4 | 259.6 | 59.4 | 1.6 | 943.8 |
| | Velingara | 2.2 | 15.7 | 100.5 | 207.4 | 234.3 | 221.2 | 41.8 | 0.6 | 823.7 |
| | Kerevane | 0.0 | 3.1 | 117.1 | 177.1 | 198.1 | 237.2 | 48.2 | 1.8 | 782.6 |

( ) = estimated values

= valeur estimée

### 5.1.6. Anambe Basin Precipitation and Probabilities.

Basin-wide rainfall patterns have been constructed for purposes of estimating basin run-off and calculating drainage and irrigation requirements. Long-term data available from Velingara, weighted with data from Koumkane, were utilized as the basis for these analyses and treated to probability rating determinations. A 50% probability of rainfall in the basin had been taken as being more representative and more conservative for calculating irrigation requirements, while averages have been used for determining run-off and drainage requirements. Selected probabilities for the basin are compared to 44-year averages as follows :

Probabilities of Anambe Basin Rainfall (mm)

| Probability | J-A | M | J | J | A | S | O | N-D | Total |
|---|---|---|---|---|---|---|---|---|---|
| 90 % | 0 | 0 | 65 | 150 | 161 | 187 | 20 | 0 | 583 |
| 75 % | 0 | 5 | 89 | 174 | 247 | 215 | 53 | 0 | 783 |
| 50 % | 0 | 19 | 131 | 211 | 295 | 275 | 89 | 0 | 1,020 |
| Average | 3 | 32 | 133 | 233 | 318 | 297 | 10[illegible] | 10 | 1,128 |

Figure 5.1.6.A., which follows, graphically illustrates monthly rainfall probabilities and averages at Velingara. Figure 5.1.6.B. shows the probability of Velingara annual rainfall being equalled or exceeded in any year. Based on Figure 5.1.6.B, a 1% probability of annual rainfall at Velingara, or 1 year out of 100, would be approximately 2,685 mm which compares to the 2,306 mm recorded in 1934. By utilizing the developed relationship between Velingara and Koumkande station data and averaging the results for the Anambe Basin, the following pattern emerges :

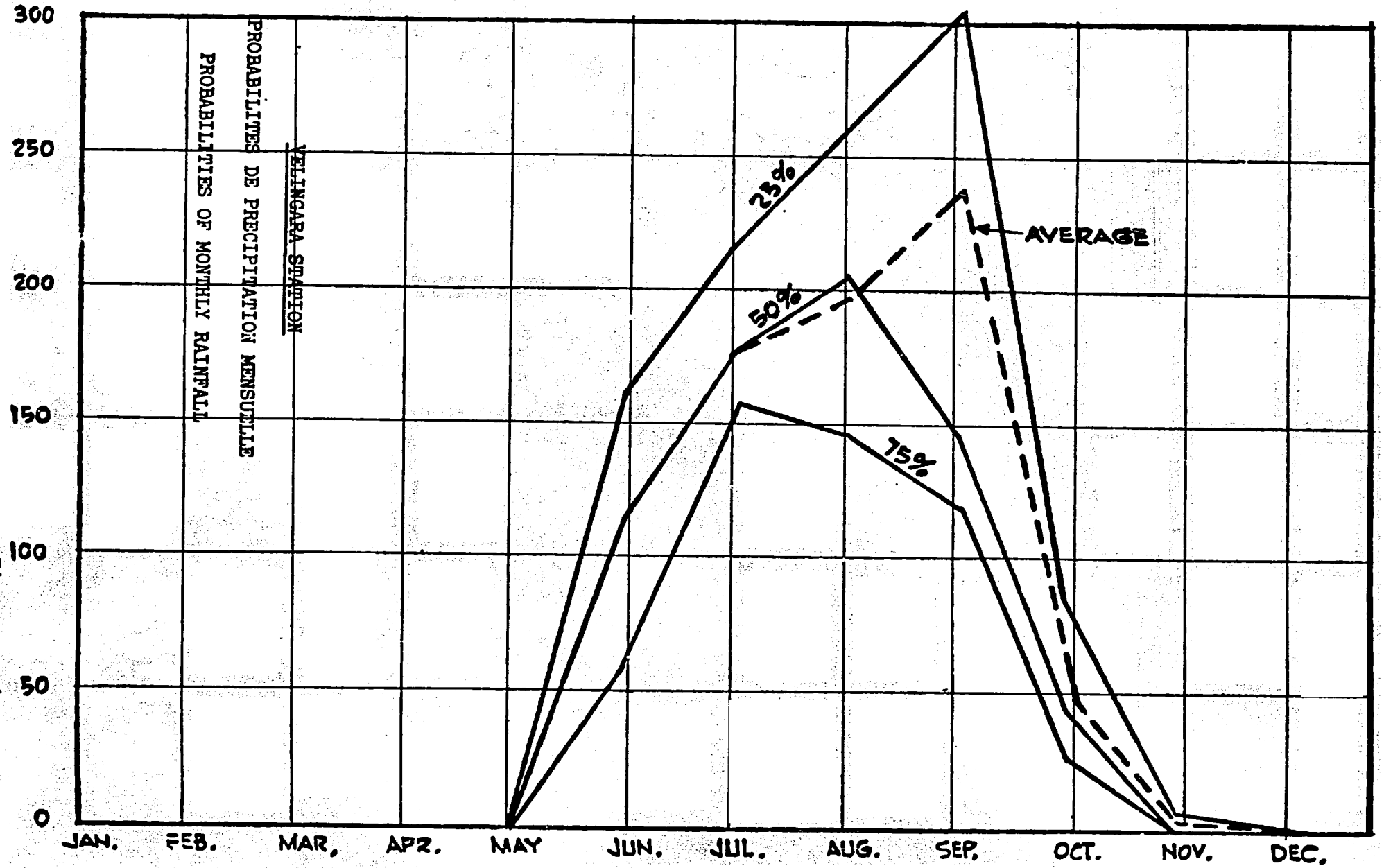

VELINGARA STATION
PROBABILITES DE PRECIPITATION MENSUELLE
PROBABILITIES OF MONTHLY RAINFALL
300
250
200
150
100
50
0
JAN.
FEB.
MAR.
APR.
MAY
JUN.
JUL.
AUG.
SEP.
OCT.
NOV.
DEC.
25%
50%
75%
AVERAGE

Figure-5.1.6 A

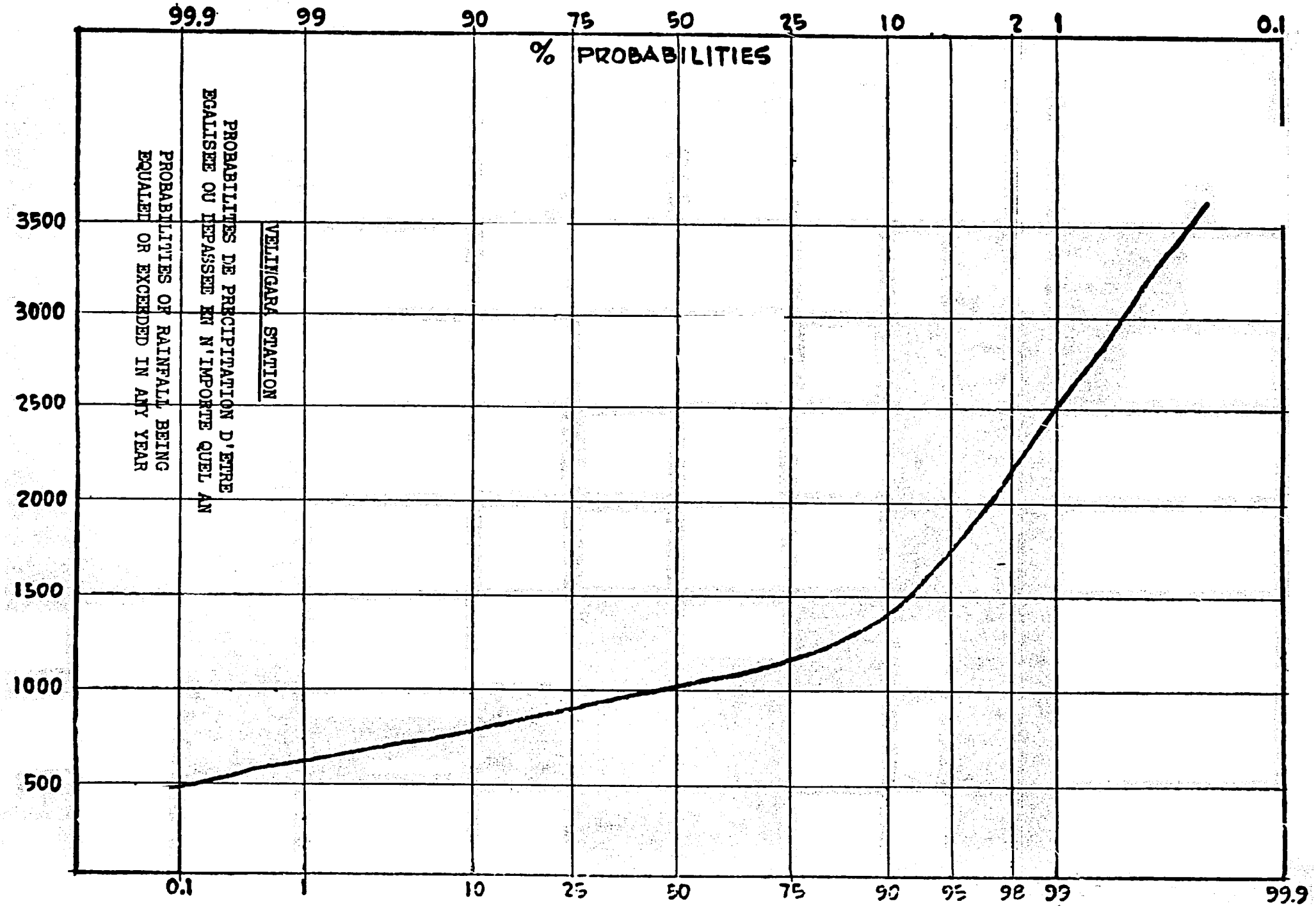



Figure 5.1.6 B

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## ANAMBE BASIN RAINFALL

One Year out of 100 Probability of Rainfall (mm):

| Probability | J-A | M | J | J | A | S | O | N-D | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1% | 45 | 181 | 313 | 564 | 757 | 721 | 221 | 14 | 2,816 |

The highly erratic nature of rainfall in the Anambe Basin and its effects on existing flooding and rainfed agriculture will be analyzed in a later section of this chapter.

### 5.1.7. Temperature.

As far as could be determined, no temperature statistics exist for the Anambe Basin. Three first-class synoptic stations near the area have been operated intermittently since 1918 (see Section 5.1.1.). Temperature data from two stations - Tambacounda and Kolda - have been used to estimate a synthetic temperature pattern for the basin.

The 1974 ORSTOM report, "Etude Hydrologique du Bassin Continental du Fleuve Gambie", summarized monthly and annual maximum, minimum, and computed averages $\frac{(\text{max} + \text{min})}{2}$ for Tambacounda, using a 23-year period of observation (1951 through 1973). This data, in degrees centigrade, is as follows :

.../...

Tambacounda Temperature (°C)

| Average | J | F | M | A | M | J | J | A | S | O | N | D | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maximum | 35 | 37 | 39 | 40 | 40 | 36 | 32 | 31 | 32 | 34 | 36 | 34 | 35 |
| Minimum | 16 | 18 | 21 | 23 | 26 | 24 | 23 | 22 | 22 | 22 | 18 | 15 | 21 |
| Average | 25 | 28 | 30 | 32 | 33 | 30 | 27 | 27 | 27 | 28 | 27 | 25 | 28 |

Kolda temperatures for a 30-year period (1932 - 1961) have been averaged in the GERCA report, published in 1962, as shown below :

Kolda Temperature ( )

| Average | J | F | M | A | M | J | J | A | S | O | N | D | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maximum | 34 | 37 | 40 | 40 | 40 | 36 | 32 | 31 | 32 | 33 | 34 | 33 | 35 |
| Minimum | 13 | 16 | 20 | 22 | 23 | 24 | 23 | 23 | 23 | 23 | 20 | 15 | 20 |
| Average | 24 | 27 | 30 | 31 | 32 | 30 | 27 | 27 | 27 | 28 | 27 | 24 | 28 |

It may be noted that recorded temperature averages at both stations are nearly identical although they are approximately 165 kilometers apart. Tambacounda is at a higher elevation than Kolda (92m and 20 m respectively) and about 0°53' further north. Tambacounda temperature averages are slightly higher by less than 0.5 degrees, which is likely due to its greater distance from the coast.

True average monthly temperatures are estimated to be less than the mathematical average between maximum and minimum, by up to 3 degrees. Thus, Anambe Basin average temperatures may closely approximate the following pattern :

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Estimated Anambe Basin Temperature (°C)

| Average | J | F | M | A | M | J | J | A | S | O | N | D | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maximum | 34 | 37 | 40 | 40 | 40 | 36 | 32 | 31 | 32 | 33 | 35 | 33 | 35 |
| Minimum | 13 | 16 | 20 | 22 | 23 | 24 | 23 | 23 | 23 | 23 | 20 | 15 | 20 |
| Average | 21 | 24 | 27 | 28 | 29 | 27 | 25 | 25 | 25 | 26 | 26 | 21 | 25 |

Absolute maximum annual temperatures normally occur in May when values in excess of 43°C may be anticipated. Absolute minimum recordings are registered in January but rarely fall below 10° C. The diurnal range in absolute temperatures is in the order of 33° C; in average temperatures, it is 27° C.

Following the May high, average temperatures decline during the rainy season and rise again in October and November and notably lower during December through February. The Anambe Basin should never experience frost.

The effects of the temperature regime on planned agricultural developments will be covered in subsequent section of this chapter.

5.1.8. Insolation.

Average monthly hours of sunshine have been recorded at Tambacounda and are considered to be representative for Anambe Basin conditions. Maximum insolation occurs during March and April and decreases during the wet months to a low in August.

The average values are given below :

.../...

Hours of Sunshine

| Average | J | F | M | A | M | J | J | A | S | O | N |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 188 | 176 | 199 | 254 | 250 | 217 | 156 | 151 | 147 | 174 | 191 | 204 |

5.1.9. Relative Humidity.

Monthly averages of relative humidity recorded at Tambacounda and Kolda have been averaged to represent the estimated relative humidity for the project area. Humidity is normally about 95% at 6 AM during the rainy season resulting in heavy dew fall. It lowers to less than 30% at 6 PM during January through March. Average values are shown below :

Relative Humidity

| Station | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tamba | 28 | 30 | 29 | 34 | 49 | 68 | 78 | 82 | 80 | 73 | 58 | 41 |
| Kolda | 44 | 40 | 40 | 42 | 50 | 66 | 78 | 82 | 79 | 78 | 70 | 54 |
| Project | 36 | 35 | 34 | 38 | 45 | 67 | 78 | 82 | 79 | 75 | 64 | 48 |

5.1.10. Evaporation.

Piche evaporation is recorded daily at Tambacounda and Kolda stations. Data from these two stations have been averaged and weighted in estimating an average piche evaporation applicable to the Anambe Basin. Shown below are the daily and montly estimates considered representative for average basin conditions :

.../...

Hours of Sunshine

| Average | J | F | M | A | M | J | J | A | S | O | N |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 188 | 176 | 199 | 254 | 250 | 217 | 156 | 151 | 147 | 174 | 191 | 204 |

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Relative Humidity

| Station | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tamba | 28 | 30 | 29 | 34 | 49 | 68 | 78 | 82 | 80 | 73 | 58 | 41 |
| Kolda | 44 | 40 | 40 | 42 | 50 | 66 | 78 | 82 | 79 | 78 | 70 | 54 |
| Project | 36 | 35 | 34 | 38 | 45 | 67 | 78 | 82 | 79 | 75 | 64 | 48 |

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.../...

Estimated Piche Evaporation - Anambe Basin (mm )

| | J | F | M | A | M | J | J | A | S | O | N | D | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Daily | 8.3 | 9.9 | 10.7 | 10.8 | 10.2 | 6.2 | 2.8 | 2.0 | 1.9 | 2.6 | 4.3 | 6.9 | 6.37 |
| Month. | 257 | 280 | 332 | 324 | 316 | 186 | 87 | 62 | 57 | 81 | 129 | 214 | 2,325 |

There are no reliable formulas for converting piche evaporation values into USA Weather Bureau Class A pan evaporation. Kedougou station installed a Class A pan in 1974 and have been intermittently recording piche and Class A evaporation since that date. Data for the period of record cormonto both methods is shown below :

Average Evaporation an Temperature, Kedougou, 1973 - 1976

| | Piche (mm) | | Class A (mm) | | Ration (1) | Temperature(2) |
|---|---|---|---|---|---|---|
| | Daily | Total | Daily | Total | % | (° C) |
| Jan. | 9.0 | 279 | 8.1 | 251 | .90 | 21.4 |
| Feb. | 9.9 | 277 | 9.1 | 255 | .92 | 24.6 |
| Mar. | 11.1 | 344 | 9.9 | 307 | .89 | 26.1 |
| Apr. | 9.4 | 282 | (7.9) | 237 | .84 | 27.8 |
| May. | 5.8 | 180 | (6.2) | 192 | 1.07 | 27.9 |
| Jun. | 3.9 | 117 | 5.4 | 162 | 1.38 | 28.0 |
| Jul. | 2.1 | 65 | 4.5 | 140 | 2.14 | 28.1 |
| Aug. | 1.5 | 47 | 3.6 | 112 | 2.40 | 28.0 |
| Sep. | 1.8 | 54 | 4.8 | 144 | 2.67 | 28.8 |
| Oct. | 2.8 | 87 | 5.1 | 158 | 1.82 | 28.9 |
| Nov. | 5.9 | 177 | 6.7 | 201 | 1.14 | 25.2 |
| Dec. | 7.4 | 229 | 6.8 | 211 | 92 | 22.9 |
| Aver. | 5.9 | ----- | 6.5 | ----- | 1.11 | 26.5 |
| Total | ----- | 2,138 | ----- | 2,370 | ---- | ---- |

(1) $\frac{\text{Class A}}{\text{Piche}}$ = Ratio (%)

(2) Average of maximum and minimum values shown in brackets are estimated

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The weather station at ISRA's Djibelor rice research center, near Ziguinchor and approximately 50 kilometers from the coast, has recorded evaporation by both methods simultaneously for the last 3 years (1974-1976). The relationship between the two methods developed at Djibelor is shown below :

Average Evaporation and Temperature, Djibelor, 1974-1976

| | Piche (mm) | | Class A Pan (mm) | | Ratio(1) | Temperatur.(2) |
|---|---|---|---|---|---|---|
| | Daily | Total | Daily | Total | % | (°C) |
| Jan. | 10.8 | 334 | 4.7 | 147 | .44 | 24.0 |
| Feb. | 11.5 | 325 | 5.6 | 157 | .48 | 26.2 |
| Mar. | 10.8 | 335 | 6.5 | 203 | .61 | 27.3 |
| Apr. | 9.9 | 296 | 7.4 | 222 | .75 | 27.8 |
| May. | 7.2 | 222 | 6.9 | 215 | .96 | 28.0 |
| Jun. | 5.6 | 169 | 6.1 | 182 | 1.08 | 28.7 |
| Jul. | 3.7 | 115 | 3.7 | 116 | 1.00 | 27.6 |
| Aug. | 2.3 | 70 | 3.1 | 96 | 1.37 | 26.8 |
| Sep. | 2.5 | 76 | 3.7 | 112 | 1.47 | 27.2 |
| Oct. | 3.0 | 94 | 4.0 | 124 | 1.32 | 27.8 |
| Nov. | 4.9 | 146 | 4.1 | 124 | .85 | 26.7 |
| Dec. | 7.9 | 245 | 3.8 | 119 | .49 | 24.1 |
| Aver. | 6.7 | --- | 5.0 | ----- | .75 | 26.8 |
| Totals | ------ | 2,427 | ------ | 1,817 | -------- | ------- |

(1) $\frac{\text{Class A}}{\text{Piche}}$ = Ratio (%)

(2) Average of maximum and minimum

In 1962, CERCA installed a 1m x 1m pan, buried to ground

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level, at Goundaga near the confluence of the Anambe and Kayanga Rivers. Daily evaporation was recorded from June 1962 until January 1963. The values obtained were as follows :

Pan Evaporation at Goundaga in mm

(June 1962 - Jan. 1963 - monthly monthly Total)

| | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan |
|---|---|---|---|---|---|---|---|---|
| Daily | 4.4. | 4.4. | 3.7 | 3.6 | 4.3 | 5.0 | 5.9 | 6.4 |
| Monthly | 132 | 136 | 115 | 108 | 132 | 150 | 183 | 202 |

By extropolation with Tambacounda results, GERCA estimated an annual pan evaporation in the magnitude of 2,300 mm for the 1962/63 year at Goundaga, which lies at the extreme south of the basin. This data compares favorably with Kedougou recordings, but, as expected, would be higher during the dry season primarily reflecting decreasing relative humidity from south to north.

In addition to the above information, SODAGRI has analyzed empirical data established for other areas with similar meteorological conditions and at similar longitudes.

An analysis of all information studied has resulted in the structuring of synthetic pan evaporation values as follows, which are estimated to be representative values for the study basin.

.../...

Estimated Pan Evaporation in the Anambe Basin (mm)

| | J | F | M | A | M | J | J | A | S | O | N | D | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Daily | 7.0 | 10.3 | 10.7 | 9.7 | 7.2 | 5.3 | 4.9 | 3.9 | 3.9 | 4.9 | 5.6 | 6.5 | 6.6 |
| Total | 217 | 291 | 332 | 291 | 223 | 159 | 152 | 121 | 117 | 156 | 168 | 202 | 2,425 |

5.1.11. Potential Evapotranspiration in the Anambe Basin.

Total evaporation and transpiration, or evapotranspiration, represents the total water loss, minus run-off and deep infiltration, from a surface area. Potential evapotranspiration is the maximum evapotranspiration that would occur on an area totally and continually vegetated with an ample supply of soil moisture for plant use. In any given climatological regime, potential evapotranspiration is therefore affected by the type of soil and vegatative cover, but experience under mixed climatic and semi-humid conditions have shown that in the absence of empiric data, lake evaporation may be used as a reliable estimate of potential evapotranspiration.

The conversion of pan evaporation to open water (or lake) evaporation depends upon the type and location of pan used, elevation and climatic variances. Coefficients for the USA range from 0.60 to 0.90 based on US Weather Bureau isopleths. For conditions similar to the Anambe Basin, coefficients average 0.75 and this factor has been used to estimate the basin's potential evapotranspiration, shown below:

..../...

Potential Evapotranspiration -Anambe Basin

(mm per month )

| J | F | M | A | M | J | J | A | S | O | N | D | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 163 | 218 | 249 | 218 | 167 | 119 | 114 | 91 | 88 | 114 | 126 | 152 | 1,819 |

5.1.12. Potential Evaporation at Kayanga Dam Site.

The GERCA pan evaporation recordings at Goundaga are considered to be reliable indications of existing conditions in the area which would be flooded by the storage and floodcontrol structure which is to be discussed subsequently in this report. As potential evapotranspiration closely approximates lake surface evaporation, SADAGRI has estimated potential reservoir evaporation losses to be:

Estimated Lake Evaporation - Kayanga Reservoir (mm)

| J | F | M | A | M | J | J | A | S | O | N | D | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 152 | 219 | 244 | 218 | 165 | 99 | 102 | 86 | 81 | 99 | 113 | 137 | 1,710 |

5.1.13. Moisture Regime for the Anambe Basin.

By comparing the 50% probability of monthly rainfall estimated for the Anambe Basin with the estimated potential evapotranspiration, the following moisture regime emerges:

..../...

Available Moisture - Anambe Basin (mm)

| | J | F | M | A | M | J | J | A | S | O | N | D | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 0 | 19 | 131 | 211 | 295 | 275 | 89 | 0 | 0 | 1,020 |
| Etp- | 163 | 218 | 249 | 218 | 167 | 119 | 114 | 91 | 88 | 114 | 126 | 152 | 1,819 |
| Ex - | --- | --- | --- | --- | --- | 12 | 97 | 204 | 187 | --- | --- | --- | ----- |
| Def - | 163 | 218 | 249 | 218 | 148 | --- | --- | --- | --- | 25 | 126 | 152 | 799 |

p = Precipitation
Etp = Potential Evapotranspiration
Ex = Excessive Moisture (including run-off)
Def = Moisture Deficiency

From the above comparison, it can be assumed that 50 % probability rainfall will always be more than sufficient to cover potential evapotranspiration during July, August, and September; it is frequently sufficient during June and October; and always insufficient from November through May. If average rainfall is compared, the evapotranspiration is usually covered by rainfall in June. On a 75 % rainfall probability (or 3 years out of 4) rain always exceeds potential evapotranspiration in July, August and September, but is always insufficient the balance of the year.

5.2. Climatic Constraints.

552.1. General Climatic Pattern.

A study of long-term rainfall data (1932-1976) available from Velingara Station indicates that until 1968, annual recorded precipitation values had generally been uniform and dependable. Considering only the period between 1932 through 1967, 26 out of 35 years

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(or 74%) recorded in excess of 90% of average rainfall and 30 out of 35 (or 86%) recorded 85% or more of normal. On the average, less than 1 out of 6 years could be expected to yield insufficient total precipitation to insure normal crop harvest.

Rainfall: Despite of the reliability of gross annual rainfall, all previous meteorological and agricultural reports on the basin agree (and this report concurs) that the spatial distribution of rain during the June through October farming season, is more important to crop maturation and yield than annual total. A study of daily rainfall patterns as shown on ASECNA computer printouts, reveals that completely rainless periods lasting from 7 to 11 days have occured at least 21 times during the midst of the farming season within the last 44 years and that dry spells of 4 to 7 days are common. These dry periods are frequently preceded or followed by a light shower insufficient for daily evapotransportation requirements and all crops, except those which are drought resistant, suffer various degrees of stress losses.

In recent years, rice yields are reported to have been below normal, particularly during 1973 an 1974. In 197[illegible], a 10-day rainless period occured from the 10[illegible] through the 19[illegible] of July during tillerage stage, followed by a 9-day rainless period in late September during grain formation. 1974 was considered a disaster year for rice in the Anambe Basin. From mid-June to early July, while seedings were being established and when residual soil moisture was

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minimal, only 7.6. mm of rain were recorded during a 23-day period and those rice plants which survived were severely and permanently stunted. 1975 was the only year since 1967 to record near normal rain. The rice yield per hectare was better than average due to heavy rains in late September which provided a high phreatic water level near or at the surface and a saturated soil resulting in sufficient residual ground moisture for grain formation and filling. Light showers in early October further assured a reasonable yield.

Maximum Storms. The greatest 24-hour rainfalls observed in Velingara during the 44 year period were 237.5 mm (9.4 inches) on 8 September 1933, and 218.6 mm (8.6 inches), on 3 September 1964. 24-hour storms in excess of 100 mm (3.9 inches ) have been recorded on more than 21 occasions. The maximum 48-hour duration storms were observed on the 2nd and 3rd of September 1964, when their combined total reached 241.8 (9.5 inches). Other heavy 48 hour storms were 237.5mm for 8-9 September 1933, and 234.5 mm for 18-19 August 1950 when consecutive 24 hour storms over 100 mm were recorded (103.0mm and 126.5 mm per day respectively). Significant 72-hour rainfall accumulations have occurred in 1934 (322.8 mm on 15-17 September), 1944 (260.1 mm on 3-5 September) and 1950 (242.1 on 18-20 August). 7-day duration storms have exceeded 300 mm (11.8 inches) on at least five occasions since 1932, the maximum being 498.1 mm 19.6 inches) between 12-18 September, 1974.

Data from Kounkande and Kerevane show equally erratic patterns of precipitation as Velingara. This information when compared to

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1962 recordings by GERCA, gives emphasis to the conclusion that areal rainfall is considerably different from point rainfall, and even when seasonal totals are relatively uniform, monthly distributions may vary widely within short distances. Daily precipitation during periods of common records for Velingara, Kerevane (7.5 kilometers west) and SODIFITEX (1 kilometer north) show unexpected extreme variances, especially notable during heavy storms.

Other climatic characteristics do not exhibit such drastic annual or monthly variations, and the slight changes which are recorded are agriculturally unimportant. Average monthly maximum and minimum temperatures seldom vary more than 2° C from year to year. Insolation, relative humidity and evaporation annual and monthly fluctuations do not vary over 15 % plus or minus from the norm.

5.22. Rainfall Constraints.

As previously stated, average monthly rainfall totals are usually sufficient to meet potential evapotransportation requirements during June, July, August, and September, are usually insufficient during October and always insufficient the rest of the year. All agricultural practices are dependant on the onset of the heavy rains, and farmers traditionally will not plant until they are confident that steady rains will follow.

A study of probability of onset of dependable rain, based on Velingara records, indicate that in three (3) years out of four (4), farmers could prepare their land and have seed in the ground

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by the 20 th of June and expect to have continued sufficient moisture. Traditionally farmers are conservative and the loss of seed in even one out of four years might prove to be an extreme hardship, so seeding is normally delayed by two or three additional weeks. The growing season is, therefore, shortened and an early recession of the rain front in September is equally damaging to yields. Without irrigation, the possibility of lengthening or altering the growing season is nil.

Irrigated agriculture is entirely unknown in the basin, and peasant farmers are totally inexperienced in water control, drainage, and flood protection principals and benefits. The farmers are wholly dependant upon the vagaries of the erratic rainfall pattern for agriculture. A year of heavy late rainfall may result in a good yield on rice and a loss of cotton and peanut crops. During the recent drought years, hectarage allotted to rice has been drastically reduced and replaced by increased land in groundnuts and cotton.

5.2.3. Temperature Constraints.

There are few, if any, major temperature constraints affecting traditional rainfed agriculture. During the wet season, night temperatures are generally warm and daytime temperatures near 40° C are common and the diurnal range between average daily highs and lows is minimal. Thus from a thermal perspective, growth conditions for adapted crops are near ideal.

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The introduction of irrigated agriculture, including the provision of major drains and flood control measures, will force the impact of drastically altered cultural practices upon the farmers who pratice irrigation . Feasibility will primarily be dependant upon the farmer's acceptance of adjusted cropping patterns and increased work load. In principle, the future dry-season crop may become the most important as water will be fully controlled.

Dry season and winter temperatures have a much wider diurnal range than experienced during the summer rains. Night time lows during December and January which approach 10° C will have a constraining effect on some crops, notably tropical rice varieties, and may limit the selection or lengthen the normal growing season for others. Frost should never be experienced.

5.2.4. Other Climatic Constraints.

The introduction of dry season irrigation, especially from lake storage, and wet season drainage has a direct and measurable impact on an area's climate. Relative humidity is increased and average temperature slightly lowered during the dry season without constraint to crop maturation.

Excessive cloudiness during the rainy season, causing shorter hours of effective insolation, may lengthen the maturity period for many rice varieties but adapted varieties have already been introduced into the basin.

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## 5.3. SURFACE WATER RESOURCES.

This report will consider two major potential water sources for developpement into irrigation supplies the Kayanga and the Anambe Rivers. Possible alternative sources also discussed are the shallow water table and the unexplored deep aquifers beneath the Continental Terminal.

A last alternative for future consideration, would imply developing the Koulountou River - a major contributor to the flow of the Gambia River - and providing for inter-basin transfer to divert additional flow into the Kayanga. It is beyond the scope of this report, and not enough information is presently available on topography, flows, water requirements and potential irrigation demands to evaluate this latter alternative at this time, but at some future date such investigations and studies may be justified.

### 5.3.1. Sources of Data on Surface Hydrology.

The field studies conducted by SODAGRI covered a 6 - week period between early January and mid-February, 1977, during a time of low flow in the Kayanga and the drying of the Anambe. Discharge measurements were not taken and would have been inconclusive at best. All data utilized in this report have been taken from three pertinent previous studies :

1. "Hydrogéologie de la Moyenne et Haute Casamance (Sénégal)",

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prepared for the Direction de l'Energie et de l'Hydraulique in 1967 by J.C. Napias of BRGM.

2. "Hydrological Studies in the Casamance" prepared by ORSTOM in 1969.

3. "Hydro-Agricultural Development in the Casamance and the Upper Gambia" published by GERCA in 1962.

Hydrographic Stations.

Stream runoff in the Anambe Basin was observed by ORSTOM between 1967 and 1969. Gauges were installed on the Anambe River at the bridge on the Kounkande - Kolda road near the village of Kabendou and on the Kayanga River at the Niapo bridge. The stations were abandoned after 1969.

New automatic recorders have recently been installed by ORSTOM at Niapo and at the new Kayanga bridge 15 kilometers downstream on the Kabendou - Wassadou Road, and are now functioning. ORSTOM plans to re-equip the Anambe Stream with a similar recorder on the Kabendou bridge in the near future.

In addition to ORSTOM's measurements, flow rates were intermittently taken on both streams during 1962/3 by GERCA.

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5.3.2. Kayanga Basin Runoff.

The Kayanga River rises in northern Guinea, just south of the frontier with Senegal and at the western face of the Fouta Djalon, a series of low hills dividing the Kaliba and Rio Geba watersheds. In its beginning, the Kayanga drains several swampy areas at the foot of the Fouta Djalon lying on nearly level topography at approximately 80 meters elevation. After the stream becomes clearly identifiable, it flows in a general northwesterly direction. It enters southern Senegal near Patim Kouta and the slope increases notably.

Near the village of Sansankoto, the stream bears to the west and follows that general direction for most of its course through Senegal, turning southward as it approaches the Guinee-Bissau frontier. The Kayanga merges with the Anambe River near Niapo, approximately 75 kilometers down stream from its source. At this point, the ground elevation is 28 meters. Between Niapo bridge and the new bridge on the Kayanga some 15 kilometers downstream, the ground slope averages 0.27°. Over this route, the streambed is fairly clear and would allow for rapid evacuation of heavy runoff. Beyond the new bridge, however, the bed flattens, forest and underbrush encroach into the bed, and flow becomes clogged. Between the new bridge and Kaone, some 30 kilometers further, the slope is only 0.07 .

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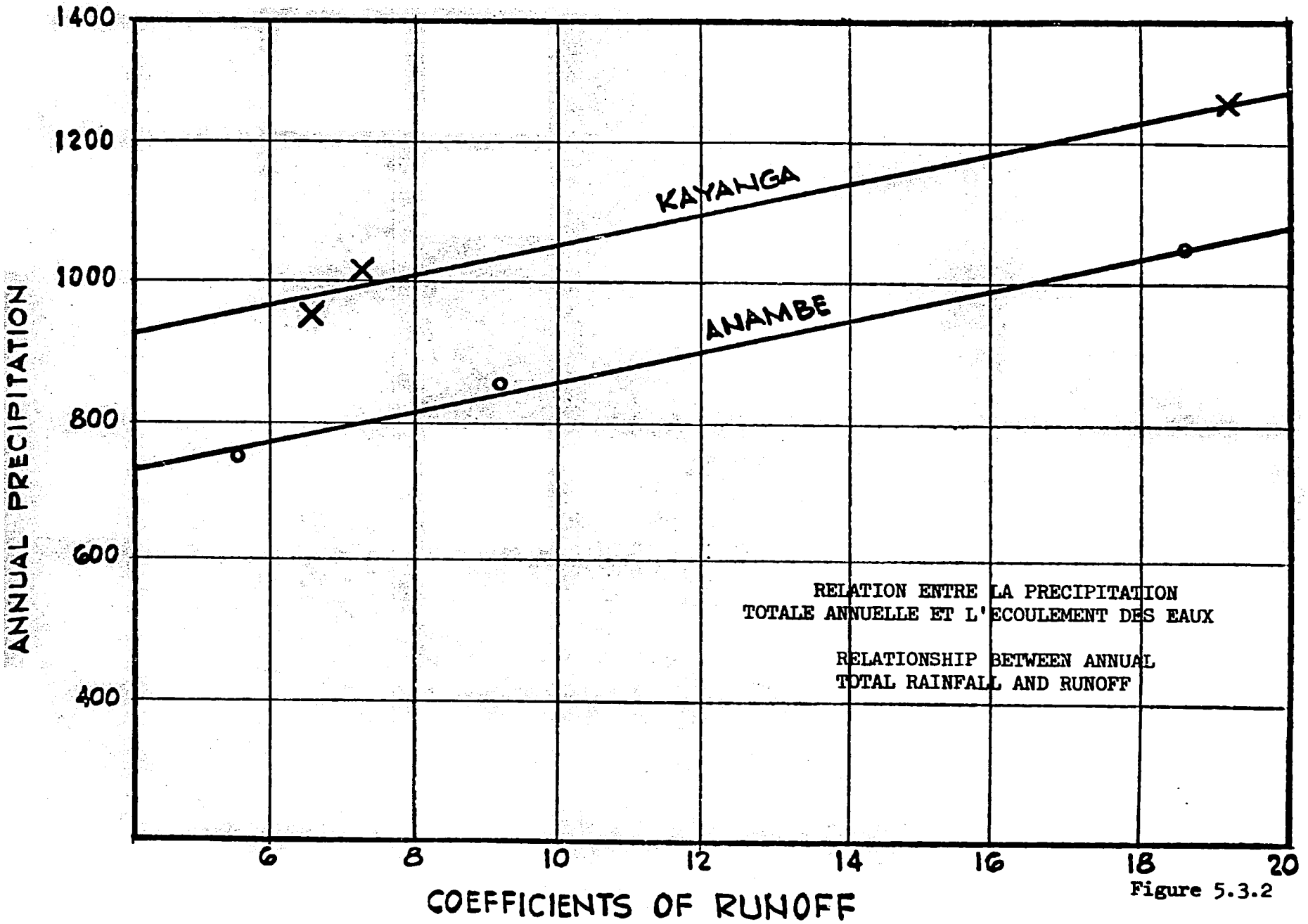


RELATION ENTRE LA PRECIPITATION TOTALE ANNUELLE ET L'ECOULEMENT DES EAUX

RELATIONSHIP BETWEEN ANNUAL TOTAL RAINFALL AND RUNOFF

Figure 5.3.2

The river meanders for a total of 140 kilometers in Senegal and exits into Guinea-Bissau where it becomes the Rio Geba and flows past Bissau into the Atlantic. The Geba is navigable for almost 80 kilometers upstream from its mouth and is nearly 10 Kilometers wide at Bissau.

Dry season flow in the Kayanga originates from a poorly yielding substratum appearing eastward from Velingara-Pakane. Downstream from Niapo, the porous sediment of the exposed Continental Terminal is more favorable and yields an increased supply of bank storage into the river from the upper groundwater table.

The Kayanga Basin above Niapo is approximately 1,755 square kilometers in area. Precipitation data covering the basin is scarce, but the isohyets shown on Figure 3. 1. 4B. indicate that average annual rainfall would range between 1,200 mm and 1,350 mm.

Monthly and annual average runoff of the Kayanga River at Niapo (based on a 3-year ORSTOM observation) is shown on Table 5.3.2 in cubic meters per second. As shown on this table, the mean annual runoff for the three-year period was 7.04 cubic meters per second representing an average yield of 126.5 millimeters from the drainage area. The annual average flows were :

| 1967/68 | 1968/69 | 1969/70 |
|---|---|---|
| 13.5 $m^3/s$. | 3.51 $m^3/s$. | 4.12 $m^3/s$. |

The maximum daily flow during the period was 135 cubic meters per second recorded on October 7, 1967 ; the lowest flow was 0.62 cubic meters per second on May 26, 1970. Based on Table 5. 3. 2., total annual runoff volumes and basin yields are estimated, as follows:

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Average Kayanga Runoff at Niapo, 1967 - 70 ($m^3/s$)

| MONTH | 1967-68 | 1968-69 | 1969-70 | AVERAGE |
|---|---|---|---|---|
| JUN | 2.88 | 2.29 | 2.30 | 2.49 |
| JUL | 5.71 | 3.60 | 5.97 | 5.09 |
| AUG | 6.26 | 4.52 | 4.50 | 5.09 |
| SEP | 30.64 | 12.54 | 13.44 | 18.87 |
| OCT | 86.03 | 9.21 | 10.38 | 35.21 |
| NOV | 14.84 | 3.15 | 5.88 | 7.96 |
| DEC | 5.24 | 1.81 | 2.05 | 3.03 |
| JAN | 3.30 | 1.38 | 1.33 | 2.00 |
| FEB | 2.55 | 1.12 | 1.07 | 1.58 |
| MAR | 1.94 | 0.99 | 0.96 | 1.30 |
| APR | 1.42 | 0.82 | 0.82 | 1.02 |
| MAY | 1.17 | 0.69 | 0.72 | 0.86 |
| AVERAGE | 13.50 | 3.51 | 4.12 | 7.04 |

Source : ORSTOM

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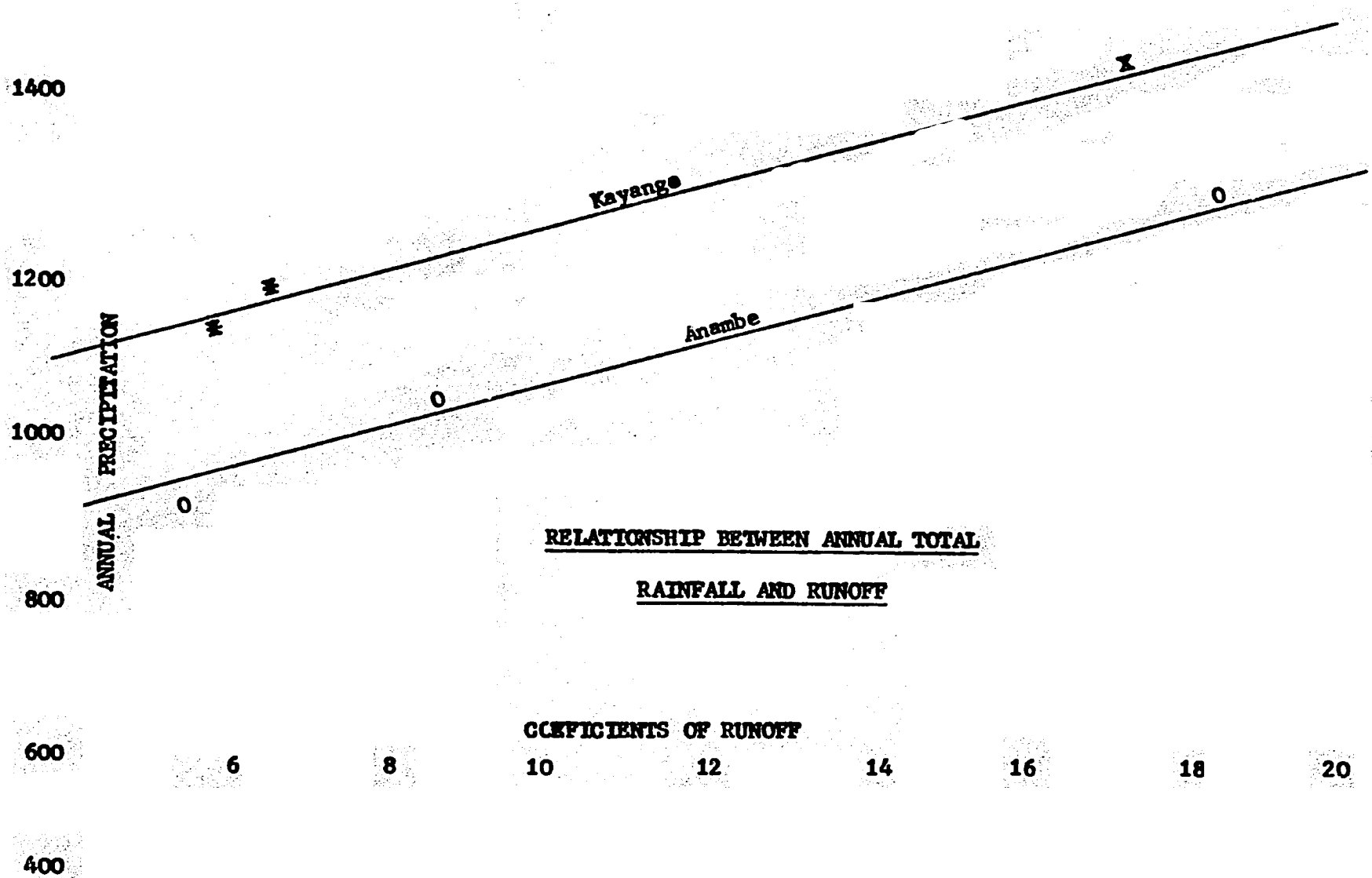


**RELATIONSHIP BETWEEN ANNUAL TOTAL RAINFALL AND RUNOFF**

Figure 5.3.2 A

| Date | Total Runoff (million cubic meters) | Basin Yield (mm) |
|---|---|---|
| 6/67-5/68 | 425 | 242.0 |
| 6/68-5/69 | 111 | 63.2 |
| 6/69-5/70 | 130 | 74.2 |
| Average | 222 | 126.5 |

These notable variations in annual runoff and basin yield are directly related to total rainfall as well as to intensities and durations of major storms. Data on daily rainfall representative for the catchment area during the period 1967-1970 is not available. Using rainfall data from Velingara and Kedougou, SODAGRI has estimated the precipitation and runoff coefficients to have been :

| Year (Hydrologic Cycle) | Total Rainfall (mm) | Runoff Coefficient (%) |
|---|---|---|
| 1967-1968 | 1251 | 19.3 |
| 1968-1969 | 956 | 6.6 |
| 1969-1970 | 1016 | 7.3 |

Rainfall during 1967-68 closely approached the estimated long-term average based on Velingara and Kedougou analyses, while the subsequent two periods were the beginning of the disasterous drought years. Figure 5.3.2. is a graphic illustration of the relationship established between total annual rainfall and the corresponding runoff coefficient as projected for

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a coefficient rage between 6 and 20%. In effect, Figure 5.3.2. indicates that total rainfall of less than 1,000 mm with a normal distribution yields a low basin runoff, as most precipitation is lost in evapotranspiration. Runoff coefficients increase by roughly 2% for each incremental increase of mm in annual total rainfall.

The GERCA study during 1962/63 included a calibration curve for the Kayanga River at Niapo bridge, based on 7 measurements made between 3 July 1962 and 21 January 1963. Based on both observed and estimated values, GERCA contructed the following monthly flow pattern for that period :

Monthly Flows - Kayanga River at Niapo Bridge 1962/63 ($m^3/s$).

| M | J | J | A | S | O | N | D | J | F | M | A | AVERAGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.7 | 1.3 | 5.2 | 17.6 | 10.0 | 51.5 | 17.7 | 5.6 | 3.7 | 2.7 | 1.8 | 1.0 | 13.25 |

source : GERCA.

GERCA estimated that rainfall on the basin during the period totalled 1,390 millimeters. Data available to SODAGRI, including weighted consideration to Kolda, Velingara and Kedougou totals, indicate that the average basin-wide precipitation would have been in the vicinity of 1,250 mm during June through October 1962.

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Based on this presumption, basin flow data for the 1962/63 hydrologic year may be expressed as shown below :

| | | |
|---|---|---|
| Watershed area at Niapo bridge | - | 1,755 $Km^2$ |
| Assumed rainfall in basin | - | 1,230 mm |
| Total Runoff | - | 425 million $M^3$ |
| Coefficient of Runoff | - | 19 % |
| Average stream flow | - | 13.5 $M^3$/second |
| Average basin yield | - | 7.7 liters/sec/$Km^2$ |

The relationship between total annual rainfall and the runoff coefficient fits well into the Kayanga pattern shown on Figure 5.3.2. and supports the validity of the curves thereon.

5.3.3. Anambe Basin Runoff.

The Anambe Basin, as previously described in this report, is a large depression separated from the Gambia watershed to the north, the Kayanga watershed to the south and east and the Casamance watershed to the west by a ring of almost imperceptible low ridges that, with the exception of the outlet to the Kayanga, completely surround the basin.

Morphologically, the basin is a recent evolution. The vast areas of weathered psuedo-gley soils found in the basin lead to the conclusion that until the early quartenary period, the basin was closed and contained a permanent lake. The lake slowly began accumulating deposits of shallow alluvium and volcanic ash forming anaerobic gleys on the floor of the

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depression. In recent geological history, either a collapse of the substratum or erosion from overtopping of the lake provided the basin with an outlet to the Kayanga. The lake was drained, exposing the gleys to weathering and soil formation processes, but depressions deeper than the outlet remained as evaporation ponds during the dry season.

The surrounding ridges average between 65 to 70 meters in elevation and enclose an area of approximately 1,100 square kilometers. The basin is drained by a network of shallow marigots whose beds are very broad and difficult to distinguish. Side slopes are on the average from 0.5 to 3°, while the north-south slope is considerably less on the basin floor, dropping only 7 meters in 15 kilometers. The basin narrows on the southern rim and measures 1,040 square kilometers at the Kabendou bridge.

Runoff flows from the periphery towards the center of the basin. Flow in the Anambe River occurs later than in its affluent marigots, as considerable runoff is required to fill and connect the various deeper depressions in the center of the basin before sustained flows can begin. Thus, Anambe runoff coefficients may be lower than expected due to the quantity of storage and surface evaporation within the basin.

The GERCA study includes results of 5 Anambe gaugings at the Kabendou bridge station. The flows were periodically measured as follows :

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Anambe River Runoff - 1962 - 63

| Date | Flood Level (m) | Flow Speed (m/ sec) | Basin Yield |
|---|---|---|---|
| 23.8.62 | 21. 1 | 0.10 | 8.8 |
| 3.10.62 | 23.0 | 0.06 | 39.3 |
| 27.10.62 | 22.2 | 0.09 | 26.7 |
| 7.12.62 | 20.5 | 0.18 | 1.0 |
| 24.1.63 | 20.2 | 0.09 | 0.1 |

Based on statistics and other observations, GERCA estimated the 1962-63 Anambe runoff as follows :

Anambe Runoff - GERCA Report (1962/63

| Aug | Sep | Oct | Nov | Dec | Jan | Feb-July | Average |
|---|---|---|---|---|---|---|---|
| 8.4 | 31.3 | 33.7 | 10.5 | 0.5 | 0.2 | 0.0 | 7.1 |

Values shown are cubic meters per second.

Temporary rain gauges installed by GERCA during 1962 indicated an average basin rainfall of 1,200 mm. Based on this precipitation and the estimated runoff shown above, the following conclusions were obtained :

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| | | |
|---|---|---|
| Basin area at Kabendou bridge | = | 1,040 $Km^2$ |
| Runoff flow volume | = | 223 Million $M^3$ |
| or equals | = | 214 mm basin yield |
| Runoff coefficient | = | 17.8% |

The basin runoff coefficient compares very favorably with the coefficient assumed for the Niapo Station on the Kayanga. SODAGRI calculations estimate a somewhat lower average rainfall for the Anambe basin in 1962, but the variation does not materially alter the results. Runoff percentages vary annually and not only reflect total pluviometry but also the intervals between heavy rains and the intensity and duration of major storms. Figure 5.3.2. shows the relation ip between the coefficient of runoff curve and the annual rainfall for the basin.

5.3.4. Anambe Basin Floods.

Runoff from the basin is restricted by a combination of several factors : the very slight north-south slope in the floor; constrictions in the outlet (a 10 kilometer long effluent connecting the basin to the Kayanga); and generally higher flood surface levels in the Kayanga at the point of discharge. Therefore, the basin floor is annually flooded up to approximately 3 meter depth for a period of between 3 and 4 months

The GERCA study provides the only known source of technical data for estimating the extent and volume of the annual floods. During the flood season of 1962 (a year of near normal rainfall) the flood level was reported to have reached the 24.5 meter elevation at the northern edge of the basin floor. It was 23.07 at Kebendou bridge discharge point and had a surface slope of 0.1%.

The flood peaked in October when an area approximately 15 kilometers long and 4.7 kilometers wide was innundated. The flood surface at that point covered approximately 75 square kilometers, or some 7,500 hectares of potential agricultural land, and held some 100 million cubic meters of stored volume.

The flood waters that accumulate in the Anambe Basin and particularly what remains in depressions after streamflow ceases constitute a readily available source of irrigation water, needing only to be pumped to adjacent fields. The shallow depth of these stagnant pods and the high rate of evaporation place rather severe although undetermined limits on the quantity of water available from this source.

## 5.4. THE SHALLOW WATER TABLE IN THE ANAMBE BASIN.

The 1962 GERCA report and the 1967 BRGM report by J. C. Napias provide detailed information on the behavior of the shallow goundwater table. The geomorphology identifies several basic materials in the crust; recent thin alluvium deposits of heterogenous sand; sand and argillaceous

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sandstone of the Continental Terminal; several layers of laterite in various stages of weathering and thickness, and clays. The Continental Terminal rests, in places, on thick chalk layers pertaining to the Miocene Period. In the bottoms of depressions, heavy vertisol clay deposits are common. Except for the expanding lattice clays and the remaining true gley deposits, the other materials are fairly porous and fractured and are reasonably permeable.

In the GERCA report, a total of 150 shallow wells investigated, 100 being tied into known elevation levels. These shallow wells were all hand dug and ranged beween 5 to 15 meters depth. The report concludes that, with minor exceptions, the shallow water piezometric level is a true match to surface topography. The water levels begin rising after the first heavy rains and recede quickly as the basin drains in November. Underground drainage follows a similar pattern as the surface drainage except that in the northern rim, the ground-water slope is towards the Gambia Basin. Many shallow wells are completely dry by mid-February. As expected, the water- table is nearer the surface in the southern portion of the basin.

It may be further concluded that the phreatic level of the shallow groundwater table is directly tied to the surface water level in the depressions. Observations indicate that volumes of water available from the shallow sub-surface storage are insufficient for consideration as a dependable source for large scale irrigation in the dry season, but small areas such as farm gardens, particularly in the southern portion of the basin, could be irrigated from this source.

## 5.4. DEEP AQUIFERS.

Insufficient information is available on the deep aquifers to assess their possible use as a source of irrigation supply - either as primary or supplemental source.

The water supply for Velingara is taken from a shallow concrete lined well 17 meters deep (55.8 feet) and 2.5 meters diameter. SODAGRI inspected the well in January, 1977, and were informed that the water level was 7.4 meters below the cover plate level before pumping and reached a static level of 9.2 meters depth after one hour at an average pumping rate of 22.5 cubic meters per hour (99 gals. per minute). The well is pumped for only two hours at midday and two hours at evening to provide Velingara requirements (90 cubic meters or 23,800 gallons per day).

The SODEFITEX cotton gin is equipped with a bore hole with an 8 inch casing to a depth of 50 meters. The well was reported to yield 37 cubic meters per hour but drawdown was not determined. The well operated only intermittently and for short durations to supply the requirements of the industrial complex. However, both of these wells tap the shallow groundwater table.

The deep aquifers lying under the Continental Terminal offer a possible reliable source for irrigation exploitation. Based on information obtained from the Service de Mines et Geologie in Dakar, the sub-strata of the Anambe

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Basin would likely have the following stratigraphy :

| Depth below surface (meters) | Description |
|---|---|
| 0 - 100 | Quaternary alluvium and Continental |
| 100 - 250 | Terminal |
| 250 - 450 | Eocene marl and limestone |
| 450 - 600 | Paleozoic sandstone and limestone |
| 600 - below | Weestrichtian aquifer, sweet water |
| | Bed rock, probably birriman. |

This stratification is very tentative and has been established from logs of deep wells drilled at considerable distances from the basin. While there are reasonable prospects of developing production wells by tapping aquifers of good quality water in the Eocene and Paleozoic deposits, no assessement can be made of potential yields.

Two drilling companies operating in Senegal, SONAFOR and SOTIF, were approached as to the cost and feasbility of deep water wells in the Project area

Neither group thought flows of 100 $m^3$/ he could be obtained from wells of less than 250 m depth, and they doubted that such wells would be economically soun considering the drilling and equipping costs.

Both compa favored shallower wells, 50-70 m deep, in the Continental Terminal. Yield of such wells might reach 60 $m^3$/ hr. SONAFOR costs for drilling and lining were $ 485

per meter of depth, estimate of and SASIF estimate of costs for drilling, lining and testing exploratory boreholes were $153 per lineal meter.

Considering the theoretical case when all the irrigation supply was to be obtained from deep well pumps i.e., 200 million m3 (actually 240 million m3).

| | | |
|---|---|---|
| Number of wells required (operating 20 hrs/day for 5 dry months, 60 $m^3$/hr.) | = | 1.111 |
| Drilling & lining cost | = | 1.111 X 70 X 485 |
| | | $37;718,450 |
| Pumps to 1,111 wells at estimated $20, 000 each | | |
| | | $22,220,000 |

These high initial costs and the inflated operational costs owing to high power requirements - approximately double the power requrements of the preferred reservoir and irrigation canal plan indicate the unsuitability of wells for the supply of irrigation water.

However, several wells should be drilled in the first phase of the project, in order thoroughly to investigate the potential, or lack thereof, of this source of water. These wells can be used to provide water to experimental stations.

To be considered feasible for economic irrigation development, wells should yield in the magnitude of 200 or more cubic meters of water per hour. Until such time



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as in situ experience from exploratory drilling and pump draw-down and recovery tests are available, the only dependable source of irrigation water supply appears to be from storage of stream flow - on the Kayanga or possibly the Anambe or Koulountou Rivers.

## 5.5. WATER BALANCE.

The complete cycle of water regime within the Anambe Basin is complex and unusual. As previously stated, the Basin was formerly occupied by a large permanent lake without a surface outlet. Anaerobic gleys were formed from volcanic ash sediments in the lower depressions and expanding lattice clays (Vertisols) were deposited at medium depth. Coarser materials including sandy colluviums espace were accumulated along the shallow edge of the lake. The remnants of these quaternary deposits and the vestige the lake provide the key for determining the present hydrological cycle, which primarily considers precipitation, actual evapotranspiration (ETA), the useful water retention capacity of the various soils (bank storage), deep, percolation, all lake storage, runoff into the lake end lake discharges into the Anambe River channal (total runoff) which connects the Basin with the Kayanga River.

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The movement of water through the deep aquifers have not been considered in this analysis as they cannot be evaluated at this time. As no water is currently being extraced from this source within the Basin, it may be presumed that inflow and outflow are thus in balance.

For the water balance analysis presented below, the historic period covering the May, 1952 through April, 1963 Hydrologic Year has been used, and is considered representative of average Basin conditions. Anambe River discharges covering this period were measured and estimated total monthly flows developed in the GERCA report (see Section 5.3.3.) that report provided the runoff date. The rainfall has been constructed based on Velingara recordings for the same period.

5.6.1. Precipitation for the 1962/1963 Hydrologic Year

By utilizing the established relationship developed between Velingara and Kounkanda precipitation, data recorded at Velingara between May, 1962 and April, 1963 have been adapted in order to construct a synthetic pattern representative of average basin-wide rainfall during that period. The precipitation estimates used in the water balance analysis are shown below in millimeters per month :

| M | J | J | A | S | O | N | D | J-M |
|---|---|---|---|---|---|---|---|---|
| 27 | 163 | 249 | 316 | 227 | 133 | 2 | D | 0 |

The annual total of 1117 millimeters is near mathematically perfect for the estimated average Basin rainfall and the distributional pattern very closely approximates the monthly averages shown for the

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Anambe Basin in Section 5.1.6.

5.6.3. Actual Evapotranspiration.

In Section 5.1.11, the potential evapotranspiration (ETP) for the Anambe Basin is given. The annual total is shown to be 1,819 mm which is 62% more than the average total rainfall. However, (potential) ETP can only occur when an area is completely covered with a short fast growing crop such as alfalfa and when the soil remains at maximum field capacity continuously. Considering the wet and dry cycle of Basin weather, it is apparent that potential ETP would be likely to occur only during the months of August and September when the entire basin is covered with growing vegetation, the soils are close to saturation, and the lake is near its maximum size. The months of July and October have a slightly lower evapotranspiration requirement and ETA is somewhat lower than ETP, but for the balance of the year, the actual monthly values are considerably lower than the potential.

Following the annual recession of the rain front, crops are quickly harvested, the upper layers of soil rapidly dry, all annual vegetation dries and becomes completely dormant. Fires are ignited to burn crop residues, trash, and dry foliage, and the only plant species to continue to transpire are deeply rooted evergreens. Evaporation is limited to the ever-reducing surface of the remaining shallow water in the deeper depressions which do not drain into the Kayanga due

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to elevation blockage.

For the above reasons, the data on ETP given in Section 5.1.11 have been revised to reflect an estimated actual avapotranspiration (ETA) for the Basin during the period used in this water balance analysis. The revised ETA values total 501 mm, distributed monthly as follows :

| M | J | J | A | S | O | N | D | J | S | M | A |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 50 | 60 | 103 | 91 | 88 | 103 | 53 | 61 | 57 | 65 | 75 | 65 |

5.6.3. Water Retention Capacity of the Solum.

A four meter depth of soil has been taken as representative of the solum and being, for practical purposes, the greatest depth of root penetration by most of the evergreen plant species.

As discussed in Section 4.2, the Basin's soils range from permeable sandy loams and crumbly fractured laterites to Vertisols and nearly impermeable clays and gleys. By weighting the extent of each soil group within the Basin and estimating their effective water retention capacity ( water which can be extracted by plants ), an average value, of 100 mm of useful water storage per meter of soil has been assumed as representative of field capacity.

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5.6.4. Deep Percolation.

Considering the geomorphology of the Basin's soils, it can be assumed that with the exception of the more permeable soils along the upper rim of the area, deep percolation will be very limited over the entire area. A total of 22 millimeters equivalent, or 2 percent of the total rainfall, will gravitate below the root zones, and eventually reach the upper aquifers of the Continental Terminal and will be unutilized in the Basin. More than half of this loss will occur during July and August before the deep cracking clays and the fractured laterite formations have been sealed.

5.6.5. Lake Storage

During each wet season, the lower depressions in the Basin fill with runoff from higher elevations and base flow from the bank. They unite and begin to flow down the established channel into the Kayanga River as soon as the surface elevation of the lake exceeds the ground level under the Kounkande-Kolda road bridge at Kabendou. The flow does not begin for sometime after the onset of the early rains and the maximum flow occurs after the heavy rains are waning. This phenomenon is primarily due to the blockage of the lake's outlet by higher water levels in the Kayanga River at the point of confluence.

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As the Kayanga flow recedes, the lake's drainage flow increases rapidly. Flow usually starts in August, peaks in October and effectively terminates in December. Water remaining in the inland depressions is gradually consumed through evaporation ; however, there is always carry-over lake storage when the rains return the following year.

At maximum flood stage, the lake covers an area of approximately 75 square kilometers at an averages depth of 1.5 meters - the equivalent of about 118 millimeters of runoff from the Basin. At low stage it is estimated that the shallow water surface covers about 11.5 square kilometers holding some 3.5 million cubic meters of storage.

5.6.6. Runoff.

All Basin runoff is channeled towards the inland depressions which must fill and connect before the Anambe River channel begins to flow. Runoff from early rains is minimal (14 and 15% coefficients for June and July respectively) due to the dryness of the solum and the rapid percolation into the loose top soil. As the soil reservoir begins to fill and the rains become more intense, runoff coefficients increase to 27% in September and 66% in October.

5.6.7. Water Balance Analysis for the Period

Figure 5.6.7, which follows, gives the annual water balance for the hydrologic Year under review. The analysis

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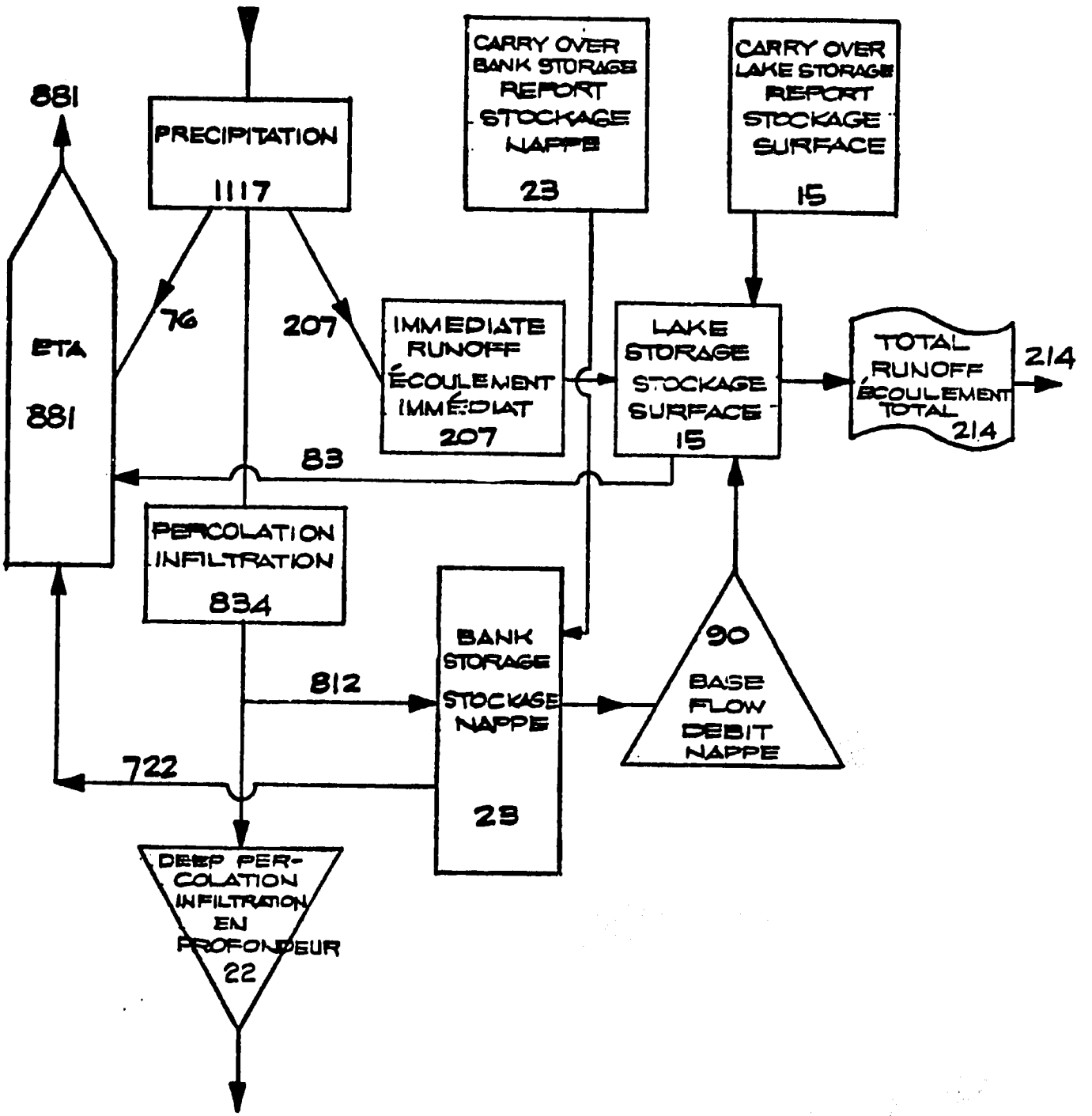
ANAMBE BASIN (1,040 KM²)
BASSIN DE L'ANAMBE (1,040 KM²)

## ANNUAL WATER BALANCE IN mm.
## REGIME HYDROLOGIQUE ANNUEL EN mm.

(MAY 1962 - APRIL 1963)
(MAI 1962 - AVRIL 1963)




ETA = ESTIMATED ACTUAL EVAPOTRANSPIRATION
ETA = EVAPOTRANSPIRATION REELLE ESTIMEE

FIGURE 5.67

assumes an amount of soil moisture (bank storage) and lake storage equivalent to 23 and 15 millimeters respectively as carry-over water ressources from the previous wet season.

Figures 5.6.7. A through 5.6.7.L, which are presented in the Annexes to this report, are monthly balance sheets for May through April respectivaly and show the monthly breakdown of the total values shown on Figure 5.6.7.

The annual water balance equation may be summarized as follow :

May 1962, Water Balance (Fig.5.6.7.A.)

| Inflow (mm) | | Outflow (mm) | |
|---|---|---|---|
| Precipitation | 1117 | ETA | 881 |
| Carry-over bank storage | 23 | Runoff to the Kayanga | 214 |
| Carry-over lake storage | 15 | Lake storage | 15 |
| | | Deep parcolation | 22 |
| | | Residual soil Moisture | 23 |
| Total Inflow | 1155 | Total Outflow | 1 155 |

Early rains begin in May (22 mm) but runoff is not expected and, with the exception of a 2 mm evaporation loss, the balance enters the top soil and is rapidly removed by ETA. By the end of the month,

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the available soil moisture in the upper 4 meters of solum is nearly exhausted and the lake is at its lowest volume due to ETA being in excess of the rainfall. Base flow occurs in a minimum amount (1mm) as the lake surface lowers to its final elevation.

June 1962, Water Balance (Fig. 5.6.7.B.): Precipitation increased in June (163 mm) and runoff into the lake has begun (23 mm). As ETA has been calculated at 50 mm, there is a net gain in water and the lake rises perceptibly. Base flow into the lake has ceased, reflecting the paucity of bank storage at the beginning of the month. There is no runoff into the Kayanga as the lake surface has not reached the elevation of its discharge under the road bridge.

July 1962, Water Balance (Fig. 5.6.7.C.) : Rainfall in July totaled 249 mm and ETA increased to 103 mm. Deep percolation through cracks and fissures reduced the net monthly gain to 143 mm. Resumed base flow and increased runoff to the lake combined to raise the lake level to near discharge elevation and the soil's water retention capacity is nearly 50% filled.

August 1962, Water Balance (Fig. 5.6.7.D.) : The highest precipitation of the year occurs in August; runoff into the Anambe River channel downstream from the bridge begins; and the lake approaches its maximum level. Soil moisture (bank storage) is at 86% of field capacity.

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September 1962, Water Balance (Fig. 5.6.7E.): Although precipitation is waning, the soil has attained full its capacity and saturation. Runoff and base flow into the lake is at its heaviest, but, due to drainage restriction caused by Kayanga River flows backing into the lowerlower Amvabe channel, lake discharge is constrained and the lake registers its maximum volume while discharging a monthly total of 78 mm (33.7 cubic meters per second average.)

October 1962, Water Balance (Fig. 5.6.7.F): Precipitation has decreased to 133 mm but inflow into the lake from runoff and base flow, combined with the effect of a lower level on the Kayanga River to increase the 87 mm (33.7 cubic meters per second). Increased ETA plus reduced rainfall begin to lower soil moisture and the top stratum begins to dry. The lake level is drastically reduced by month's end.

November 1962, Water Balance (Fig. 5.6.7G.): Rainfall is of no importance during this month and no runoff to the lake occurs. The lake continues to flow into its discharge channel fed only from base flow return. ETA is supplied solely from lake evaporation and vegetation respiration drawing from residual soil moisture. The upper soil has dried and annual vegetation and deciduous plants have begun to dry. All crops are harvested and ETA is decreasing.

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December 1962, Water Balance (Fig. 5.6.7H): Precipitation has ceased and effective rainfall will not occur again until the following May when the humid front again re-enters southern Senegal. Lake discharge ceases during this month and the lake slowly loses volume as evaporation exceeds return flow from bank storage. Transpiration depends entirely upon bank storage, which has now been reduced to slightly over 60% of solum capacity. Total ETA is reduced, as only deeply rooted evergreen trees and shrubs continue to transpire.

January - April 1963, Water Balance (Fig. 5.6.7 I. Through 5.6.7.L.): For the balance of the dry season, ETA continues to deplete the only sources of moisture in the Basin, lake and bank storage (excluding deep aquifers, which have not been considered in this analysis as they cannot be evaluated at this time). Base flow into the lake is minimal but continuous, as groundwater from higher elevation drains towards the basin. By the end of April, the remaining lake and bank storage balance with the quantities assumed at the start of the analysis. If May precipitation delayed or is appreciably less than average, many evergreen plants will enter into a permanent wilting stage and will perish. Evidence of deadwood is plentiful in the Anambe Classified Forest, primarily young tress or those with shallow fibrous root systems, which have not survived the recent drought years.

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## 5.7. PROJECT STRUCTURE AND DEVELOPMENT PLANS AS DICTATED BY CLIMATE AND HYDROLOGY.

### 5.7.1. Climatic Dictates.

Effective precipitation represents that portion of total rainfall available for evapotranspiration on agricultural land after immediate runoff and deep percolation have been excluded. Based on small watershed runoff measurements conducted by GERCA, an order - of-magnitude coefficient of 75% has been accepted for conversion of total or probable rainfall into effective precipitation. By applying this factor to 50% and 75% probabilities of monthly rainfall occurrance as shown in Paragraph 5.1.6. and comparing the results with potential evapotranspiration values for the Anambe Basin, as shown in Paragraph 5.1.13., it is clear that in three out of four years (or 75% probability ) there is sufficient moisture available for rainfed agriculture only during the months of July, August, and September.

In order to justify the capital outlays required for all land preparation, flood control and construction of the proposed agro-industrial complex, it will be necessary not only to increase the productive capacity of the arable basin lands, but concurrently to increase the percentage of land utilization by reclamation and irrigation. Without irrigation only one crop can be expected per year on land presently under cultivation, and in one out of four years, this crop may receive insufficient rainfall for production of an average yield.

Without drainage, the potentially most productive lands in the Basin cannot be utilized except for dry season livestock grazing.

Therefore, due to climatic constraints, future development

of advanced-type agriculture in the Basin, requires the combination of irrigation and drainage natworks, which would vastly increase the existing low level of arable land utilization.

5.7.2. Hydrology Dictates.

The results of field studies and surveys, and the analysis of existing technical reports, lead to the conclusion that the development of the Kayanga River would be the logical means for providing the basin with a dependable source of irrigation supply. A dam site has been provisionally selected upstream from the Niapa bridge, where topography appears to be more favorable for construction and storage than other alternative sites investigated. The dam will be described in preliminary terms in later Chapters of this report.

Storage and controlled releases of Kayanga flows would prevent blockage of the Anambe discharges where these two streams converge, and would in itself greatly reduce the depth and extent of annual flooding in the Basin.

The provision of a system of collector and primary drains, within the Basin would facilitate rapid removal of runoff and would allow for paddy rice cultivation on 7,000 to 10,000 hectares of heavy clay soils presently unavailable to agriculture.

Therefore, hydrologic considerations dictate a future projet structure incorporating storage and regulating facilities on the Kayanga River upstream from Niapo bridge and drainage structures within the Basin.

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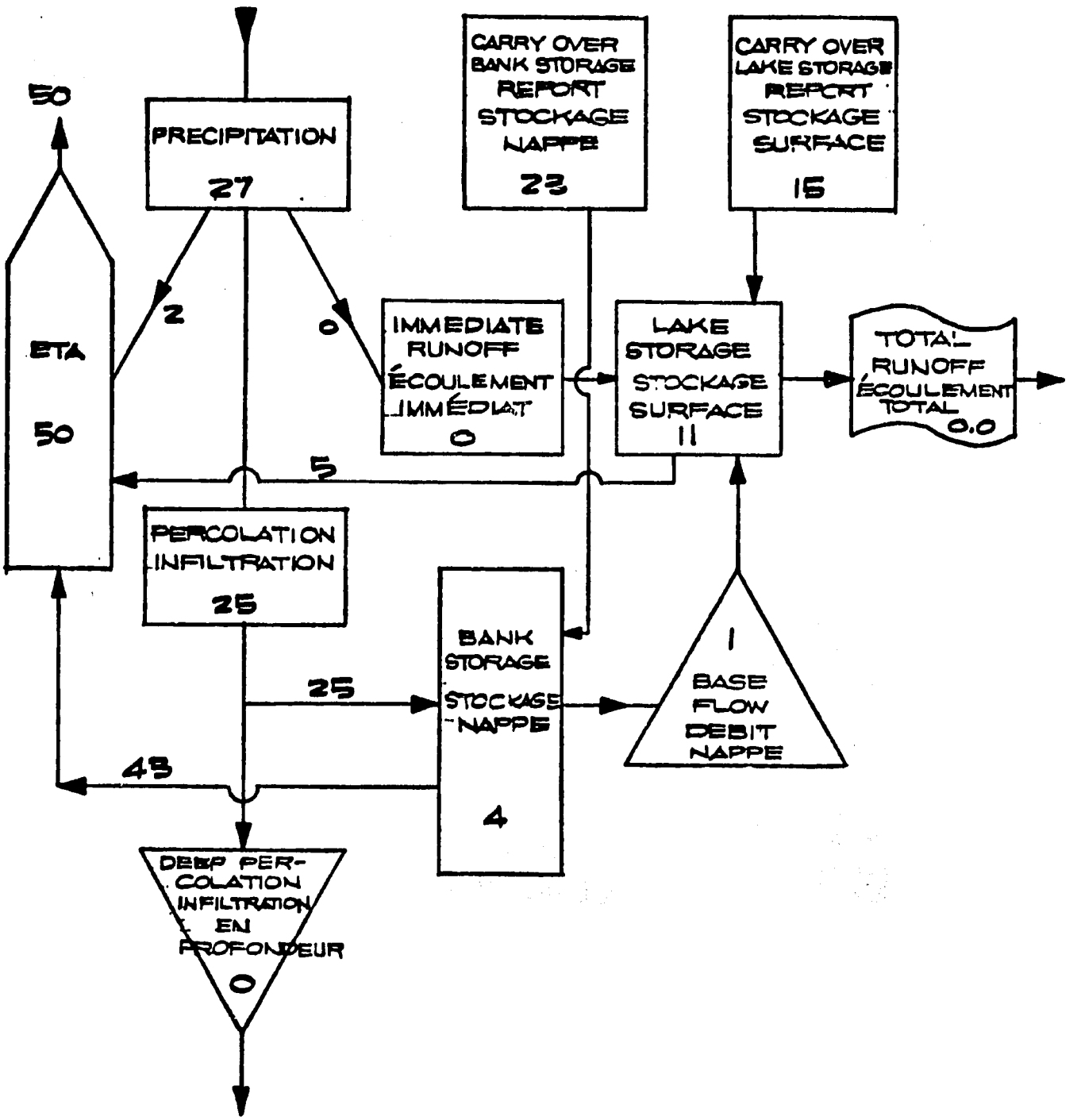
ANAMBE BASIN (1,040 KM²)
BASSIN DE L'ANAMBE (1,040 KM²)

MONTHLY WATER BALANCE IN mm.
BILAN MENSUEL D'EAU EN mm.

MAY 1962 MAI 1962




ETA = ESTIMATED ACTUAL EVAPOTRANSPIRATION
ETA = EVAPOTRANSPIRATION REELLE ESTIMEE

FIGURE 5.67A

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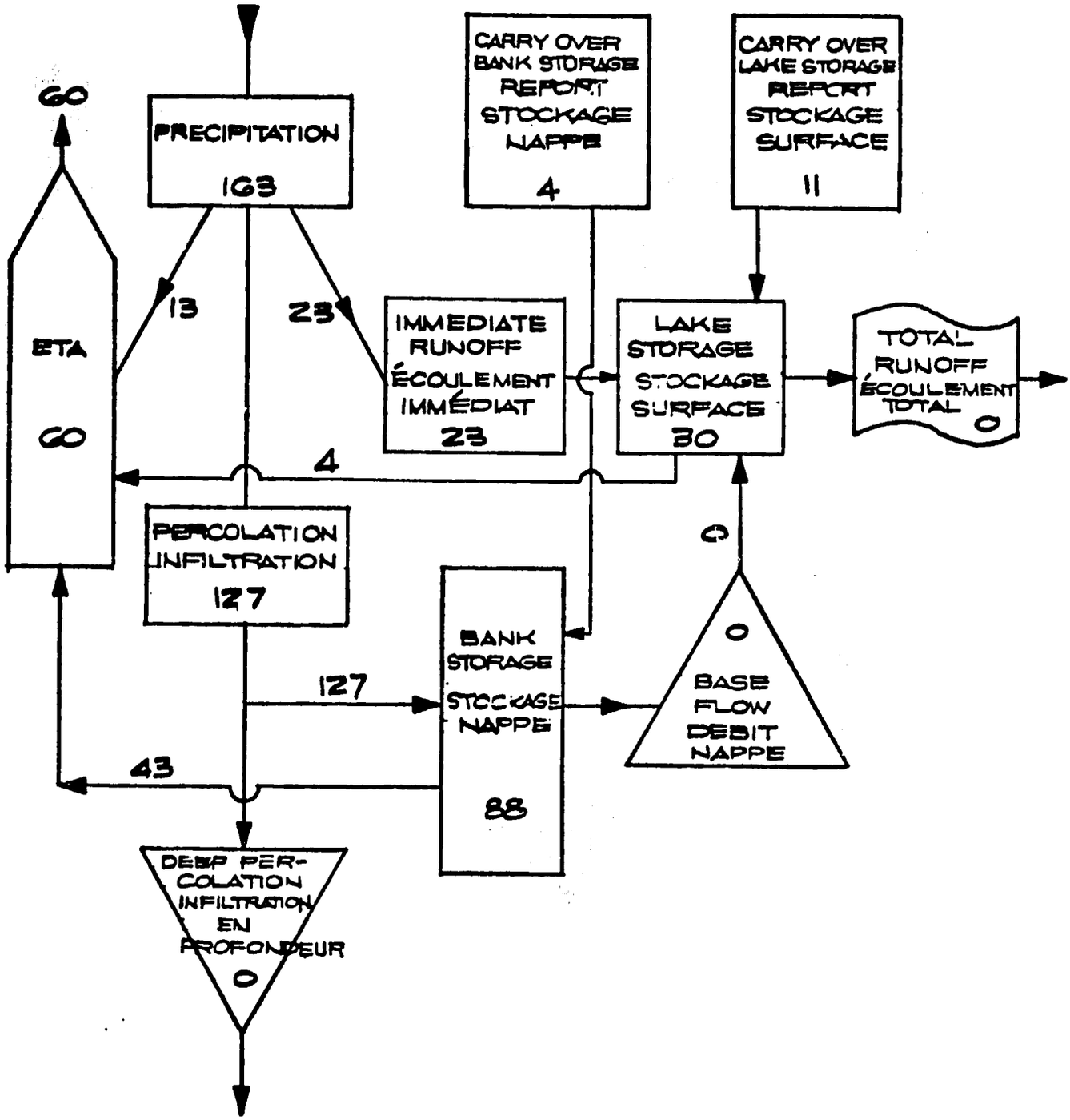
ANAMBE BASIN (1,040 KM²)
BASSIN DE L'ANAMBE (1,040 KM²)

MONTHLY WATER BALANCE IN mm.
BILAN MENSUEL D'EAU EN mm.
JUNE 1962 JUIN 1962

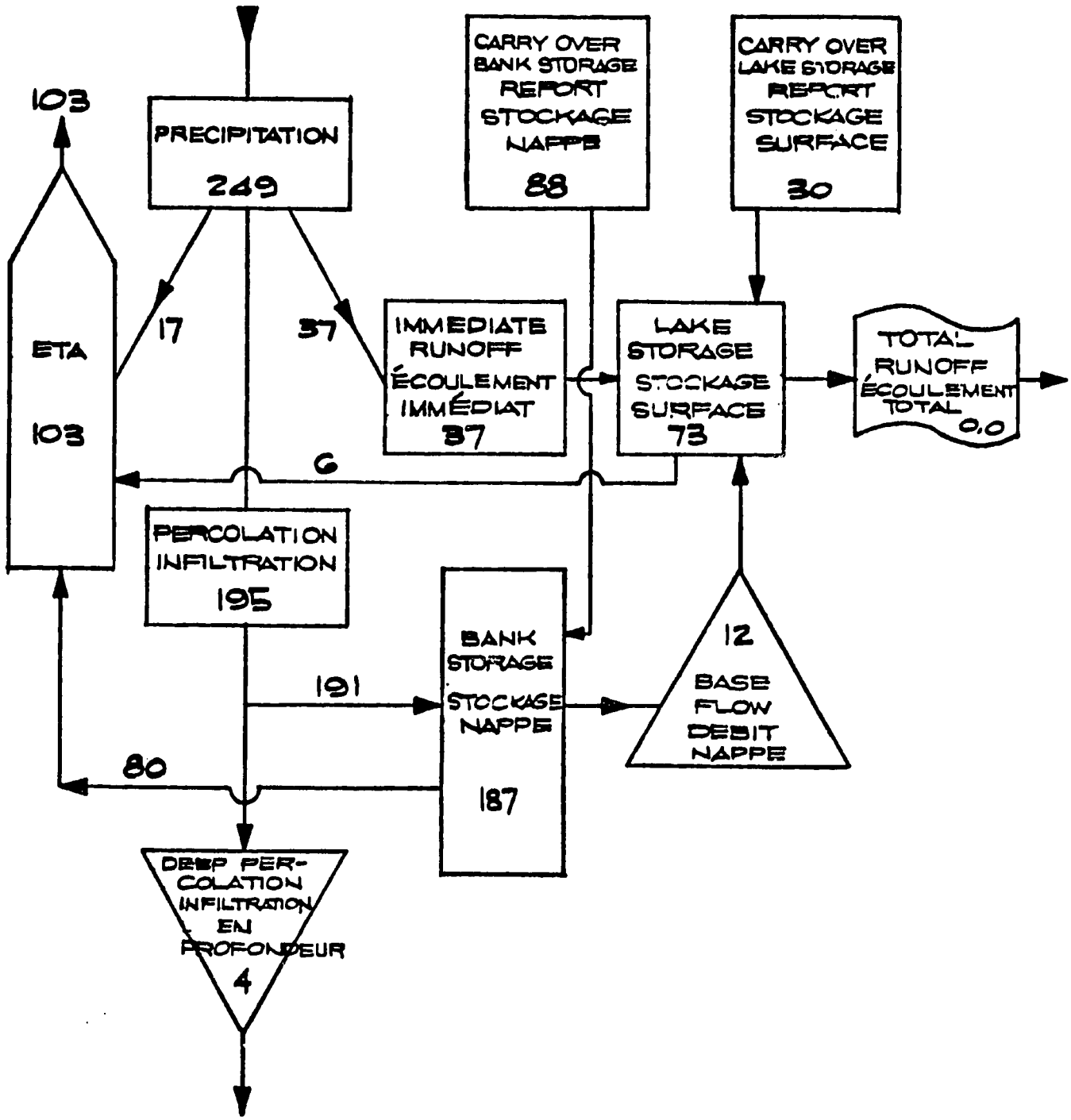



ETA = ESTIMATED ACTUAL EVAPOTRANSPIRATION
ETA = EVAPOTRANSPIRATION REELLE ESTIMEE

FIGURE 5.67B

ANAMBE BASIN (1,040 KM²)
BASSIN DE L'ANAMBE (1,040 KM²)

MONTHLY WATER BALANCE IN mm.
BILAN MENSUEL D'EAU EN mm.
JULY 1962 JUILLET 1962



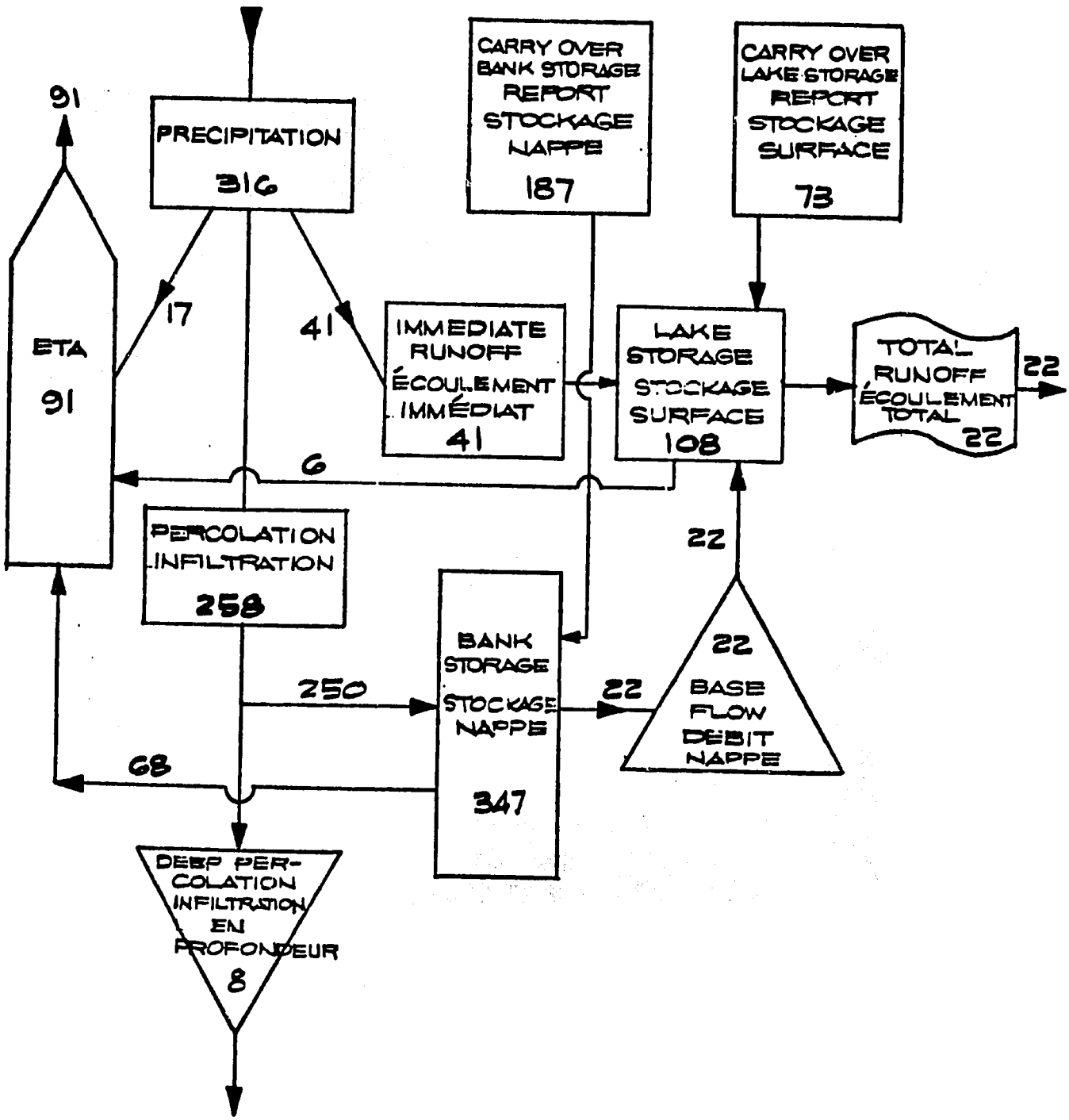

ETA = ESTIMATED ACTUAL EVAPOTRANSPIRATION
ETA = EVAPOTRANSPIRATION REELLE ESTIMEE

FIGURE 5.67C

ANAMBE BASIN (1,040 KM²)
BASSIN DE L'ANAMBE (1,040 KM²)

MONTHLY WATER BALANCE IN mm.
BILAN MENSUEL D'EAU EN mm.

AUGUST 1962 AOUT 1962



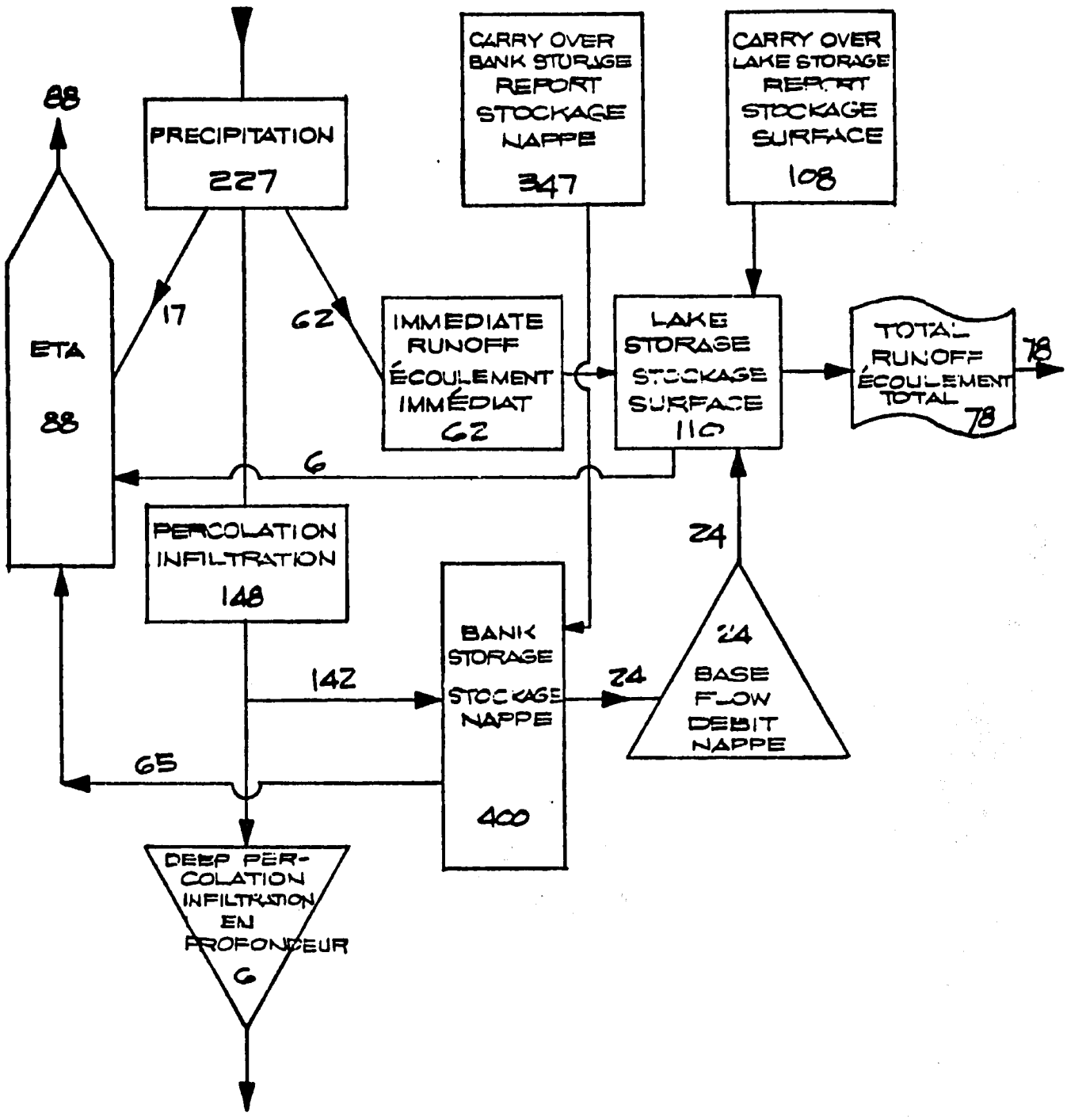

ETA = ESTIMATED ACTUAL EVAPOTRANSPIRATION
ETA = EVAPOTRANSPIRATION REELLE ESTIMEE

FIGURE 5.67D

ANAMBE BASIN (1,040 KM²)
BASSIN DE L'ANAMBE (1,040 KM²)

## MONTHLY WATER BALANCE IN mm.
## BILAN MENSUEL D'EAU EN mm.

SEPTEMBER 1962 SEPTEMBRE 1962



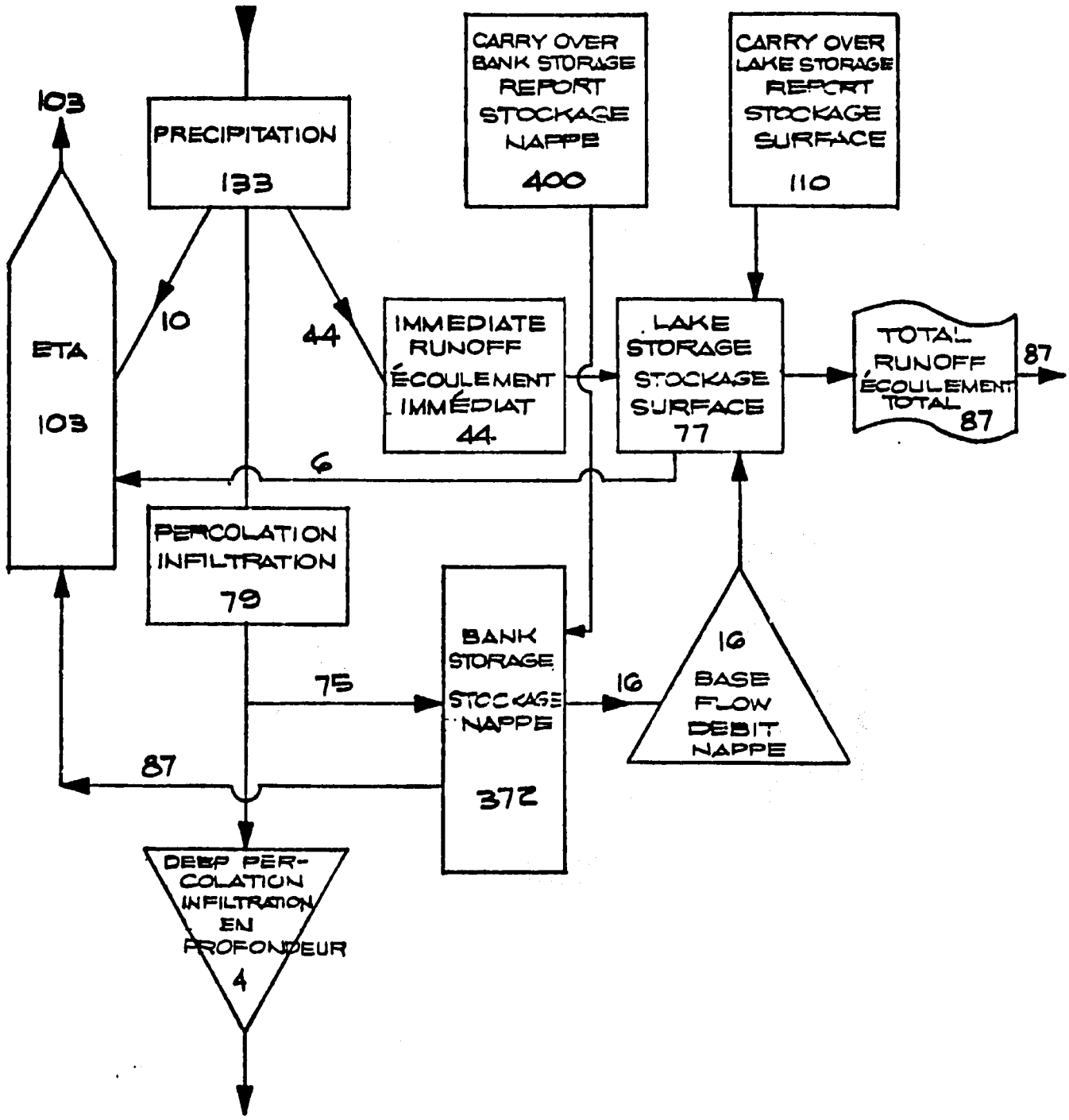

ETA = ESTIMATED ACTUAL EVAPOTRANSPIRATION
ETA = EVAPOTRANSPIRATION REELLE ESTIMEE

FIGURE 5.6.7E

ANAMBE BASIN (1,040 KM²)
BASSIN DE L'ANAMBE (1,040 KM²)

MONTHLY WATER BALANCE IN mm.
BILAN MENSUEL D'EAU EN mm.

OCTOBER 1962 OCTOBRE 1962



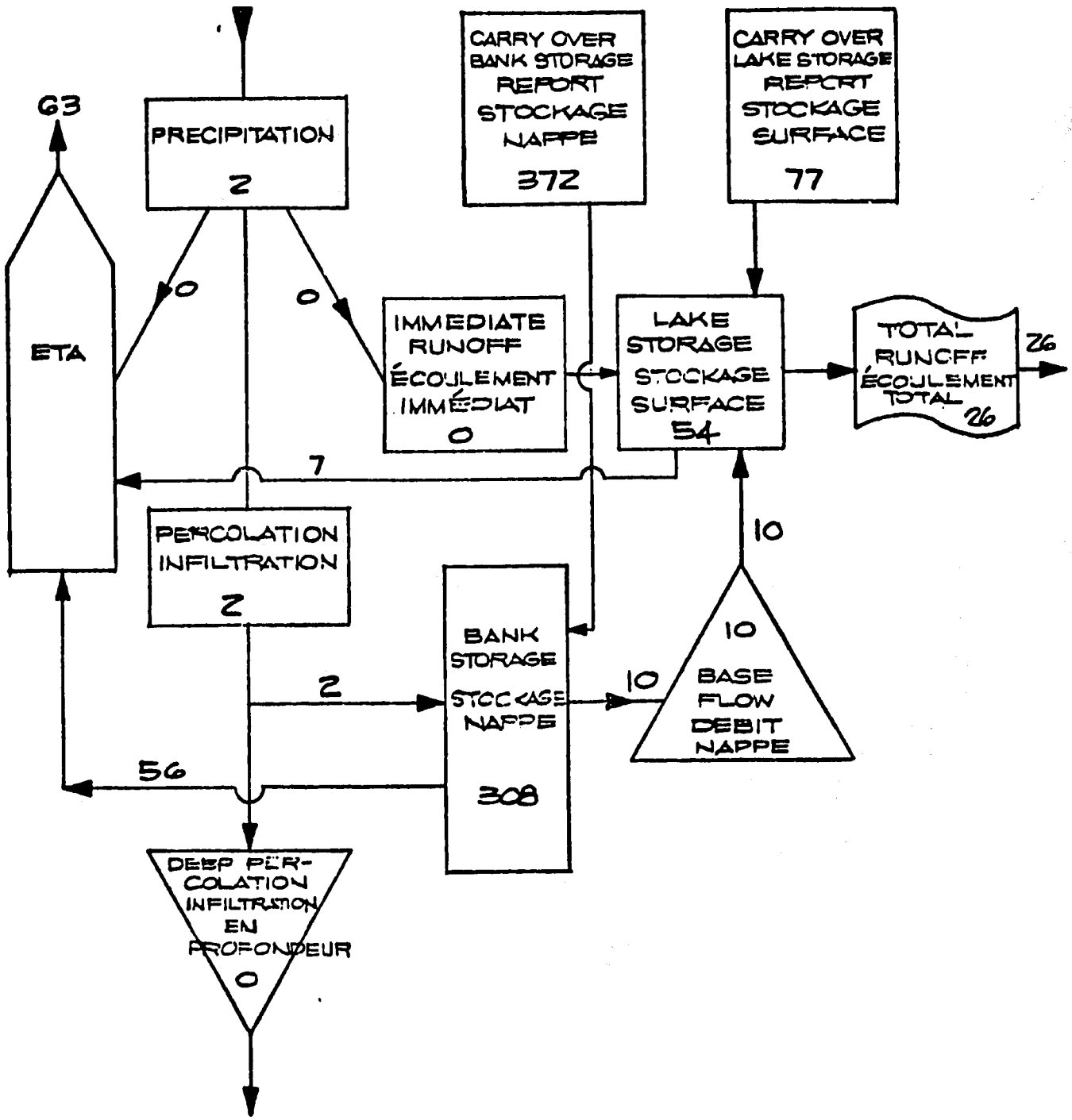

ETA = ESTIMATED ACTUAL EVAPOTRANSPIRATION
ETA = EVAPOTRANSPIRATION REELLE ESTIMEE

FIGURE 5.67F

ANAMBE BASIN (1,040 KM²)
BASSIN DE L'ANAMBE (1,040 KM²)

MONTHLY WATER BALANCE IN mm.
BILAN MENSUEL D'EAU EN mm.

NOVEMBER 1962 NOVEMBRE 1962



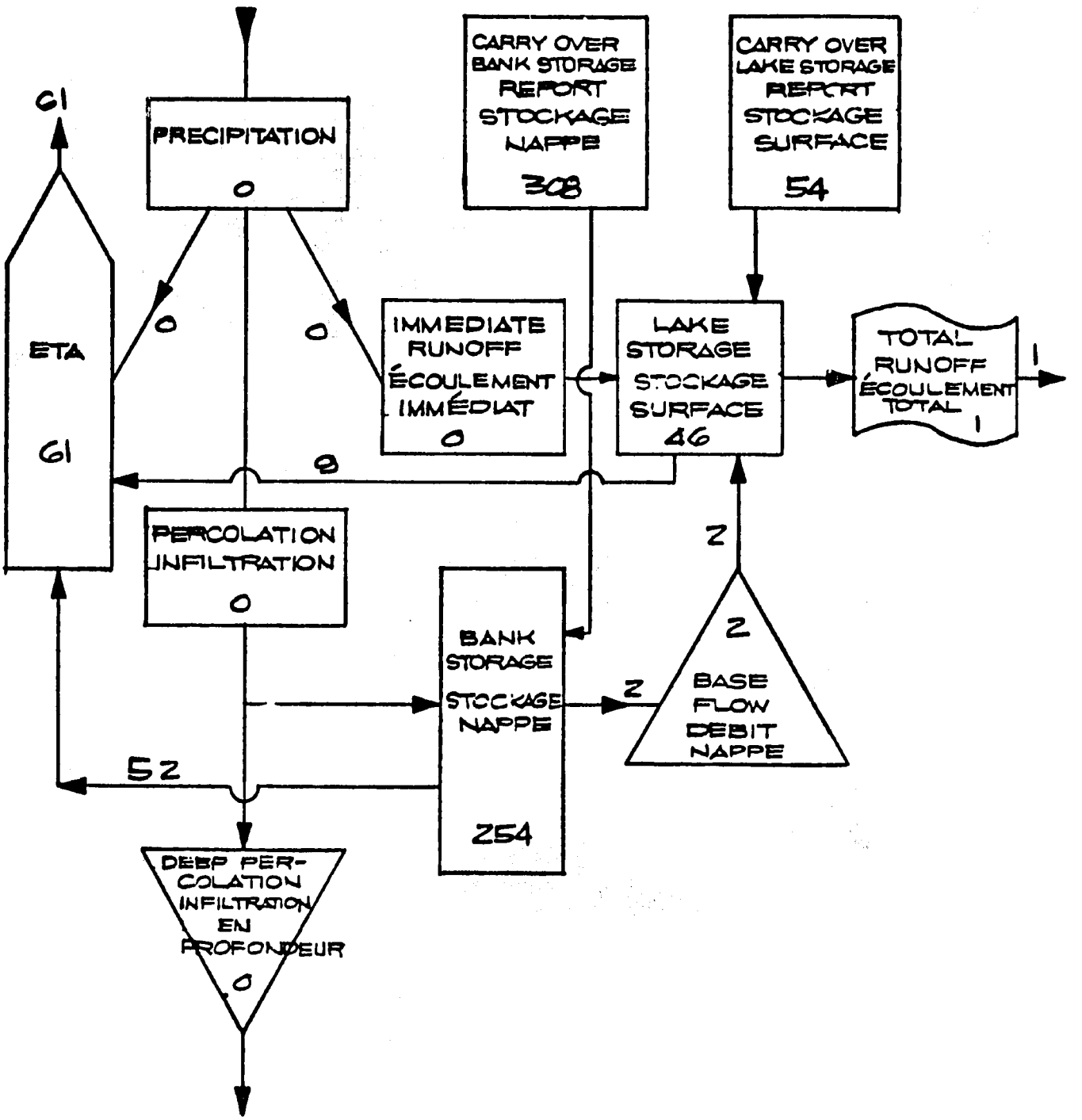

ETA = ESTIMATED ACTUAL EVAPOTRANSPIRATION
ETA = EVAPOTRANSPIRATION REELLE ESTIMEE

FIGURE 5.6.7G

ANAMBE BASIN (1,040 KM²)
BASSIN DE L'ANAMBE (1,040 KM²)

## MONTHLY WATER BALANCE IN mm.
## BILAN MENSUEL D'EAU EN mm.

DECEMBER 1962 DECEMBRE 1962



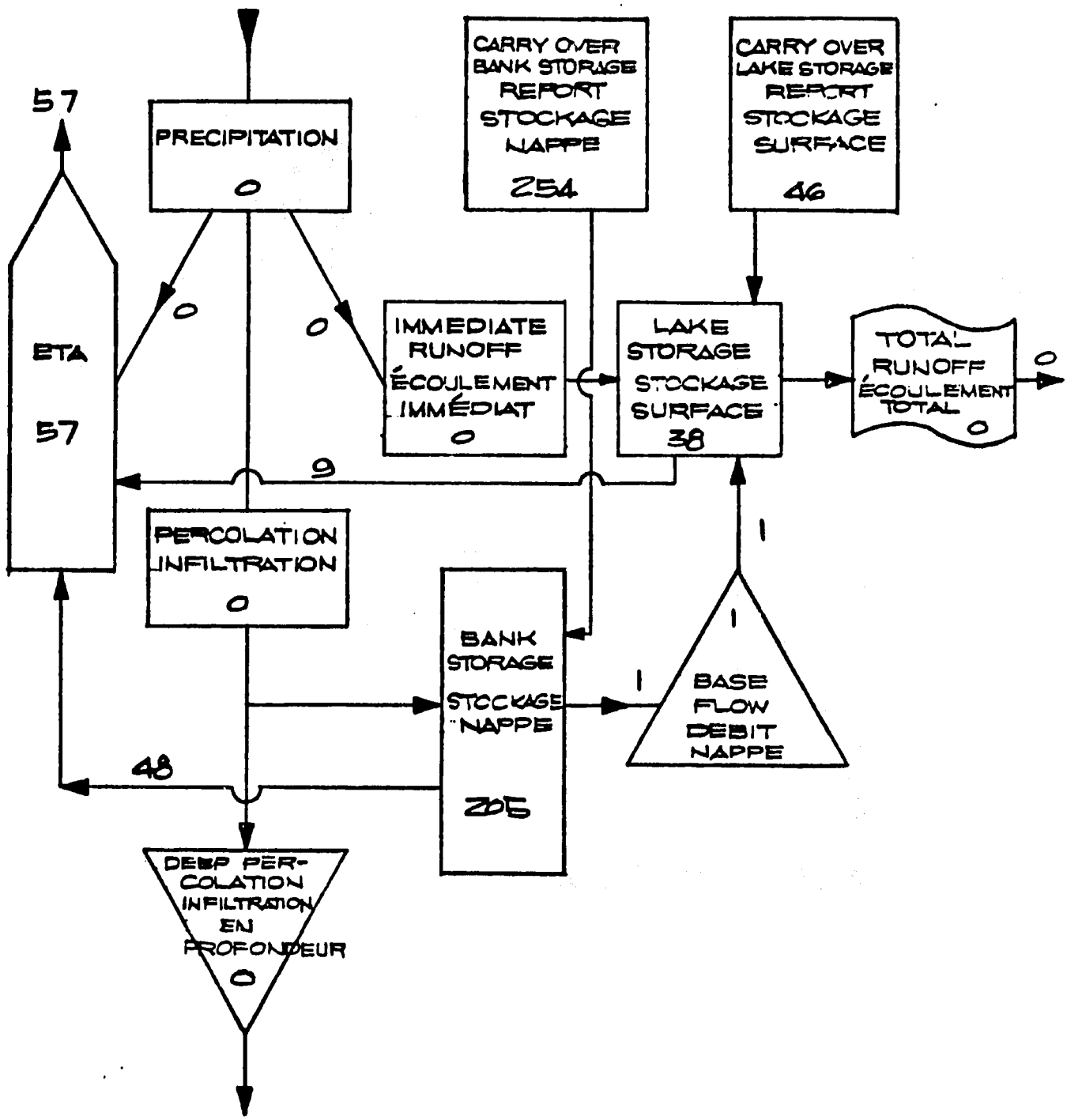

ETA = ESTIMATED ACTUAL EVAPOTRANSPIRATION
ETA = EVAPOTRANSPIRATION REELLE ESTIMEE

FIGURE 5.67 H

ANAMBE BASIN (1,040 KM²)
BASSIN DE L'ANAMBE (1,040 KM²)

## MONTHLY WATER BALANCE IN mm.
## BILAN MENSUEL D'EAU EN mm.

JANUARY 1963 JANVIER 1963



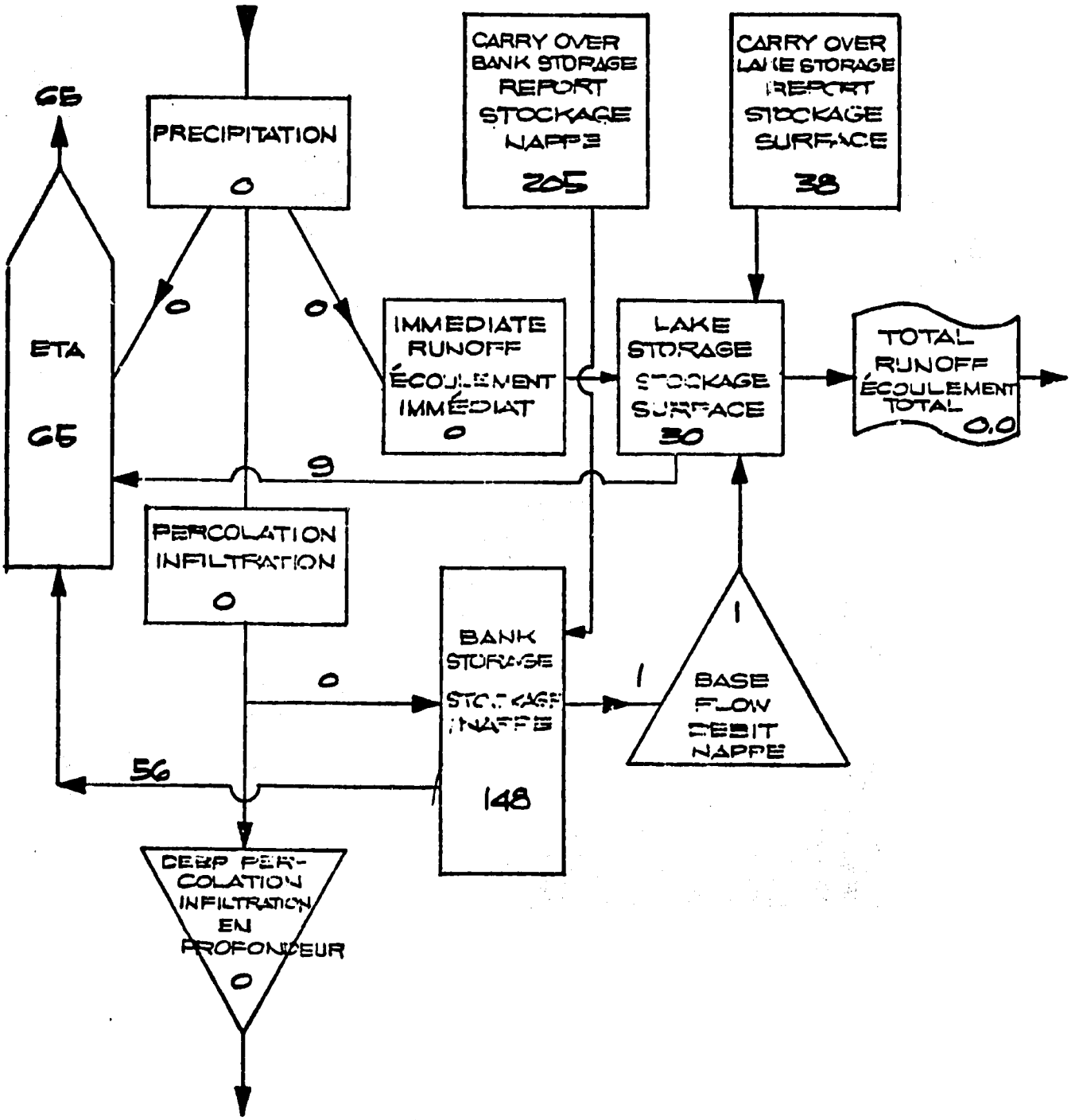

ETA = ESTIMATED ACTUAL EVAPOTRANSPIRATION
ETA = EVAPOTRANSPIRATION REELLE ESTIMEE

FIGURE 5.67 I

ANAMBE BASIN (1,040 KM²)
BASSIN DE L'ANAMBE (1,040 KM²)

MONTHLY WATER BALANCE IN mm.
BILAN MENSUEL D'EAU EN mm.

FEBRUARY 1963 FEVRIER 1963



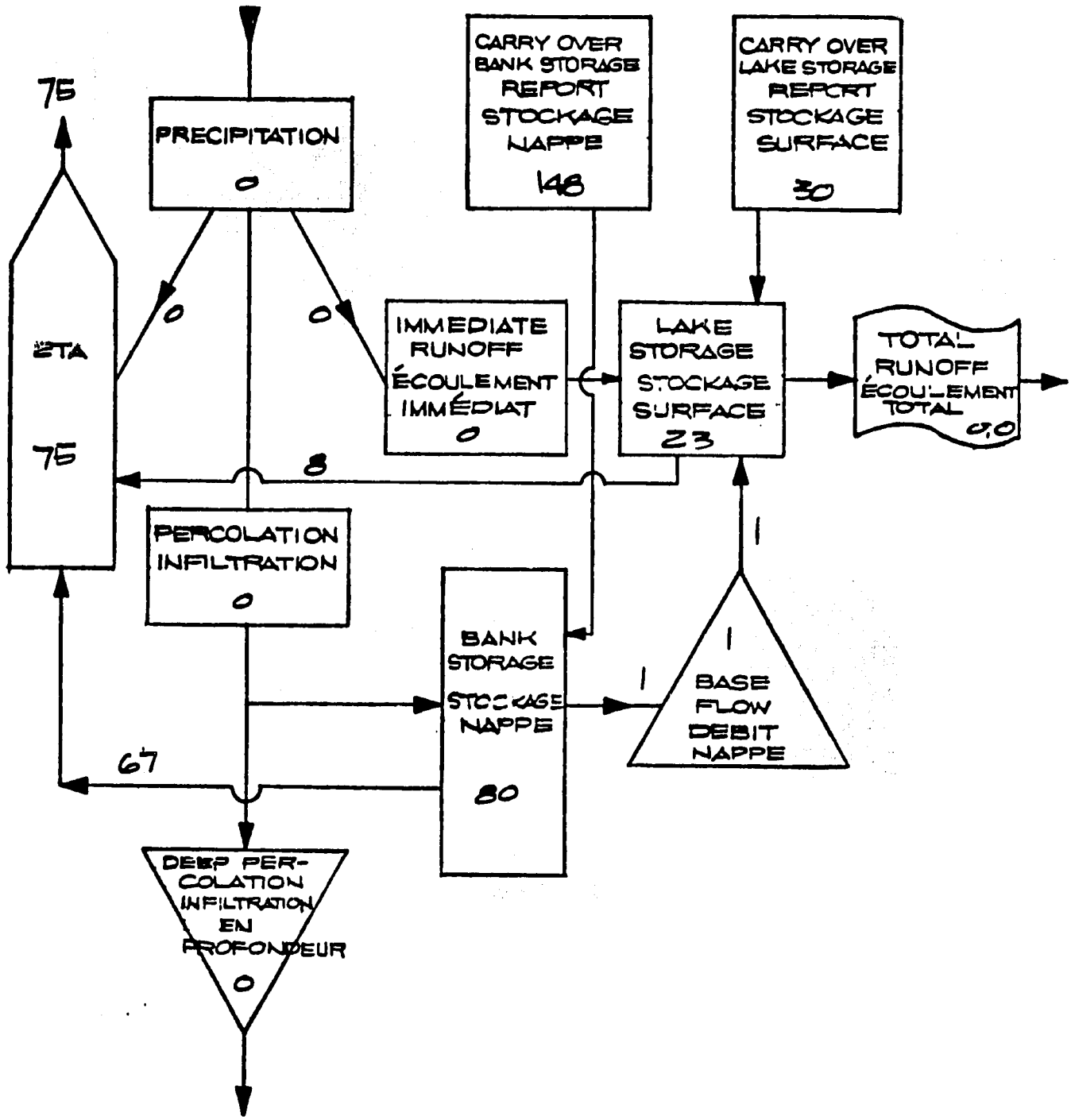

ETA = ESTIMATED ACTUAL EVAPOTRANSPIRATION
ETA = EVAPOTRANSPIRATION REELLE ESTIMEE

FIGURE 5.67J

ANAMBE BASIN (1,040 KM²)
BASSIN DE L'ANAMBE (1,040 KM²)

## MONTHLY WATER BALANCE IN mm.
## BILAN MENSUEL D'EAU EN mm.

MARCH 1963 MARS 1963



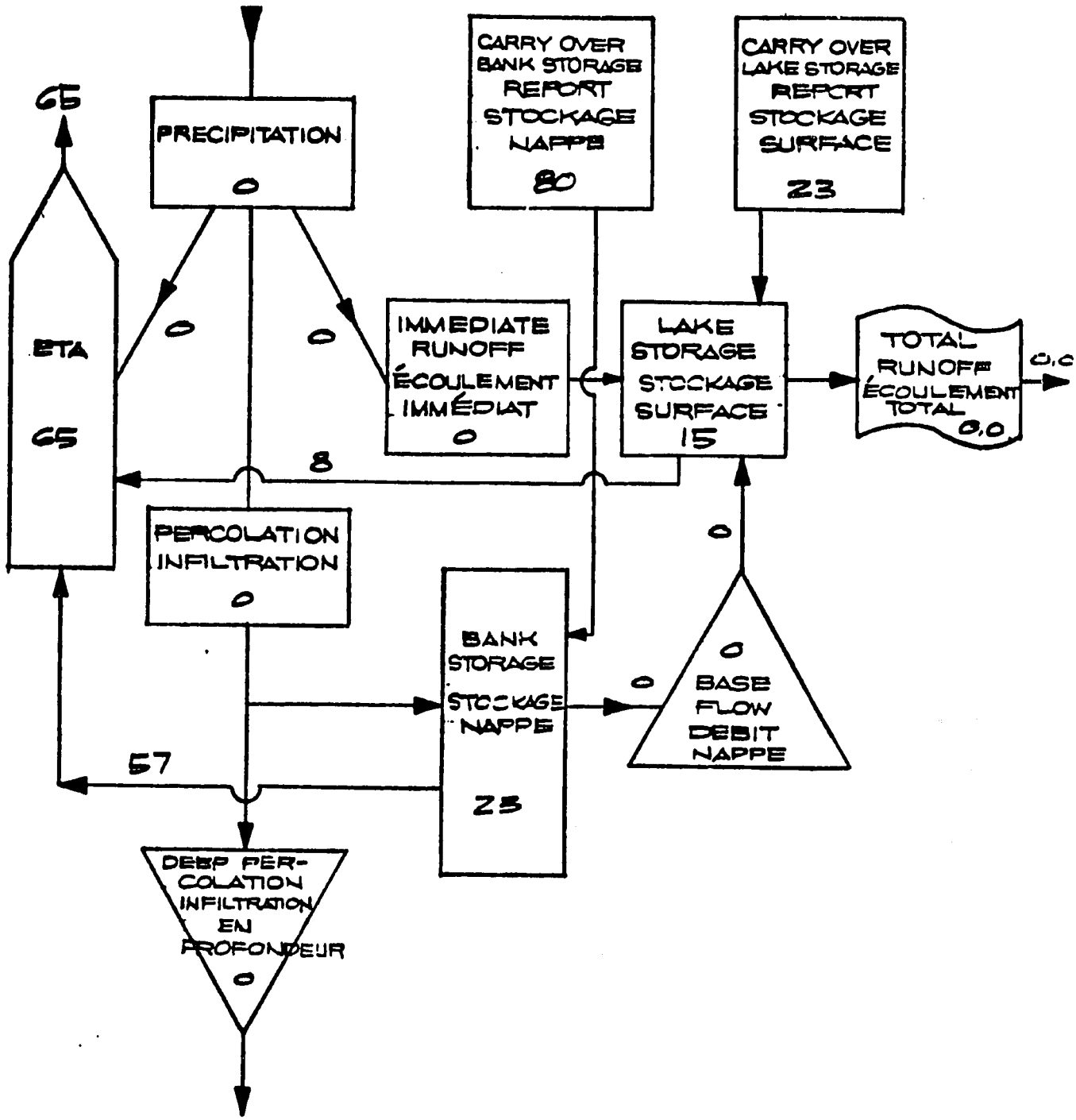

ETA = ESTIMATED ACTUAL EVAPOTRANSPIRATION
ETA = EVAPOTRANSPIRATION REELLE ESTIMEE

FIGURE 5.67K

ANAMBE BASIN (1,040 KM²)
BASSIN DE L'ANAMBE (1,040 KM²)

MONTHLY WATER BALANCE IN mm.
BILAN MENSUEL D'EAU EN mm.

APRIL 1963 AVRIL 1963




ETA = ESTIMATED ACTUAL EVAPOTRANSPIRATION
ETA = EVAPOTRANSPIRATION REELLE ESTIMEE

FIGURE 5.67 L'

# CHAPTER 6 - SOCIAL ORGANISATION, INSTITUTION AND ATTITUDES IN THE ANAMBE BASIN.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6.2. THE HISTORICAL CONTEXT OF THE FOULADOU

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# CHAPTER 6 : SOCIAL ORGANISATION, INSTITUTIONS AND ATTITUDES IN THE ANAMBE BASIN.

## 6.0. INTRODUCTION.

The resources for development in the Anambé Basin include the people of the region, with their strengths, their weaknesses and particular characteristics. In order that the design of the project could adapt itself to the sociological necessities or limitations of the local population, a team of sociologists studied social aspects of the region. This chapter reports their findings.

## 6.1. OBJECTIVES, FRAMEWORK, METHODS, AND LIMITS OF THE STUDY.

The objectives of the study. The sociological study was designed :

- to inform local communities of the objectives of the project.
- to define the characteristics of local communities and the system of land tenure in relation to project requirements.
- to define constraints on development and the attitudes of the populations concerned to the project.

The framework of the study. The project for the development of the Anambé basin principally affect the Kounkandé district (department of Vélingara), the Dabo district (department of Kolda), and a few villages in the Bonconto district (department of Vélingara). Essentially, the project will reach :

- villages located within and bordering on the Anambé basin.
- villages located in the proximity of the Kayanga.
- a few villages which, although not within the limits of the valley, use the basin as a watering-spot and pasturage for cattle during the dry season.

The methods of the study mission. The sociological study team stayed in Vélingara for two weeks, from the 27th January to the 11th February 1977. Of this time, the team spent three days consulting basic

official and agricultural extension services : SODEFITEX (Société du Développement de Fibres Textiles), the C.E.R. (Centre d'Expansion Rurale) in Kounkandé, the Livestock Service, the Forestry Commission, O.N.C.A.D. (Office National de Coopération et Assistance au Développement), the Labor Office, and the border police in Kounkandé.

The balance of the time was spent in investigations in ten villages : Dialakegni, Mountoumba, Saré Ouinor, Djimini, Diaobé, Mayel Mareve, Niandouba, Anambé, Kandia, and Kabindou. The meeting at Kandia assembled delegates from nineteen other hamlets and villages : from Saré Boulel, Souriel, Saré Boula, Voloto, Saré Yala, Saré Thierno, Banakour Sambayel, Banakour Bakary, Pitiana, Saré Kourtiba, Saré Bassi, Saré Fily, Néto, Saré Sambacoumbel, Saré Yoro Méta, Bourto, Madina Samba Diallo, Témento Demba, Lambidou Dicori. The meeting at Kabindou assembled delegates from the villages of Saré Koutayel, Saré Sadio, and Soutouré. Thus persons representing at least 32 villages and hamlets within the project area were contacted in this study.

<u>The limits of the study</u>: There are several topics of interest that were not investigated. Chief among them are marriage patterns and the inheritance patterns of lowland rice fields by women. What kind of marriage strategy will people therefore pursue to minimize the tensions inherent in dependence on the ability of a number of potentially unfamiliar women to work cooperatively in the family rice lands for a certain amount of material well-being?

In addition, the team was not able to explore the question of formal co-operative organization to the extent desired. The internal organization of the co-operatives in the area, and how these co-operatives might be adapted to the demands of large-scale rice production were not explored. The administrative re-organization scheduled to be carried out in the area in 1978 will doubtless serve as a framework for re-orienting many government services. The peasant rice farmer will have to make a concomittant re-orientation of his responses to the Administration. Without an understanding of the present co-operative structure, it is not possible to suggest the impact of the reform on the co-operatives.

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The information given to local communities : In order to determine the reactions of the population of the zone, the following elements of information were given out at the village level.

1. SODAGRI plans to undertake mechanized production of rice in the bed of the Anambé basin,
   - by draining the basin, which is flooded during the rainy season, in order to cultivate the land during this season, and
   - by constructing a dam on the Kayanga River, to store the water necessary for irrigated cultivation during the dry season.

2. SODAGRI plans a program of agricultural extension for the family production units in the zone,
   - by providing the assistance necessary for the improvement of the existing system of cultivation,
   - by offering work to the local population in employing salaried laborers, and
   - by offering to those farmers who show interest the possibility of irrigated cultivation during the dry season.

3. A socio-economic study is presently being done in the zone,
   - in order to determine the social and economic feasibility of the project,
   - and particularly to determine the position of the populations affected as regards the project.

## 6.2. THE HISTORICAL CONTEXT OF THE FOULADOU.

The Fouladou, which includes the districts of Vélingara and Kolda, occupies the territory commonly known as the upper Casamance.

According to different historical sources, the Fouladou was originally inhabited by the Bainouk people. The Bainouk were driven out and replaced by the Mandingo people, who came from the center, and



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who in turn were progressively infiltrated by Fulani[1] migrations primarily from Boundou and Macina.

The Fulani placed themselves under the protection of the Mandingo. Profiting from the liberty that the immensity of the vacant lands and the vast pasturage afforded them, and thus the possibility of practicing food-crop agriculture without abandoning their pastoral vocation, the Fulani settled side by side with the Mandingo and adopted Mandingo agricultural techniques and dietary customs.

During the sixteenth century, the region belonged to the Mandingo Empire, within which indigenous Sossé and sedentary Fulani lived in mutual understanding : the Sossé served in political, administrative, and religious capacities, and the Fulani filled the subordinate roles of herdsmen, warriors, and artisans.

In the meantime, the gradual infiltration of Fulani herders into the area continued. They now came from several different areas but the majority owed their origin to the Fouta Djallon in the present Republic of Guinea. By the mid-nineteenth century, they were in a strong enough position to launch a series of holy wars against the Mandingo to create a Fulani-dominated theocratic state comparable to those created by other Fulani groups in other parts of the West African Sudan at the same period.

Within the last 40 years, a new element has been added to the local population : a more recent wave of Fulani immigrants from the Fouta Djallon.

## 6.3. THE CHARACTERISTICS OF LOCAL COMMUNITIES.

### 6.3.1. Socio-demographic data.

Ethnic groups : During wartime, many of those in the Fouta

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1. A number of different names are used to designate these people : Fulani, Fulbé, Peulh, Fulakunda, and Fula. Their name for themselves is Peule (sigular) or Fulbé (plural).

Djallon moved into the Fouladou. Once peace was re-established, the wave of immigrations continued, notably other Fulani immigrations coming from Gabou (the present-day Guinea-Bissau).

A. In the Fouladou, the Fulani constitute the large majority (82 %) of the population. The Fulani fall into four principal groups [1] :

- the "Firdou" or Fulakunda Fulani who claim to be originally from Macina (25%).
- the Gabou Fulani (8%).
- the Diayabé Fulani, descendants of the captives of the Fulakunda Fulani (53%).
- the Fouta Fulani, originally from the Fouta Djallon (the present-day Guinean Republic). (14%).

B. The Mandingo are the most numerous of the ethnic minorities, making up about 7% of the total population. Their former principality, the Ferdou, has been completely absorbed into the present-day Fouladou. Several villages in the area date from the period of Mandingo dominance; Mountoumba and Kabindou, for example, have Mandingo-speaking majorities. In fact, any village whose size surpasses a small group of related compounds will necessarily be a multi-ethnic community.

C. The other ethnic minorities, which are the Badiaranké, the Soninké, the Diakhané, the Toucouleur, the Wolof, and the Diola, are for the most part recent immigrants. In general these groups show a preference to settle along the border zones of the Gambia and Guinea-Bissau, although there are nonetheless a few families scattered throughout the region.

Within the Fouladou, a certain uniformity of structure is apparent on the linguistic as well as on the cultural and economic levels. This arises from the fact that all of the groups composing the present-day Fouladou are either Fulani in origin or have been profoundly influenced by the Fulani. However, none of the peoples in the Fouladou is endowed with a true rich "civilisation" : the Mandingo and the Fulani are traditionally either millet cultivators or herders. But at the present

1. Enquête CINAM - SERESA : La Casamance, Etude Régionale. Publiée par Bompard/G.I.A., Dakar 1960. 3 tomes.



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time, the Fulani of the Fouladou, of whatever origin they may be, are sedentary and practice both agriculture and livestock raising at the same time.

The pther important aspect is that the integration of the Fouta and the Diayabé Fulani (who form the large majority, roughly two-thirds, of the Fulani population) into overall Fouladou society meets a certain resistance on the part of the Firdou and Gabou Fulani. The Firdou and Gabou Fulani relegate the Fouta and Diayabé Fulani to a secondary role, considereing the Fouta Fulani as "foreigners" and the Diayabé Fulani as the "property of the foreigners".

According to our information, there is no intermarriage among the Fulakunda, the Fouta Fulani and the Diayabé Fulani. Even if it is occasionnaly permitted that a "devient" Fulakunda man may marry a Fouta Fulani woman, or a freed Diayabé woman, the reverse situation would never be allowed.

6.3.2. <u>The Migration Phenomenon.</u>

<u>Migration into the region</u> : There are two types of migration into the Anambé basin. First are the permanent migrants, principally Fulani from the Fouta Djallon. They have been coming regularly for the last 40 years, although their rate has picked up recently in response to growing political tensions between the Fulani and the central government of the Republic of Guinea. The attraction of the Anambé basin is its sparse population and the opportunity it offers for mixed farming. One may cite the example of Mayel Mareve, a small village of seven households, whose members came to the area shortly before Sénégal became independent. About ten years ago, they dug themselves a well, a sure statement of long-term intentions. Their main interest is still the welfare of their herds, but they cultivate the full range of food crop and some cash crops.

A second type of immigrant comes only for the season, and then



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returns home. He usually comes in April or May when preparations for the year's cultivation are seriously under way. Most stay through the harvest before returning home or continuing their trek in other regions of Senegal or the Gambia. They, too, are mainly Fulani from the Fouta Djallon. At first they seek lodging with relatives who have settled permanently in the area, or they may rent a room with a villager. It is hard to tell whether the level of seasonal migration is increasing, decreasing or remaining stable; the villagers themselves give contradictory responses to this question.

Moreover, the high number of applications for employment made at the Prefecture already shows to a degree the impact which the project is likely to have in the region. The creation of a "development pole" in a region which may be considered as a pioneer zone may attract a spontaneous migratory influx. This influx could interefere with the activities of the "Terres Neuves" program, which is responsible for the reasonable settlement and development of vacant lands in the Vélingara district.

Migration out of the region : Up until recently there was a strong seasonal movement of people, young unmarried men principally, out of the area toward the peanut basin in the Sine-Saloum.[1] The young men left usually toward the end of the rainy season to help harvest peanuts in the peanut basin. Peanuts have to be harvested before the sun bakes the ground hard shortly after the rains stop. Since the rains in the peanut basin stop before the rains in the Upper Casamance, it was possible to earn money harvesting the former without in any way jeopardizing the interest in the peanut crop at home.

At one time, almost all young men left to look for unskilled work. The level of Wolof fluency among the more mature men of the area is a memento of their travels. Now, many fewer leave. The level of seasonal emigration has dropped for two reasons. For one thing, the spread of cotton as a cash crop obviates the need to look for income

1. Within 16 villages, we noted 16 seasonal migrants, of which three were talibés (students of Koranic schools). The CINAM-SERESA survey shows that this form of migration touches between 5 and 14% of the population (CINAM-SERESA, op. cit. Dakar, 1960).

out of the area. Moreover, cotton cultivation does not permit worker's absence. Secondly, the increasing mechanization of peanut cultivation in the Sine-Saloum has reduced the need for such itinerant rural labor. Nonetheless, seasonal migration continues to exist, as the threshing of peanuts is still done by hand, and not all family farms are equipped with peanut lifters.

The most keenly-felt result of this migration by young Fulakunda is the reduction of active labor, which delays the harvest of peanuts and cotton in the Upper Casamance. This causes a slowdown in the threshing of peanuts and the sorting of cotton, which in turn slows down the process of debt reimbursement and marketing of the crops.

However, if full-time occupation for the young Fulakunda could be provided by rice cultivation during the dry season by family production units and/or salaried employment in the agro-industrial complex, a notable reduction in seasonal migration can be foreseen.

6.3.3. Population.

The population analysis is based on census data for the Kounkandé district, which is to a large degree continuous with the project area. The year of reference is 1970, at which date the last list of the villages of Sénégal was made by the Statistical Direction. A pyramid by age and by sex for 1970 establishes that the population of that year was roughly comparable to that of 1976.

The Kounkandé district covers 2,534 square kilometers, and has a population of 43,469 inhabitants distributed throughout 342 villages, and residing in 2,964 family compounds. The official population of the district oscillates over time in a saw-toothed pattern, as is shown by the following data :

- in 1963 : 40,355 inhabitants
- in 1965 : 44,177 inhabitants
- in 1967 : 41,117 inhabitants
- in 1970 : 43,469 inhabitants



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- in 1975 : 44,440 inhabitants
- in 1976 : 43,843 inhabitants.

The population is young, with 59% being under the age of 25. It is an active population, as 57% of that total fall between the ages of 15 and 64 years. The division by sex shows 22,886 men to 20,583 women. This overall disparity between the sexes (111 males for 100 females) exists at the level of different age groups as well :

- from 0 to 14 years : 9,507 males and 8,074 females, or 118 males per 100 females.
- from 15 to 39 years : 8,615 males and 8,710 females, or 99 males per 100 females.
- from 40 years and over : 4,764 males and 3,799 females, or 125 males per 100 females.

The analysis of the population reveals certain characteristics (and perhaps anomalies) which raise questions.

1. Population density is 17 inhabitants per square kilometer. However, this figure has very little significance, due to the fact that the population is very unevenly distributed over the territory, being highly concentrated around Kounkandé and south of Vélingara.

2. The population increases and decreases from period to period. Is this situation the result of migratory phenomena, or due to imperfections in the administrative census?

3. Men are more numerous than women. Is this characteristic due to the fact that most of the migrants who settle in the region are men? Or is this a natural phenomenon?

4. Men have a longer life span than women. Actually, for the generation aged 55 years and over, 166 males are counted for 100 females. Is the mortality rate higher among women? If this is true, why ?

What effect may the demographic situation have on the project?

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Generally, in socio-economic terms, the youth of the population and the active character of the human resources are considered as positive factors. But on the socio-cultural level, if the disparity between the sexes is real, and being helped along by the system of polygamy, in the long run social problems in the marital domain could arise : rivalries resulting in heavy expenditures, a prolonged bachelorhood for young men, adultery and marital mobility, unless the men decide to seek spouses outside of the region.

### 6.3.4. The social framework of life and development in the hamlets and the villages.

In the Fouladou, the mobility of individuals and family groups is related to the foundation of the hamlets and the villages.

The village, composed of family compounds or groupings based on kinship ties, constitutes a form of social organization, a framework for communal living and collective development. The creation of the village is either authorized or confirmed by the representatives of authority, both under the domination of the Mandingo or the Fulani and under colonial and Senegalese administration.

Each village is led by a chief. The village chief is in general the oldest descendent of the founding family. Lineal families live in communities and may or may not have kinship ties or common origins with other families of the same village. The heads of the family compounds form the village council. In many villages, the order or arrival in the area serves as a reference for the establishment of a certain order of precedence or hierarchey among the families, the notables, and the elders.[1]

In the same way, the spatial organization or layout of

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1. During village meetings, it was observed that the village chief and a few of the family compound heads (notables or elders) take the lead in the discussions; younger len are present but do not participate in the discussions; women are absent from these meetings.

the village - if heterogenous - often depends on social or ethnic criteria. As the predominant ethnic group in the zone is the Fulani, the dispersed type of village characteristic of the Fulani is the type most frequently encountered. Each village appears as a group of compounds spread out with more or less distance between them. Each compound is generally enclosed by wattled panels. The passage-way between compounds is often large enough to admit auto traffic. Some compounds are separated from each other by large open spaces, probably indicative of the social distance between the residents.

In 1970, the district of Kounkandé consisted of 342 villages and hamlets grouped around 198 administrative villages; the average number of inhabitants was 129 for a hamlet and 219 for an administrative village.

The following table shows the size distribution of administrative villages.

| | Number of Villages | | Population |
|---|---|---|---|
| Size (population) | absolute | % | % |
| 13-49 | 11 | 5.6% | |
| 50-128 | 45 | 22.7% | |
| 129-218 | 62 | 31.3% | |
| Subtotal | 118 | 59.6% | 37% |
| 219-399 | 64 | 32.3% | 35% |
| 400 and up | 16 | 8.1 | 28% |
| Subtotal | 80 | 40.4% | 63% |
| Total | 198 | 100.0% | |



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In relating the villages to the population, it is found that 59.5% of the villages contain 37% of the population, while 40.5% of the villages contain 63% of the population, and of this 63%, 28% live in the 16 largest villages, that is, those villages with more than 400 residents. This shows a tendency for the population to concentrate in the larger villages. This should be qualified by the additional observation that 144 "associated hamlets" are attached to the administrative villages, although these hamlets consider themselves independent villages. Thus the concentration is somewhat less than indicated by the official data.

The villages in the Anambé basin are scattered along the upper rim of the basin. The low-lying areas in the center of the basin are unoccupied and uncultivated. The villages range in size from two compounds such as in Saré Ouinor to 35 to 40 compounds as in Kandia and Diaobé, the two largest villages, to the town of Kounkandé, the largest concentration of people in the district.

Each village has its alloted farm lands. Every exploitable square inch of the basin, whether presently cultivated or not, has been allotted to one villager or another.[1] The only exception to this rule is the Anambé forest reserve, which by government order cannot be exploited by any of the villages. The farm lands of any one village abut those of other villages on all sides. The low-lying areas in the center of the valley are, however, not exploitable. They are flooded during the rainy season and during the dry season they serve as common pasterland for the local herds.

6.3.5. Inter-village relations.

There is no long-term stability to the number of compounds in a village or even to the number of villages in the basin. Compounds split off from their parental villages to move closer to the farmlands, or to avoid rising flood waters, or to resolve intravillage tension. Whole villages like Toungoulel and Saré Ouinor have moved to new sites,

1. The land allotted to a village may not always be assigned to an individual, particularly if it is not exploited.

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in these two cases in response to flooding from heavy rains about 15 years ago. The latter site has been occupied for the last seven years by another group which has split off from its home village. In spite of the movement, there are a limited number of village centers which have given birth to a larger number of satellite hamlets. Many of the smaller villages in the basin are offspring of the larger village centers and preserve their family ties with the parent villages. These are not family ties in the abstract historical sense, but kinship ties between specific families in different villages in one zone.

This type of living arrangement, with a central nucleus and dispersed family compounds, has the advantage of eliminating overcrowding and insuring the polarizing role of the center, while at the same time safeguarding the nearby farmlands and cattle.

The Kounkandé district is composed of the three former cantons of Pathiana in the south, Bissabor in the center, and Patimkandia in the north, which are identified with the so-called "homogenous" zones recognized by the local administration.

As a function of the establishment of collective facilities (schools, dispensaries, collective warehouses, central stockyards, etc.) the partitioning of the zone into 37 cooperatives, and the size of the villages (16 villages of over 400 residents), the departmental administration has proposed, by zones, the hierarchy of the villages according to the following schema :

| Zones | Central villages | Large villages |
|---|---|---|
| Pathiana (south) | Wassadou<br>Paroumba<br>Kaono, Pakour<br>Payoundgou<br>Patim-Kouta | Diattel<br>Moussacounda<br>Boya |

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| Zones | Central villages | Large villages |
|---|---|---|
| Pathiana (south) | Wassadou<br>Paroumba<br>Kaone, Pakour<br>Payoungou<br>Patim-Kouta | Diattel<br>Moussacounda<br>Boya |
| Bissabor (Central) | Kounkandé<br>Teyel, Diaobé<br>Niandouna | Goundaga, Kandiaye<br>Temento Madia<br>Saré Madia, Saré Coly |
| Patim (North) | Kandia<br>Nématabа<br>Kérévane<br>Saré Bassi<br>Doubirou | Souriel, Kandoby<br>Mountoumba<br>Lambatara<br>Ste Jeanne d'Arc |

This proposal of the departmental administration raises questions concerning :

- the form and the nature of relations freely established and experienced by the local communities.
- the perceptions held by local populations of the administratively established relations.
- the other forms of traditional organisation and the way in which local leaders exercise their influence upon a group of villages.

These questions were not addressed by the SODAGRI study. However, a study team of the Direction of Territorial Development is operating in the Casamance region laying the groundwork for the future partitioning of the rural communities and the determination of the central villages. It may be presumed that these questions will be considered by the latter team.

The existence of central villages and the stability of village satellites facilitates on the one hand the establishment of collective facilities, and on the other hand, the expression of community life and development within the framework of future rural communities and inter-village cooperatives.

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A final aspect of intervillage relations, an aspect not explored to any depth, is the force of common religious institutions. Everyone in the Anambé basin is at least a nominal Muslim. Almost everyone is a member of the Q'adir brotherhood. The most influential Imam, or religious leader, in the area is Sherif Bakar Haidara, the Imam of Vélingara. In addition to his religious functions he is currently chief of one of the quarters of the town, he is president of the local parent-teachers' association, he used to be chief of the town of Vélingara, and he is an officer in the local courts. His nephew is Imam of the village of Diacbé. Islam is a force for the coherence of the basin and a common denominator facilitating many kinds of interchanges.

6.3.6. Basin social structure : the family compounds.

The family compound constitutes the basic social and residential unit of the village. In most villages, the family compounds are grouped according to familial or ethnic affinities.

In the field, the family compound (or "Callé" in Fulani) represents the patrilocal residence of yesteryear which grouped the overall family of 50 to 100 or more persons. The largest compound visited contained 14 households. Each compound is led by a man, generally the senior member directly descended from the founder of the compound. The other members of the compound have some kind of kinship to him. Usually they are his sons, their wives and children, and on accasion, their daughters, their husbands and children. The latter case is more probable in cases of new economic opportunities opening up where the son-in-law is willing to forego his patrimony for the access to the more promising resources that attachment to his wife's family offers. To this common core group other kin may add themselves : close cousins, poor relatives, family retainers of casted origin, captives, or even, in the case of immigrants, people merely born in the same village as the compound head, or itinerant laborers temporarily engaged in the family fields.

Under pressure of political and economic changes, this type of family grouping has gradually dissolved to give way to more restricted family units.

In 1970, the Kounkandé district numbered 43,469 persons distributed over 2,964 family compounds, which represnts on the average :

- 8.6 compounds per hamlet or 15 compounds per administrative village;
- 14.6 individuals per compound.

Observations of the SODAGRI study were in line with official data. Observation of 35 compounds and 114 households showed :

- 3.25 households per compound and 4.6 individuals per household (1 to 10 households per compound).
- 15 individuals per compound (varying between 2 and 40 individuals per compound).

The head of the compound, in consultation with the head of the member households, allots cultivation rights in compound lands among the member households annually. He decides who will cultivate where and what. His main considerations are his knowledge of the individuals of the compound and his years of experience on the family farmlands.

Many compounds, especially those in which the kinship ties among the households are particularly close, work in a common field for food crop production. Compounds that cultivate together tend to own agricultural equipment in common. They may store the harvest in a common granary, in which case the compound head administers the daily food distribution to the households in the compound. Each household, however, generally prepares and consumes its meals separately. On the other hand, cash crops such as rice, peanuts, and cotton are cultivated seaparately by individual members of a household. The cattle of the compound, while often herded as a group by the early adolescent males



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of the compound, are owned by individuals who have complete control over the disposition of them and their by-products.

6.3.7. Inter-household relations within the compound.

Each household in the compound generally consists of an adult male household head, his wife or wives, and their unmarried children. Rarely is an unmarried adult male a household head. A woman may be the household head if she is a widow past her reproductive period. There may be some unmarried siblings of the husband or even of the wife attached to the household. The household head represents the members of the household in compound affairs. He is responsible for seeing that the household is able to cultivate as much farm land as it needs. He is responsible for the internal order of the household and for representing it in compound political and judicial affairs.

To supplement this general picture, an inquiry was made into the population structure of specific households.

The village meeting at Djimini provided a list of 35 male-headed households. According to this list, two household heads were unmarried, while the remaining 33 household heads had a total of 39 wives. The list proved to be somewhat inaccurate or out of date; we visited a compound in which we expected to find eight households and found fourteen. The fourteen men in the compound had seventeen wives and 37 unmarried but economically active co-residents. This particular compound was not representative of the village of Djimini or of the Anambé basin. It was far larger than most, and had proportionally far more unmarried economically active members than most. It was composed entirely of people born in the Fouta Djallon. Many households had arrived only recently and were not permanent, and many of the unmarried members were transients.

The village meeting at Dialakegni furnished a list of 36 male-headed households. In each of two compounds visited, there

were eight unmarried household heads. In the first compound there was a total of nine wives and three adolescent workers. In the second compound there was a total of twelve wives, two of whom had been so recently married that they had not yet come from their parents' house, and nineteen unmarried workers.

Within the Sabaly compound, at Dialakegni, three types of households could be identified :

- 2 guardian households.
- 3 autonomous households.
- 3 dependant households, of which two immigrant families were under the guardianship of another household. The other was under the jurisdiction of an older brother. These eight households included 37 individuals, almost all of them having kinship ties. Socio-economic relations among these individuals are described in detail in an Annex to this report.

In the much smaller village of Sarê Ouinor, a visit to one compound revealed three married men, three married women, and five unmarried women workers. A fourth adult male was too old to work in the fields.

From this limited data, certain statements can be made with some confidence. Most men have only one wife. Only one man we met had three. Most compounds tend to have slightly fewer unmarried economically active members than married ones. These unmarried workers are not necessarily the children of the married ones; they can be younger brothers (more often than younger sisters who would be married shortly

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after they reach maturity) or cousins. They can be, as in the case of a compound we visited in Djimini, simply born in the same village in the Fouta Djallon as the head of the compound.

A man and his wife or wives generally work the household food crop fields together. They store the grain in a common granary. Unmarried children begin to cultivate in their mid-teen years, turning over their harvest to the household granary. Several years after he gets married, the young male moves out of his father's household to create a household of his own with an autonomous granary, but usually within the same compound.

In contrast to common activity for food crop production, within the household as within the compound, cash crop production is done by the labor of individuals working on their own account. Each individual cash crop producer has complete control over the disposition of his harvest and its revenue. This is true for adult males as well as for their wives and their unmarrried sons. The only exception is unmarried daughters who work with their mothers until their marriage when they generally leave the household.

If the household cultivates independently, it may choose to buy its agricultural equipment itself. Sometimes, however, it is more economical for the compound as a whole to buy the equipment and have the households, even though working individually, share it. This seems to be the general case in practice. In this way, the compound may be

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transforming itself into a rudimentary co-operative.

The distribution of mechanized equipment, like the use of money and commercial exchanges, has facilitated the individualization of cultivation, of needs, and of goods. This system has modified the relationships between production and consumption in the following way : even if certain features of community living are maintained at the level of the family compound, it is notable that the individual efforts tend to surpass those made by the collective group. The use of money makes it possible for each producer to personnally possess the product of his labor, and more and more, social relationships are becoming indirect, due to the intervention of money.

In the evolution of social relationships, the solidarity of the extended family tends to diminish and the network of kinship ties progressively loses its original impact. Brothers now differentiate themselves from cousins. The nuclear family tends to replace the extended family.

In its present-day structure, the family compound, as a social unit, is simply a group of nuclear families whose heads are unified by kinship ties.

In each autonomous household, the head of the household - normally the oldest man - traditionally has the sole power to make decisions both in terms of production qnd in consumption. This authority of the oldest man is progressively disintegrating and

declining toward a role as consultant on social or personal problems.

From the analysis of basic social structures, it is evident that the family compound constitutes more a framework for family life than a structure of communal action. The compound is above all characterized by a shared desire for communal living between relatives, friends, and dependents; a simple disagreement is capable of provoking the departure of a household from the compound.

The evolutionary change of social and familial structures is continuing. In the long run, the household is tending toward fundamental and functional identification as a family production unit (FPU). The modernization which the SENERIZ project will provoke in relation to the FPU's should be guided so as to promote their economic and social expansion. This should take place in the larger framework of community and cooperative developmental structures.

## 6.4. LAND TENURE IN THE ANAMBE BASIN.

Everywhere in the rural environment in Senegal, the rights of land-clearing and cultivation, as well as pasturage rights, are the most important. They can be distinguished according to the ecology, the ethnic group, the socio-political system, and the activities of the region.

In the region of the Fouladou, where the people live in the territory is strongly influenced by the hydrographic network : rivers,

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valleys, lowlands, etc.

### 6.4.1. Agro-pastoral Land Tenure in the "Vendou" : History.

The floodplain at the center and lowest part of the Anambé basin is known locally as the "Vendou".

According to oral tradition, the chief Moussa Molo accorded the primary right to the Vendou to Koliyel Diao[1]. Koliyel, of the village of Diaobé, used the valley to water his livestock.

Rights to land at the time were in accordance with customary regulations applied in pastoral zones, where control of water points gives effective control of the entire region.

Thus, the Vendou was both a region for the watering and the pasturage of cattle, and a rice cultivation and fishing zone for the local population; the rights of usage were accorded to those using the zone by the Diom Vendou, Koliyel Diao, who in turn collected dues for these rights.

Since the colonial conquest, this customary land tenure applied in the Vendou was abolished.

At the present time, the Vendou and its borders are used freely and without charge by the village people of the zone.

1. Ancestor of Mr. Salif Diao, second deputy of Vélingara.

6.4.2. Toponymie of the Basin.

The basin of the Vendou is composed of nine secots : Kované, Télev, Louguère Gabé, Kankadéla, N'goyrou, Niougntian, Kocour, Dialafara, et Boutou.

This toponymie is known by all villages which cultivate the edges of the Vendou. Among these are the following villages :

In the Vélingara zone : Soutouré, Kabindou, Aïdara, Marévé, Saré Bassi, Saré Koutayel, Saré Sadio, Kolda Molo, Saré Bamako, Médina Paté, Kounkandé, Saré Bouram, Saré Oumar Coly, Saré Paté, Saré Yoro Soudy, Namara, Saré Yérodji, Tianfara. (This toponymy is also recognized by the villages which use the Vendou as pasture land).

In the Kolda zone : Only the village of Anambé cultivates the fringes of the Vendou, whereas Saré Bouti, Sancagne, Saré Yoba and Ninnekidji use the Vendou basin as pasture land for their cattle.

6 4 3. The Origin of Rights.

In the region of the Fouladou, the establishment of the territory of villages is linked to the foundation of the hamlets and the villages themselves. A village which establishes itself defines the limits of the agricultural and pastoral space which is for the exclusive use of its inhabitants. This territorial unit, placed under community jurisdiction, is at the disposition of the entire village community which exercises

within this unit its fundamental collective rights, under the authority and the responsibility of the village chief.

This right is essentially based on first occupation.

6.4.4. Toponymy and Occupation of the Village Lands.

A village's farmlands are recognized toponymically, that is to say, discrete sectors of the village farmlands are assigned names by which they are known to the villagers. A given field is defined in terms of its distance from the village, its soil quailites, and its previous cultivation history; these characteristics determine to what use the field will be put

There are three types of farmland : rotating land, pasture land, and rice land. Villagers cultivate millet and maize perenially on the lands closest to the village. Cattle droppings help maintain the soil fertility from year to year. Cash crops and periodic fallowing usually appear on the lands in a crude concentric circle past the perennially cultivated nucleus. Villagers prefer to use their more distant fields for pasture. They are willing to cultivate there only if the nearest fields are exhausted. Rive lands are the hollows and depressions into which water drains and in which it remains. The largest portion of the village farmlands have rotating crops and pasturage (which may mean bush in the long term). Rice does not often come into the rotation with other food grains, although it is possible depending on the variety of rice cultivated.



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As an illustration of toponymic recognition, the farmlands of the village of Anambé include nineteen sectors, which are cultivated as follows :

- Farmlands cultivated in rice : Sinfandié, Tiabouli Gadiadji, Dongui, Monvidé, Vingkoba, Batanto, Louguéré Koyli.

- Farmlands cultivated in millet, maize, peanuts, and cotton : Saré Bali, Tourboung, Saré Sékou, Toumb Yoro Gano, Kayda, Vélé N'Guéré, Délel Sibéré, Bitayel, Gorol Tabadié.

- Lands reserved as pasture : Vendou, Koba, Waïm

- "Haunted" lands used as pasture but not cultivated : Diata Mara[1], Tabayal Nava.

The village families have their fields dispersed through the different sectors. To have all the lands of a family concentrated in one sector would be unusual.

Bordering villages recognize the traditional limits of each village's farmlands. Should the limits of the farmlands be contested, the head of the district, assisted by the notables of the concerned villages, determines the new limits.

In all of the villages visited, the local communities stated that there was still uncleared land in their territory.

1. Diata Mara has been timidly cultivated since 19[illegible]

### 6.4.5. Land Clearing and Usage Rights and their Inheritance.

It is on the lands appropriated by the village that families and individuals exercise their land rights by clearing and using the land.

In the past, when a man needed land, he took a tour of the village's then uncultivated lands. He chose the most promising area and asked the chief for an authorization to clear and cultivate the land. The man could be a new settler asking for admission in the village, or he could be an older resident whose lands had ceased to be productive.

Every compound, every household, and every individual who clears a piece of land has the right of usage of the land as long as he occupies and cultivates the land effectively. In other words, usage rights are considered permanent.

In the case in which the compound holds this right, it is the compound head who is responsible for the management of the land which has been cleared in common. He decides the distribution of the land between the collective food-crop fields and the cash-crop fields which are cultivated by individuals.

Any parcel abandoned by an individual or a family may be used by another resident of the village, or it may pass under the jurisdiction of the village chief. The right to use of lands left by

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the death of the head of a household passes to the heirs of the deceased or to the members of his compound. According to custom, a woman has no usage rights except for those which are given to her by her husband. She may not inherit land. If she is a widow, she may cultivate the land granted to her sons. Should she remarry, it is her new husband who provides her with land for cultivation.

Land rights in principle are passed from fatehr to son. Orthodix Muslim law prescribes that a father's property be divided equally among his sons at his death, with each daughter getting a half-share. The law is not applied in the Anambé valley. Since there is no shortage of land, it is still possible for sons to clear as much new land as they think they will need. Only the hollows and depressions suitable for rice cultivation are in short supply. They are, in fact, often divided among a man's heirs.

At the present time it is becoming general practice to petition the chief as the case may be, before going to the government Forestry Commission offfice in Vélingara for authorization to clear the land. The chief may or may not be informed before this petition. A departmental commission then goes out to the lands (in principle) inspects the indicated zone, and authorizes the clearing of land, with the condition that trees useful for their wood or as wind breaks be spared, and that the need for the land is truly justified. The authorization by the Forestry Commission is sufficient.

Briefly, two principal types of land tenure exist in the zone ;

1) Collective land tenure by the village, which is managed by the village chief for the benefit of the community, and

2) Cultivation rights based on actual accupation, which are inalienable for every member of the village collectivity.

In principal, cultivation rights which are impermanent or subject to repeal do not exist in the region as they do in the peanut zone, nor do land rights which are subject to the payment of rent or other kind of dues. In certain cases, land, howver, can be lent or rented, which amounts to the same thing. An outsider, say a resident of Vélingara, who has no land of his own but would like to supplement his income with some cultivation, comes to the village to ask for a plot of land. A resident of the village, after some negotiation, lets the outsider cultivate part of his family lands. In exchange, the tenant surrenders a negotiated fraction of his harvest to the family. The fraction varies according to how much ir how little clearing the tenant has to do to prepare the fields for cultivation, but it never exceeds one-tenth.

It appears that the system of land tenure applied in the zone generally conforms to the principles which govern the national domain.

The negative aspect of this system is the practice of shifting cultivation. The system of authorizations for land-clearing given by administrative authorities is designed to restrict this abuse until such time as the rural councils are established.

6.4.6. Shifting Cultivation.

Although all of the exploitable land in the basin has been allocated to one village or another, it cannot be said that there is a land shortage. There is still enough land available to allow the continuation of extensive cultivation with long fallowing. There are areas, as well, that are never cultivated. The largest uncultivated area is the center of the basin, which is flooded during the wet season. Moreover, there is a government forest preserve in the basin. Lastly, there are several fields which are not cultivated because they are haunted. Cattle graze in them nonetheless. (SODAGRI should approach cultivation in the haunted areas gingerly.) In short, all land is allocated but little if any is exploited intensively.

Because of the abundance of uncleared land, the control that village communities are able to exert on the land is rather weak.

After a plot is cleared, it becomes involved in a sequence of cultivation that leads to a long fallowing period before the cycle begins again. The first year, the farmer plants either peanuts or millet. The second year, he alternates with the crop he did not plant th the first year. He continues this annual alternation for six years if th the plot was cleared from woodland, or for four years if the plot was cleared from bushland. Then he leaves the land fallow for about five years. He can then resume the crop alternation for another three years before he must let it lie fallow again. He may substitute cotton for peanuts anywhere in the cycle. At some point, the plot becomes so

exhausted that it must be retired to lie fallow for fifteen to twenty years. At the end of that period it can be cleared and the whole cycle begins again. As the plot lies in fallow, the farmer will look for other fields elsewhere, either clearing virgin land if that is available or clearing land previously cleared by members of his family but now lying fallow. Obviously, the area of land that a family actually cultivates is but a small part of the lands in which they hold cultivation rights.

Shifting cultivation is influenced by location as well as technology. The system of manuring the fields by folding the livestock in them is only practiced on the land situated near the village, but this manuring permits continued production in those fields.

### 6.4.7. Impact of the National Domain Law and the Reform of 1978.

According to the Law of the National Domain of 1964, all untitled land in the country belongs to the national government. Untitled land means virtually all rural land. In legal terms the peasants of the Anambé basin, therefore, are continuing the practice of their system of land rights at the government's pleasure. The government has the right, under the law, to evict them if it can propose more efficient use of the land, more efficient in the sense of more productive.

The implications of this law have not yet penetrated the Anambé basin. The law has not yet had any practical application here. The administrative reforms proposed for 1978 will, however, impress the

law on the whole Casamance region.

Under the administrative and territorial reform of 1978, the part of the Anambé basin that lies in the Kounkandé district will be divided into seven rural communities. These rural communities will be Kandia, Kérévane, Saré Bassi, Teyel, Niandouba, Kounkandé, and Diaobé. The administrative center of each of these communities will be in the village giving its name to the community.

Each community will be a territorial unit, in many ways similar to townships in the American Midwest. Each unit will contain not only the core village, but any number of satellite hamlets that exist within the territorial boundaries at a given moment. These satellite hamlets, many of which are also satellite hamlets under the current system, will depend on the central village for administrative services of all sorts.

Administration of lands within the rural communities will pass to the community governing bodies. Thereafter, all questions of land rights and cultivation will have to gain the approval of the local government, whose ties to the national government will be much more direct than the present chieftaincy/council-of-elders system, or its Forestry Commission alternative.

## 6.5. CONSTRAINTS ON DEVELOPMENT OF THE ANAMBE BASIN.

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### 6.5.1. Constraints on Resources and their Use.

The beginning of work on the development project for the Anambé basin has both geographic and agrarian implications.

The Kayanga River, known in the region as the "Thiayanga", floods the Vendou during the rainy season and supplies the depressions of Mounetiada, Soutoufing, Tioungayel, and Niandoubayel with water.

These depressions serve both as water points and pasture land for cattle during the dry season, and as a rice cultivation zone during the rainy season, for the inhabitants of the villages of Mayel Marévé, Mayel Patim, Niandouba, Saré Mamadou, Saré Yoro Ba, Sinetian Tibo, Koumbadan, Darsalam, Léla, Pourégua.

Relocation of villages. A reservoir constructed on the Kayanga River would inondate certain villages located on the fringes of the Kayanga's present floodplain. These villages have three main interests that the rising waters will affect : the village sites, the farmlands, and the pasture lands. The village response will depend on the extent to which these interest must be sacrificed to the new lake.

In the case of individual villages where the lake at its full extent would consume only a small part of the settlement and/or its lands, thought should be given to diking to allow the villagers to stay put.

In cases where diking is not feasible for one reason or

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another, villages will have to move. The villagers' first preference, as they will be sacrificing their homes for the sake of intensive rice cultivation, is to be integrated into the Anambé basin project. However, they will not want to be limited to exclusive rice cultivation there. They, like the present residents of the Anambé basin, will want to continue their strategy of diversified agriculture mixed with livestock raising. The advantage of the Anambé basin project to them is that it is another basket in which to put some eggs.

Those people who have to leave their flooded villages will either disperse or seek resettlement elsewhere. Dispersal is the normal strategy for nomads in times of social or ecological pressure. The people in the Anambé are not completely sedentarized, and some of them will certainly invoke their ancestral response to crisis when continuation in their present sites is no longer feasible.

The people who decide to resettle, whether within the perimeter of the SENERIZ project or without, will need assistance. They will need housing, water, and food until their first harvest comes in. They will need farm lands where multi-crop cultivation is feasible. They will need pasture land, too, for their livestock.

<u>Release of the Anambé forest</u>. The Anambé forest reserve covers 6,200 hectares if the Anambé basin. At the present time, it is not cultivated. If this land were to be put under rice cultivation, it would have to be released from its reserve status. Accomplishing the release will require a series of bureaucratic manoeuvres at the departmental,

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regional, and national levels. In addition to satisfying commissions at the various levels of the advantage of the release, the Forestry Commission must be able to identify a forested area twice as large as the released area that can be put into the national reserve as compensation.

Relocation of cattle : At the present time, the central depression of the Anambé basin is not cultivated. During the rainy season it floods. During the dry season, however, it is a reservoir of fresh grass and water for the local cattle. As such, it is a valuable resource. In order not to threaten the local farmers' interests in their herds, provision should be made for water and for pasturage away from the central part of the basin.

### 6.5.2. The Changing Roles of Men and Women in Rice Cultivation.

Before 1969, virtually all of the rice grown in the area was cultivated by women in the damp hollows and depressions below the villages. Production was consecrated exclusively to household consumption. In 1969, SATEC (Société d'Aide Technique) began to introduce more intensive cultivation of "plateau rice" to the men in the Upper Casamance. The village of Anambé was among the first villages in the basin to be organized for this purpose. SATEC, however, was less interested in the department of Vélingara than in the department of Kolda immediately to the west. SATEC abandoned the area in January, 1974. PIDAC (Projet Intérimaire de Développement Agricole en Casamance)

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took over its responsibilities which it maintained until October of that year at which time SODEFITEX (Société de Développement de Fibres Textiles) began to take over the organization of rice production in the area.

In 1973, the area under rice cultivation in the Kounkandé district was 627 hectares. By 1976, the area had grown to 1,621 hectares. The growth is due to the fact that more intensive methods of cultivation have made time spent by men in rice cultivation as remunerative as time spent elsewhere. Previously, time spent cultivating the damp hollows was an extravagance for men who could be much more productive in the larger, more open plateau fields.

The women are cultivating much less lowland rice than they used to. The drop in the average rainfall in recent years has virtually meant the end of the women's stock of seed. Women hardly participate in cotton production at all.

A number of women pursue vegetable gardening. They cultivate such vegetables as lettuce, potatoes, onions, tomatoes, cabbage, okra, and hot peppers, little of which finds its way to the market. Insofar as women are able to cultivate a field of their own, they dispose of the receipts themselves.

6.5.3. <u>Crop Production Strategy in a Subsistence Economy</u>.

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The Fouladou is a region where agriculture is relatively diversified. Millet, sorghum, maize, rice, peanuts, and cotton are all cultivated in the region, and to a progressively lesser extent, manioc and yams. All of these crops, however, are cultivated during the period limited by the rainy season. All agricultural operations are carried out by the family production units, many of which do not yet have modern agricultural equipment.

A sample of twenty households polled by the SODAGRI sociologists contained 98 economically active adults in two villages, and cultivated an aggregate of 48 hectares. That is slightly under a half a hectare per economically active adult. The aggregative area devoted to the most extensively cultivated crop was fifteen hectares given to the millets. Next came about ten hectares of cotton, an equal area of peanuts, 6.5 hectares devoted to maize, then slightly over four hectares for rice, and finally 1.5 hectares for various garden vegetables.

This study team did not get (or seek to get) enough concrete data on actual production to make a statistical statement. What data were gathered support the local administration figures of around 1000 kilograms of millet per hectare (depending on the variety), 1100 kilograms of maize per hectare, 1000 kilograms of rice, cotton, or peanuts per hectare. There are fluctuations in the yield from year to year, but the averages are fairly stable. The yields in food crops are by and large not sufficient to carry the household through to the next harvest. Revenue from the sale of cash crops is used either directly

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or indirectly - there are several credit strategies possible - to wipe out the deficit when the need arises.

The villagers' first interest is food crop production. If they were not able to maintain all their crops properly, they would sooner sacrifice a cotton or peanut field than a food-grain field. Villagers prefer peanut cultivation to cotton cultivation in the abstract because cotton cannot be eaten. But other considerations such as price, availability of credit, yield per hectare, also influence a choice between cotton or peanut cultivation. Most people produce either peanuts or cotton; few do both.

If people prefer to grow food crops and they are not able to produce enough food to feed themselves throughout the year, why do they not increase the area devoted to food crops at the expense of that devoted to cash crops? For one thing, cash crop cultivation is much easier. It is mechanized to a considerable degree. In fact, it is the increasing penetration of mechanization in cash crop cultivation that is responsible for the expansion of the overall cultivated surface of the district in recent years; the expansion has taken place solely in the area of cash crops. Secondly, cash crop production gains the villager access to a credit line. Villagers are known to eat some or even all of the peanut or rice seed distributed to them just before planting, the beginning of the hungry season, hoping to be able to repay in kind by borrowing from relatives, or in cash from cotton sales at harvest time. Finally, there is a gamble involved. A villager tries to grow exactly the amount of food he needs for the year. A surplus

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is of little use to him as a deficit. He would prefer any surplus production to be expressed in cash crops, as they are far more profitable. If he has a food deficit but a cash crop surplus, he can invest in cattle which he can "cash in" if need be when the hungry season comes.

### 6.5.4. The Agricultural Calendar.

The annual agricultural cycle begins in March as the deciduous trees dry out and lose their leaves. At that time, the men decide what fields they would like to cultivate that year and they begin cutting down trees and clearing brush. Sometimes the clearing is done communally but this can be costly to the work-party host. The work group expects refreshment at the end of the day. More often, the prospective farmer does the work himself or with the aid of his family. Since clearing can continue as late as mid-May, only a man's endurance and that of his assistants determines how much land he can clear. Moreover, men often help women clear their fields depending on time available. Toward the end of the clearing period, the bush and felled trees are burned. The ash residue that is left is the only fertilizer for most parcels, especially for parcels destined for food crop cultivation.

The first rains come during the last week of May or the first week in June. The farmers plant millet immediately. When it rained more, they used to wait until late June, until after they had planted maize, before planting millet. But millet takes longer than maize to grow and it is a more important crop, so farmers now try to take advantage of the

first rains to begin millet cultivation. Maize is planted after the second or third soaking rain, about mid-June.

By late June, if the rains are falling regularly, it is time to plough for and plant rice. Many people work the rice and cotton fields alternately during the same period; others leave cotton until after rice. The final crop is peanuts which are planted in late July. At one time, people in the area planted a lot of manioc. In the last several years, the manioc has been attacked by a virus that has left the tubers inedible. Very few people still cultivate it. When it rained more in past years, people also planted a fast-growing millet crop at the end of August in the maize fields just after the maize harvest.

Maize ripens first. The harvest is 75 days after planting. Millet ripens in four to five months after planting, depending on the variety. The lowland rice variety cultivated by women ripens in four months. The plateau rice furnished by SODEFITEX is a shorter-season variety and can be harvested with the earliest millets at the beginning of October. Peanuts take four months from planting to harvest.

Ploughing and sowing are not serious problems. Most farmers own, borrow, or rent (20,000 CFA per season for a team) a team of oxen to help them plough. They are normally able to plough and seed all of the land they cleared. The problem comes in weeding. This is a laborious operation that can become more time consuming than profitable. A farmer who cannot weed all his fields normally elects to maintain his

food crops to the detriment of his cash crops; only a bachelor would do the contrary. Of course, abandonment of cash crops in such a situation means difficulties for the farmer in reimbursing his debts to ONCAD and/or SODEFITEX, from whom he acquired his seed, fertilizer, and equipment.

By the beginning of January, the last crop, peanuts, has been harvested and threshed. The farmer then has a two-menth slack period in which he can gather thatch to repair his house, repair his equipment, or leave the area to look for work elsewhere until the March clearing begins.

### 6.5.5. Cattle Raising and its Rationale.

During 1976, 54,817 head of cattle were vaccinated in the district of Kounkandé. The government livestock service estimates another 14,000 head of cattle in the district which it was not able to vaccinate. Of those it did vaccinate, there were 2,101 bulls, 4,805 oxen, 5,956 adolescent males, 3,794 young males, 28,333 cows, 5,659 adolescent females and 3,969 young females. Apparently, three-quarters of the adult males are sold and transported to the urban centers of coastal Sénégal for slaughter.

During the wet season, farmers have their cattle watched by cowherds during the day and have them tied to stakes in their compound at night. They do not want the cattle wandering through the fields eating the grain. During the dry season, after the harvest, the cattle

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are set loose to forage where they will. They tend to wander toward the bottom of the Anambé basin where there is water and fresh grass for the larger part of the year. As part of the grazing cycle, the cattle eat the millet straw and maize stalks in the perenially cultivated fields near the village, fertilizing the fields with their consequent manure.

Most compounds have one or more teams of oxen at their disposal. Usually the oxen come from cows belonging in the compound but they can come as well from ONCAD, the government agency interested in commercial agricultural development, for 50,000 to 60,000 CFA per pair. The oxen have a working lifetime of five to six years. Farmers train them themselves but prefer to keep them for only two to three years. At that point, the farmer can sell his team for a substantial profit. Moreover, a well-trained team of oxen is a tempting prize to cattle thieves. Cattle theft is a major problem. Oxen are especially highly regarded. A well-trained ox is an easy prize. They are stolen in the rainy season when the demand for draught animals is the highest. They are often stolen to be sold in the Gambia, the Republic of Guinea, or Guinea-Bissau for meat. Cows are stolen less frequently because their liquid value is less. Thefts of cows are most likely to occur in the dry season, while they are wandering unattended through the bush. Cows are rarely slaughtered for meat. Unless the thief can smuggle the cow across the frontier, he risks discovery from her brand.

What is the value of these cows, then? They provide no meat to speak of. They provide enough milk to offer an important dietary



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supplement, They provide male offspring from time to time, which may be seen as interest on an investment. It is, in fact, best to look at cattle owning as the object of the farmers' capital investment. If he has the money, an early choice will be to buy a cow. If he cares for his investment well, it will yield interest in the form of cattle by-products, including offspring. Cattle are as much liquid assets as they are a common stock. They can be turned into cash whenever the need arises. They farmer often buys cattle with the expectation of selling during the hungry period at the beginning of the following rainy season.

The fact that the inhabitants are sedentary and practice simultaneously extensive agriculture and livestock raising, without integration of the two, is another aspect characteristic of the rural environment in the Fouladou. This pattern, which is associated with the abundance of the land, has the effect that uncleared land and pasture are utilized in an unorganized and inefficient fashion.

Actually, the association between ranching and agriculture has not been consciously made, despite the fertilization of the fields by the folding of animals in them or the use of oxen for animal traction. On the other hand, agriculture contributes very little to ranching. In reality, the two activities coexist within the framework of the family production unit and on the same farmlands.

In the future, with the improvement in animal and human health and the progressive expansion of agriculture by animal traction and the

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cultivation of cash crops, and the non-integration of livestock into the persisting market circuit, it may happen that in the long run there will be :

- firstly, a large increase in both livestock and population;
- secendly, renewed clearing of agricultural lands and over-grazing of pasture zones.

Within this perspective, the future rural communities should, as soon as they have been established, foresee such an evolution and plan the development of their rural space with a view to achieving integrated and balanced development of ranching and agriculture.

Within this same perspective, the promoters of the SENERIZ project should orient their agro-pastoral assistance efforts to avoid an economic duality between the two sectors, a phenomenon which would harm the harmonious development of the zone.

### 6.5.6. Markets in the Anambé Basin.

To aid understanding of the current role of markets and the market economy in the area, description follows of the markets at Vélingara and at Diaobé. There markets are dynamic; characteristics reported were observed in February 1977.

The Vélingara market is by far the biggest market in the area. It meets every day. The majority of the floor space is taken by sellers



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of cloth and used clothing, hardware, and bicycle parts. Food sales take up only a small area. Tomatoes (locally grown) are the most common vegetable. Onions are in plentiful supply; they are imported from Holland. No maize and very little millet was offered for sale. There was one seller of rice. Peanut products were offerent in several forms. Animal protein sources available included some live chickens (but not many) fresh fish trucked in from Kolda on the Casamance River (one seller), a lot of dried fish, and one butcher who was mobbed by beef and mutton customers. No dairy products were in evidence.

The Diaobé market, which meets every Wednesday, was founded four years ago, Since that time it has become one of the most important weekly markets in the area. The village founded the market as a convenience. With increasing revenues in the area from increasing cash crop production, it is much easier to have the merchandise come to the villagers than to have them travel to commercial centers in search of it. Most of the stallkeepers in the Diaobé market come from Kolda, although some come from Vélingara. Diaobé is a distribution market : people come from villages throughout the area, even from Guinea-Bissau, to stock up on merchandise for resale in their home villages.

Cloth and used clothing again take up the largest area. Bicycles, bicycle parts and hardware are second. Popular hardware items are enameled housewares and all sorts of devices made from worn-cut automobile tires. Food sellers occupy a relatively smaller area of the market. Again, tomatoes are the most common locally grown vegetable. The onions are still imported from Holland. No rice, millet nor

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maize was on sale. The most important food items sold in Diaobé are sugar, salt, bread, candy, and dried fish. Sometimes there is fresh beef or mutton at the market although there was none on the day when the SODAGRI team visited.

## 6.6. ATTITUDES OF THE POPULATION TOWARD THE PROJECT.

SODAGRI's sociologists endeavored to learn the attitudes of the local people toward the project. Their findings are reported here. The first three subjects were seen as problems by the villagers, who repeatedly posed questions about their lands, their cattle and indebtedness. The remaining subjects were raised by SODAGRI.

### 6.6.1. Integrity of the Traditional Farmlands.

It is very important to respect the present division of farmlands. An attempt to reallocate village lands would be an inauspicious beginning of the project. People in village meetings stressed that they would not be happy to cede control over their land to the project. They would like the project to drain and develop the presently uncultivated areas of the bottom of the basin. Even if cultivable, these areas are too far away from the villages to be exploited by them without serious inconvenience. In addition, the villages would like the project to develop a certain number of their plots for intensive rice cultivation, and

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leave these plots for the villagers to exploit.

### 6.6.2. Displacement of Cattle from the Vendou

Farmers, while not cultivating the bottom of the basin, do have use for it in the dry season. It is a source of food and water for their cattle. If the SENERIZ project achieves year-round cultivation, it will therefore threaten an important local resource. The solution is to move the cattle out of the bottom area. In principle, there is pasture land available at higher elevations. These lands only need water points to be acceptable substitutes for the bottom land. This problem was discussed in every village visited. There was universal agreement that the villagers would experience no great inconvenience in moving their cattle to higher ground if provision for water were made there

Another aspect of the Anambé basin cattle herding practice is relevant to the project. If there is to be two-season cultivation, cattle cannot continue to wander aimlessly looking for forage during the dry season. Their movement will have to be supervised. This will be as much in the interest of the local farmers doing off-season cultivation as of the SENERIZ project's industrial exploitation at the bottom of the basin; the people recognize this.

If one assumes that there are water points at the upper levels

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of the basin, the question of restricting cattle movement could be resolved by hiring herders. Villagers will be willing to do this if their return from the rice is great enough. Their first choice would be to have the herders move the cattle back and forth between the water points and pasture in fields where forage crops are cultivated. If the SENERIZ project's lands must fo through a fallow period, they would like to graze their cattle in the fallow fields.

The villagers will make sure that their cattle do not penetrate their own fields but cannot guarantee that they will not penetrate the SENERIZ project's fields. They suggest that the project surround its installation with fencing. When it was pointed out that fencing is very expensive, people said they understood, but were hoping to minimize the levying of fines against the owners of cattle transgressing the perimeter of the project. Hopefully, assuring all of the cattle's needs away from the bottom of the basin and keeping them under constant surveillance will be as effective insurance as a system of sanctions, which should be avoided as much as possible. On the other hand, if serious conflicts over cattle arise, there is a strong possibility of the physical departure of people from the area.

6.6.3. Indebtedness and risk.

Under the present system, organized by SATEC, the farmer contracts a debt of 284 kilograms of rice, 11,786 CFA at the current price of 41.5 CFA per kilogram, for each hectare of rice he cultivates. While there is talk of yields of two metric tons a hectare, in fact the people in the

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Anambe area are getting around one metric ton per nectare on the average. The return is still great enough to make rice cultivation a worthwhile venture from the farmer's point of view.

The SENERIZ project, if it is able to extend irrigation to the lands cultivated by the villagers, will add another wrinkle to the debt fabric : water charges. Farmers were very concerned that they and the project share water, that their fields not risk parching in the dry season because the project has a priority claim on the water. Secondly, they wanted to emphasize a point that hardly needs to be stated, that there is a point at which water charges can become so heavy that it will not be profitable for the farmer to continue his participation. He will then forego rice cultivation under the project aegis.

The burden of risk is largely on the peasant if he decides to cultivate rice in a given year, In principle, he is obligated to reimburse SODEFITEX his full debt whether he harvests five tons or five grains. The farmer feels that this is unfair. He feels SODEFITEX or the government is willing to absolve the peasants only in particularly dry unproductive years. Of course, if the SENERIZ system is able to bring the farmer ample water, the risk will be greatly reduced, and the probability of perennial debt repayment kind with a substential reserve or safety margin of food or cash crop will be much greater than under the present system.

6.6.4. Salaried employment.

The under-employment of the rural population is very high among men, especially at the end of the agricultural season. This "free" period is used by the men for the repair of their houses, for travel, or just for rest.

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It is for this reason that the prospect of salaried employment which would be offered by the SENERIZ project is generally welcomed, not only in the villages affected by the project, but above all by the townspeople of Velingara.

As of the 8th Febraury 1977, the Labor Office of the Prefecture of Velingara had registered 783 applications for employment, distributed as follows :

| | | |
|---|---|---|
| - agricultural laborers ..... | 645 ..... | 82.4 % |
| - extension agents ..... | 119 ..... | 15.2 % |
| - domestic personnel ..... | 11 ..... | 1.4 % |
| - drivers and machinery operators ..... | 8 ..... | 1.0 % |
| | 783 | 100.0 % |

The analysis of the 119 applications for employment as extension agents provides significant indications of the place of birth, current residence and age of the applicants.

- Percentage distribution by place of birth :

| | |
|---|---|
| Velingara department ..... | 80.6 % |
| Other depat's, Casamance ..... | 16.8 % |
| Other than Casamance ..... | 2.6 % |
| | 100.0 % |

- Percentage distribution by current residence of applicant :

| | |
|---|---|
| Town of Velingara ..... | 60.50 % |
| Arrondissement of Kounkande..... | 30,25 % |
| Arrondissement of Bonconto..... | 9.25 % |
| | 100.00 % |

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- Percentage distribution by age group :

- 12 - 17 ( born 1960 - 1965 ) ..... 3.4 %
- 18 - 27 ( born 1950 - 1959 ) ..... 77.3 %
- 28 - 47 ( born 1930 - 1949 ) ..... 19.3 %

100.0 %

The analysis of the above tables reveals that

- 80 % of the candidates were born in the department of Velingara and 60 % of the candidates are presently residents of the town of Velingara. This corresponds with the desire of political officials, who would like local residents to have priority at hiring time.

- 77 % of the candidates are in the 18 - 27 age group : most candidates are young.

The age of these candidates for employment as extension workers suggests a need to screen them carefully. Many farmers prefer rural extension agents who are mature men belonging to the rural environment, rather than young, untried agents who come from an urban environment. And in fact, some younger extension agents have tremendous difficulties in being accepted in an environment where they are ignorant of the underlying realities and have no feeling for the surroundings.

Of the laborer's applications we examined 214 for place of birth and 209 for their present residence. Slightly over 75 % of the applicants were vorn in the Kounkande district. Only 6.5 % of the applicants were born in Velingara itself. Slightly over 25 % of the applicants live there at the present time. The average age for the applicants is 32.5 years. The oldest applicant was born in 1917 and the youngest in 1966. All these applications were from men.

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6.6.5. Agricultural training and assistance for the family production Units.

Although local cultivators gave a favorable response to a proposed program of farm training and assistance managed by the project, this response is nonetheless qualified by rather important ovservations, such as :

- the farmers give priority to self-sufficiency in food crops, above all other things.
- they are extremely wary of any form of disguised or obligatory indebtedness.
- they condemn a lack of respect for the dignity of the farmer and for the character of the rural development.

Farm extension programs organized according to the crop produced may encounter serious difficulties in the coordination of efforts made separately by different intermediary agencies. Demands on the farmer from one such agency often conflict with demands from other agencies. The farmer, who does not understand the schema of organization of the technicians, cannot manage the situation, especially when he has neither the equipment nor the education for applying the instructions of the extension agents.

6.6.6. Probable uses of increased disposable income.

If the farmer had a bit more money, he would pay off debts and pay taxes. His first purchase would be clothing for the family, and then cattle. Cattle can be seen as money invested for a rainy day, to resolve difficulties at the time of the year when the previous harvest has been eaten and the current one not yet ripened. After cattle, the farmer would buy a bicycle, the most common means of transportation in the area, and maybe some furniture like a metal bedframe.

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If he had a lot of money, he would build a rectangular cinder-block house with a fibro-cement roof. He currently lives in a one-room circular dwelling, having wall of wattle-and-daub and a roof of thatch. After building the house, the farmer might think of setting up a younger brother in commerce.

## 6.7. CONCLUSIONS. THE PROJECT ENVIRONMENT AND THE POSITION OF LOCAL COMMUNITIES.

A review of both the favorable factors and the obstacles to development at the local community and land tenure level serves as a general conclusion for the sociological study.

On one hand, the cultural and economic homogenity of the Fouladou, as well as its young and active population, can be generally considered as factors favorable to development. The tendency of the individual households within the framework of the family compounds to become more independant is also a positive factor. Furthermore, there is an adequate supply of laborers for the project, if we are to judge by the number of applications presently registered at the prefecture of Velingara.

The land tenure system currently practised is in general accordance with the law of the national domain. No customary land rights whatsoever exist in the Anambe basin, which is freely used by all the inhabitants of the zone. Otherwise, at the village level, the rights of land tenure belong to the whole of the community, and within the framework of the households, the rights of land usage are inalienable for all those members old enough to work.

On the other hand, the socio-cultural context contains certain

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factors which are capable of slowing down development. In Fouladou society, social cleavage between different social groups takes place in the framework of a social environment strongly influenced by inequality between the sexes, the migratory phenomenon, the mobility of the villages, and the domination of women and young people by their environment.

On the agrarian level, the negative aspect of shifting cultivation and free-ranging livestock has the effect of subjecting forest zones to an anarchical type of deforestation, and pasture zones to disorganized usage.

Generally speaking, all the villages consulted are favorable to the development project of the Anambe basin. In the hope that the project will bring an improvement in their living conditions, they even desire the immediate beginning of operations.

Nevertheless, in order to establish a favorable climate of cooperation, within which a satisfactory solution to the constraints and the problems posed by the environment can be found, it is essential that an appropriate means of communication be established between the initiators of the project and the local communities, and that provision be made for the coexistence of the agro-industrial complex, the family production units and livestock.

In this perspective, it appears that the intermediary agencies and local groups should readjust their relationships and engage in a true dialogue in order to attain concerted action, within the framework of adequate structures of support, education, and farm extension which are indispensable to the achievement of any developmental operation in the rural environment.

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Overall, the people are very happy with the prospects of the SENERIZ project. It offers them clear advantages : increased food production, increased cash crop production, opportunity for wage labor. In fact, one of the themes that was encountered repeatedly in discussions with the villagers was dismay and even despair at the length of time it is taking for the project to get under way and to affect their lives. They have been hearing about the project for some time now, and are impatient to see something concrete.

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ANNEX I : Description of socio-economic relations in the family compound of Landing Sabaly.

This annex is an example and an elaboration of the general socio-economic relations among families in the SENERIZ project area.

As in most of the regions of Sénégal, there is a tendency for original family compounds (or extended families) to disintegrate, which results in the constitution of autonomous households (or nuclear families).

To illustrate this phenomenon, we have examined concretely the situation of the socio-economic relations among the households within the family compound headed by Landing Sabaly, on the following levels :

I - on the basis of kinship.
II - on the basis of agricultural production.
III - on the basis of the consumption of agricultural products and revenues.
IV - on the basis of livestock.

We have excluded relations concerning the exchange of gifts, work or mutual assistance, or sentiments.

Information was supplied by Mssrs. Dioumayel Diamanka and Bakary Sabaly, as the head of the compound, Landing Sabaly, was ill.

References in the text such as LHH No. 1 refer to the diagram and the code shown on page 2 of this Annex.

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## Population and Agricultural Equipment by Household.

**LHH No. 1** — TP
Men.....1
Women.....2
3

AE
Ploughs.....2
Carts.....2
Pairs of oxen.....1

**DHH 2** — TP
Men.....1
Women.....1
Girls.....1
3

AE
None

**DHH 3** — TP
Men.....2
Women...1
Boys.....1
4

AE
None

**LHH 4** — TP
Men.....3
Women...2
Boys.....2
Girls...5
12

AE
Ploughs.2
Seeder..1
Hoe.....1
Carts...2
Pr oxen.2
Horses..2

**LHH 6** — TP
Men.....1
Women.....1
Boys.....1
Girls.....2
5

AE
Ploughs..1
Pr oxen..1

**LHH 8** — TP
Men.....1
Women.....1
Boys.....3
5

AE
Ploughs..1
Rented draught animals.

**DHH 5** — TP
Men.....1
Women.....1
2

AE
None

**AHH 7** — TP
Men.....1
Women.....1
Boys.....1
3

AE
None

CODE :

AHH : Autonomous Household Head - 3
DHH : Dependent Household Head - 3
LHH : Leading Household Head - 2
Total (of which 2 polygamous) - 8
TP : Total population - 37, of which 19 are active.
AE : Agricultural equipment - 6 ploughs, 3 carts, 1 seeder. 1 hoe, 4 teams of oxen, 2 draught horses.

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1. Kinship ties between the compound head and the household heads.

1.1. The compound and household head Landing Sabaly (LHH No. 1) is the guardian of the household head Ousmane M'Ballo (DHH No. 2) and the household head Sandigui Kanté (DHH No. 3), who are his adopted sons.

1.2. The household head Dioumayel Diamanka (LHH No. 4) is the older brother and guardian of Bocar Diamanka (DHH No. 5). They are children of the same mother and the same father. They are cousins of the compound head (LHH No. 1).

1.3. The household head Ousmane Baldé (AHH No. 6) is the older brother of Yéro Baldé (AHH No. 7). They are children of the same mother and father. They live together in the same living area, but the households are automous. They are the nephews of the compound head. (LHH No. 1).

1.4. The household head Bakary Sabaly (AHH No. 8) is the brother of the compound head (LHH No. 1). His household is autonomous. He returned to the compound in 1970, after having lived at Kandia.

II. Relationships on the production level.

2.1. Food production.

2.1.1. The food crops of millet and maize are cultivated collectively by LHH 1 and DHHs 2 and 3, in fields considered to be the virtual property of LHH 1; and by LHH 4 and DHH 5, in fields considered to be the virtual property of LHH 4. The AHHs 7 and 8 have their own distinct fields for food crops.

2.1.2. Rice is cultivated both by traditional

methods and under the "encadrement" program. Traditional rice cultivation is done by women in the low-lying area, while rice under the SODEFITEX farm extension program is grown by the household heads on higher ground. Since 1969, rice grown under the extension program is a cash crop as well as a food crop.

### 2.2. Production of industrial crops.

All the household heads have their individual fields of cotton and/or peanuts. Within each household, the women may have parcels of peanuts and/or cotton, as do the boys, from the age of 15 and over.

### 2.3. Organization and utilization of the family agricultural labor force.

2.3.1. Work in the food crop fields is done collectively. This work is of priority nature and is directed by LHHs 1 and 4, from the preparation of the fields up until the end of the harvest.

#### 2.3.2. Work in the cash crop fields of the leading household heads.

DHHs 2, 3, and 5 each give two days of work for the fields belonging to LHHs 1 and 4, who, for their part, spend all of their time working in their own fields.

#### 2.3.3. Work in the cash crop fields of the dependent households.

DHHs 2, 3, and 5 use all days except those reserved for the cultivation of the food crop and cash crop fields of the leading household heads. They also use afternoons for their own profit.

### 2.3.4. Work in the women's fields.

Women work with their daughters in their own fields. They are assisted by their husbands in ploughing the rice paddies and in harvesting the peanuts. They in turn help their husbands during the sowing and the harvest of certain crops.

### 2.3.5. Work in the boys' fields.

In principle, the boys work mornings in the fields of their fathers or the LHHs. They work in their own fields in the afternoons.

## 2.4. The distribution and use of the means and the factors of production.

For peanuts, the compound head (LHH 1) receives the seed supplied by ONCAD for the members of the compound. He then distributes the seed to the eight different households.

For rice or for cotton, every farmer working under the "encadrement" program - household head, woman, or young boy - receives his or her seed directly from SODEFITEX.

### 2.4.2. Fertilizer and pesticides.

Each household head who wants to obtain fertilizer from ONCAD makes his own order for the fertilizer. For SODEFITEX fertilizer and pesticides, obtaining the products is tied to the distribution of seed.

### 2.4.3. Agricultural equipment.

LHHs 1 and 4, as well as DHHs 6 and 8, own agricultural equipment. DHHs 2 and 3 use the equipment belonging

to the LHH 1, and DHH 5 uses the equipment belonging to LHH 4. Husbands use this same equipment when they help their wives.

2.4.4. Draught animals.

LHHs 1 and 6 have each one pair of oxen. LHH 4 has two pair of oxen and two horses. AHH 8 has a large number of cattle, but rents his draught animals.

2.4.5. Cropland.

The farmlands of the compound are collectively cleared by groups of households : one parcel is cleared by the households LHH 1 and DHHs 2 and 3, another by the households LHH 4 and DHH 5, and another is cleared by the AHH 8, which benefits as well from the allocation of free fields.

After clearing, the compound head LHH 1 divides the land into fields for the common food crops and fields for the individual cash crops. LHH 4 does the same thing, whereas HHs 6, 7, and 8 each have autonomous fields. Each household head then distributes the land among those members old enough to work.

Should a DHH - No. 5 for example - make himself independent, LHH 4 would give him a portion of the communal food crop fields. The women would receive some of the cropland belonging to their husbands.

III - Relationships at the consumption level.

3.1. Food consumption.

3.1.1. Common granaries.

Harvests from the collective food-crop fields are stored in granaries which are under the responsibility of and managed by LHHs 1 and 4. Every morning, the heads of these two households re-supply their wives and the wives of household heads 2, 3, and 5 for the daily meals. The women take care of the treatment and the cooking of the products.

### 3.1.2. The rice harvest.

The harvest produced by the women is in principle divided into two parts : one is held in reserve for family consumption, and the other is sold for personal needs. Each woman manages her own stock of rice. The household heads who cultivate rice operate in the same way.

## 3.2. Agricultural revenue.

### 3.2.1. The agricultural revenue of the women.

The cotton and/or peanut harvests are sold by their husbands. In principle, all of the return should go to the wife, who disposes of the money as she pleases. However, husbands sometimes take a portion of the sum. Traditionally-cultivated rice and animal products (milk, butter) are on the other hand sold directly by the women who keep the returns from the sale.

### 3.2.2. The agricultural revenue of young boys.

The peanut and/or cotton harvests are sold by their father or by their guardian, who keeps the returns on the sale. The young boys then draw on this sum in accordance with their needs.

### 3.2.3. The agricultural revenue of the dependent household heads.

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Each dependent household head sells his own crops, keeps the returns himself, and spends the money as he wishes.

## IV - Relations on the level of livestock.[1]

### 4.1. The common herd.

LHH 4 and DHH 5 have a common herd, a part of which is an inheritance from their father. This livestock is placed under the responsibility of LHH 4.

### 4.2. Individual livestock.

Among the other household heads, each man is responsible for his own cattle.

### 4.3. Dowry cattle.

The cattle which women receive as a dowry are integrated into their husband's herd. The husband, however, cannot dispose of them. The wife may obtain income from the products of these cattle, but is not authorized to sell the cows which she has received as a dowry.

x

x x

1. Our informers did not want to reveal the exact number of livestock that each household owns.

# CHAPTER 7 : ECONOMICS OF PRODUCTION AND MARKETING


7.1. PRODUCTION OF AGRICULTURAL CROPS.

- 1.1. The Economic Base Line.
- 1.2. Quantities Produced.
- 1.3. International Perspective on Yields of Rice.

7.2. PRICES AND MARKETING OF CROPS.

- 2.1. Commodities that are sold.
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- 2.3. Marketing Structure.

7.3. ALTERNATIVE ORGANIZATION FOR PRODUCTION.

- 3.1. The Role of Large and Small Farms.
- 3.2. Small Farms and Family Nutrition.
- 3.3. Characteristics and Community Impact of Large Farms.

7.4. CROP AND ENTERPRISE SELECTION.

- 4.1. Budgets for Small Farms.
- 4.2. Choice of Crops for Large Farms.

7.5. ECONOMIC ANALYSIS IN PROJECT ADMINISTRATION.

# CHAPTER 7 : ECONOMICS OF PRODUCTION AND MARKETING

If Projet SENERIZ were proposed for implementation through investment of private capital, the economics of production and marketing would assume dominance over many, perhaps all, other factors. However, in the present context - a government owned project, to be undertaken for reasons that are at least partly political and social - economic justification of the project may be considerably less important. For that reason, the economic aspects of development of the Anambe basin that will be emphasised in this chapter are inter-project economics : relationships between inputs and outputs, and among elements of the project. Considerations of a more global nature are confined to be role and stature of the region and the project in the economy of Senegal, and potential efficiency of production there in a worldwide perspective.

## 7.1. PRODUCTION OF AGRICULTURAL CROPS.

### 7.1.1. The Economic Base Line.

The impact of a development project should be measured from a base line representing the value of production in the region, before development begins. It would, therefore, be desirable to assess the current value of production in the Anambe basin. Comparisons could then be made to the production, per capita income, or other indicators for the same region after the development program has had its effect. Unfortunately, no official statistics are kept for geographical regions such as the Anambe basin. Ex Post measurements of economic growth in the project area and of impact on the economy stemming from the project will have to be made for a larger area, such as the departments of Velingara and Kolda combined, or for the entirety of the Casamance. Such

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an evaluation, when it is done undoubtedly will use as its "base line" or starting point, existing official statistics on area, yield production, and other attributes of the political/administrative region that includes the project area.

7.1.2. Quantities produced.

Data on area and average yield of six staple crops in the Department of Vélingara are shown in Table 7.1.2. These data, while not constituting an economic base, are useful for the insights they permit into relationships among the crops.

Of the six principal crops in the department, the greatest area, on the average, has been that of peanuts, which has been the principal cash crop and the main source of monetary income. The greatest increase in area has been that of cotton, which has shown an increase in every year. It is probably important that the greatest area and the fastest growth have been accorded to cash crops, for which a dependable market is maintained.

Of the four cereals, sorghum is the leader in area by a wide margin, while rice has the least area, also by a respectable margin. The area of each of the crops has fluctuated greatly above and below its average, with each of the cereals declining in area by about one-half in some years, and increasing by about half in other years.

Variations in yields per hectare parallel those of area, although they are less extreme. Rice has the greatest variation (+55%, -58%) as well as the highest average yield. Millet is the least variable, and maize has the lowest yield. These characteristics will be seen in a later section to be of importance in the role of the respective crops in the local economy.

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TABLE : 7.1.2. Area and Yield of Principal Crops in Velingara Department, 1964 to present.[1] (in hectares and kg per ha).

| | Peanuts | | Cotton | | Rice | |
|---|---|---|---|---|---|---|
| | Area | Yield | Area | Yield | Area | Yield |
| 1964-65 | 15656 | 1000 | - | ≠ | 2333 | 1250 |
| 1965-66 | 17323 | 1000 | - | - | 4677 | 1250 |
| 1966-67 | 13227 | 1000 | 167(-99%) | 961 | 1350(-55%) | 1250 |
| 1967-68 | 18540 | 1100 | 537 | 1[illegible]2 | 4800(+61%) | 1250 |
| 1968-69 | 13500 | 1000 | 1000 | [illegible](+23%) | 2550 | 500(-58%) |
| 1969-70 | 21183 | 1250 | 1777 | 1495 | 3149 * | 1857 * [illegible] |
| 1970-71 | 23535(+48%) | 1020 | 2939 | 1350 | 4171 * | 923 * |
| 1971-72 | 16215 | 1050 | 4979 | 1300 | 2183 * | 1277 * |
| 1972-73[2] | - | - | - | - | - | - |
| 1973-74 | 13220 | 1500(+39%) | 9291 | 1426 | 2173 | 1190 |
| 1974-75 | 12225(-23%) | 1012 | 10900 | 1137 | 2640 | 1117 |
| 1975-76 | 13271 | 960(-11%) | 10995 | 800(-34%) | 2695 | 1440 |
| 1976-77 | 12816 | 1080 | 11500(+113%) | 1200 | 2971 | 1070 |
| Average | 15893 | 1081 | 5231 | 1220 | 2974 | 1198 |

Notes :

1. Percentages show deviation above (+) or below (-) the long term average.
2. Data not available for this year.

* Combined data for two categories of rice production.

≠ Available data combine millet and sorghum.

Source: Secteur agricole, Vélingara

TABLE: 7.1.2. Area and Yield of Principal Crops in Velingara Department, 1964 to present.[1] (in hectares and kg per ha). - continued

| | Millet | | Sorghum | | Maize | |
|---|---|---|---|---|---|---|
| | Area | Yield | Area | Yield | Area | Yield |
| 1964-65 | 10853 | 800 | 18749(+40%) | 600(-42 %) | 1757 | 650 (-21%) |
| 1965-66 | 9680 | 850 | 14000 | 800 | 6849 | 650 |
| 1966-67 | 5097 | 850 | 5183(61%) | 800 | 2031(-51%) | 650 |
| 1967-68 | 10500 | 950 | 14700 | 900 | 8040(+93%) | 700 |
| 1968-69 | ≠ | ≠ | ≠ | ≠ | 3500 | 650 |
| 1969-70 | 12801 | 742(-22%) | 15798 | 1379(+34%) | 4134 | 750 |
| 1970-71 | 13076(+46%) | 1200(+26%) | 15734 | 1060 | 5480 | 930 |
| 1971-72 | 8967 | 1140 | 11936 | 1100 | 3445 | 890 |
| 1972-73 [2] | - | - | - | - | - | - |
| 1973-74 | 7909 | 1025 | 12188 | 1125 | 3485 | 967 |
| 1974-75 | 9400 | 1117 | 12900 | 1145 | 3170 | 1163 (+40%) |
| 1975-76 | 4898 | 935 | 12582 | 1180 | 3968 | 1163 |
| 1976-77 | 4837(-46%) | 900 | 13306 | 1210 | - | - |
| Average | 8929 | 955 | 13370 | 1027 | 4169 | 833 |

Notes :

1. Percentages show deviation above (+) or below (-) the long term average.
2. Data not available for this year.

* Combined data for two categories of rice production.

≠ Available data combine millet and sorghum.

Source : Secteur agricole, Velingara

Table 7.1.3. Average Yield of Rice in Selected Countries, 1960-61 to 1976-77.

| COUNTRY | Metric Tons Per Hectare | Bushels Per Acre |
|---|---|---|
| Peru | 4.034 | 79.99 |
| El Salvador | 2.876 | 57.02 |
| Colombia | 2.824 | 56.0 |
| Nicaragua | 2.550 | 51.0 |
| Dominican Rep. | 2.471 | 49.0 |
| Venezuela | 2.118 | 42.0 |
| Guatemala | 2.03 | 40.25 |
| Guyana | 1.978 | 39.2 |
| Ecuador | 1.954 | 39.0 |
| Costa Rica | 1.706 | 38.82 |
| Honduras | 1.518 | 30.09 |
| Brazil | 1.454 | 28.83 |
| Philippines | 1.429 | 28.33 |
| Sénégal | 1.22 | 24.21 |
| Guinea. | 0.990 | 19.78 |

Source : Foreign Agriculture Circular, United States Department of Agriculture-FR 1-76/May 1976

### 7.1.3. International Perspective on Yields of Rice.

The yield per hectare obtained by farmers or by an agricultural production complex is one of the critical parameters determining profitability of the enterprise. Yield is also important as an indicator of success, widely used and understood although not fully reliable as a measure.

The long-term average yield of rice in a number of countries is presented in Table 7.1.3. It can be seen from the range of yields, roughly one to four tons per hectare, and with Senegal being near the bottom of the range, that there is considerable scope for increase in yields of rice. It can also be seen that the yields foreseen for Project SENERIZ (which rise to about 3.5 tons per hectare) are within the range of country averages, and thus appear feasible.

## 7.2. PRICES AND MARKETING OF CROPS.

### 7.2.1. Commodities that are sold.

In order to provide an assured market for cereals and other crops produced by Senegalese farmers, the government has authorized and empowered certain organizations to act as sole buyers for specified crops. ONCAD thus is the purchasing agency for all cereal grains and peanuts; SODEFITEX serves the same function for cotton. Prices offered by these agencies are uniform throughout a region, with no differential on account of location or transportation problems. Prices are also uniform with respect to the quality of the product, except in the case of cotton and rice, where discounts are applied for lack of quality.

All of Project SENERIZ's production of cereals will of necessity be sold to ONCAD.

Prices for cereals crops are fixed by the Government. Current (1977) levels of these prices are shown in the following table:

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TABLE 7.2.1. Producer Prices of Agricultural Commodities.

| Commodity | Price CFA PER Kg |
|---|---|
| Paddy rice: first quality (less than 15% red rice): | 41.50 |
| Paddy rice: second quality (more than 15% red rice): | 38.50 |
| Sorghum : | 35.00 |
| Millet : | 35.00 |
| Maize : | 35.00 |
| Peanuts : | 41.50 |
| Cotton : first quality : | 47.00 |
| second quality : | 22.00 |

Project SENERIZ does not plan to produce all of the foregoing products, abstaining from peanuts and cotton in order to avoid any possible conflict with existing programs. However, the prices may be used to show interesting relationships in the economics of alternative crops.

The prices fixed for the farmers are not adversely affected by "bumper crops" and overproduction, as they are in countries where the free market sets the price. Neither do ONCAD's prices to the farmer go up if there is underproduction or a shortage of a given crop. By the nature of the fixed-price market, ONCAD must buy any amount of a given crop that is produced and presented for sale, without modification of the price. "Elasticity" does not exist, in principle. This simplifies planning for a production-oriented project such as SENERIZ, although it does not necessarily simplify the planning or carrying out of ONCAD's role and function.

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7.2.2. Commodities used at home.

Under some circumstances one may wish to consider or calculate the value of cereal crops in other agricultural products that are used for family food, rather than being sold. The value of these crops may be considered to be, as a minimum, what they would have commanded had they been sold at harvest-time (at wholesale, seasonally low prices) rather than being kept for home use. The maximum value that the crops could be considered to be worth would be the replacement price, if purchased at retail when the prices were seasonally the highest. Where in this range the price should be fixed depends upon the nature, objectives, and assumptions of the analysis.

7.2.3. Marketing Structure.

ONCAD's charter as sole buyer of cereals confers upon the agency not only a monoplistic opportunity but also a heavy responsibility to provide an outlet - a market - for agricultural production. ONCAD's duty, whether explicit or implied, is still clear : the organization must place itself in position, or develop the capability, to purchase, pay for, and handle the cereals output of Project SENERIZ. In view of the stated objectives and plans for the project, annual production in excess of 100,000 tons must be foreseen and planned for, from the Anambé basin. The point of these observations on ONCAD's situation is to indicate the probability that ONCAD will be willing to negotiate arrangements under which Project SENERIZ would render assistance in carrying out ONCAD's obligation to buy and care for all that grain.

Such assistance to ONCAD might be rendered under arrangements delegating to SENERIZ the responsibility and authority to buy and store for ONCAD's account the grain produced by the project and by local farmers. Alternatively, ONCAD might supervise and nominally administer

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the cereals handling facilities of the project which would function as a grain buyer and warehouseman under the aegis of ONCAD, but employing SENERIZ personnel. Other possible arrangements could be devised.

While no arrangements or agreements have been made at this time between ONCAD and SODAGRI, it appears natural and proper that a way would be found to continue ONCAD's role in marketing and at the same time to facilitate coordination of activities, including handling and processing of cereals, within a major project such as SENERIZ.

Detail distribution of Project SENERIZ's finished product -milled, consumer-ready rice - is obviously not to be under SODAGRI or SENERIZ control while ONCAD retains its charter. However, ONCAD may wish to consider and investigate the possibility of packaging, or even of parboiling and then packaging, some fraction of the rice to be produced and processed by Project SENERIZ. This would permit further import substitution, as all of the premium quality "prestige product" rice sold in Senegal is imported at present.

## 7.3. ALTERNATIVE ORGANIZATION FOR PRODUCTION.

### 7.3.1. The role of large and small farms.

Traditionally, family farms have been subsistence level operations. Small surpluses above family needs have been used for bartering in local markets for spices, oils, medecines and small tools. Food shortages have been met through employment on larger farms or in nearby towns, or through liquidation of accumulated wealth such as cattle herds. Only in recent years have the small farmers been introduced to commercialized agriculture - growing a product for cash sale and using the profit to buy food rather than raising it. Despite this incipient metamorphosis, the small family farm continues, and undoubtedly

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will continue for some time to come, to plant some portion of its land to food grains, even though they may yield poorly and have little market value, as a measure to insure subsistence.

The impact upon the national economy from surplus returns generated by small family farms in a new agricultural development is minimal. Surplus production rarely moves further than the nearest small town market, and does little to alleviate food shortages in the major population centers or to reduce the nation's dependency upon imported food.

For a number of reasons it is desirable to continue the dominance of Senegalese agriculture by family-based production units. In order to protect the sociological and political stability of the project area and at the same time to preserve the ethnic character of the region to the maximum extent possible, it is desirable that project SENERIZ should permit the family to remain as the basic unit of production. The majority of the farmland in the region should remain in family farms, and the bulk of the crops produced should come from such production units.

At the same time that one defends the family farm, one should recognize its drawbacks or disadvantages as a vehicule for rapid increases in agricultural production. It is difficult to generate surpluses in the small family farming context. Moderate increases in production are likely to be absorbed by a higher level of consumption, i. e. a redefinition of "subsistence level". Major increases in production normally can be obtained only by increasing the number of productive units, increasing the scale of operation of existing units, or increasing the productivity per hectare. But the same stability, subsistence orientation and resistance to change that make the family farm a precious national resource preclude the prompt increase in numbers, major increase in average size, or rapid adoption by family farms of new and different enterprises and techniques and the commercial organization that is needed to boost Senegal's rice production significantly within a few short years. To achieve these different objectives, different organizational forms must be used.

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The organizational form that is suited to this need is an agro-industrial complex or large mechanized farm. Such an organization could be established promptly and expanded within a few years to provide a significant proportion of agricultural production in the project area, while retaining the ability to respond immediately to governmental requests, taking the lead in using and demonstrating new technology, developing even better methods through research and experimentation, and moving rapidly toward the development and use of large areas of under-utilized land.

SODAGRI recognizes both needs, and feels that both kinds of production units have their place in a development project such as project SENERIZ. Both are in fact planned, with characteristics and programs described in the following sections.

The existence of a large mechanized farm or agro-industrial complex is not necessarily competitive to or in conflict with family farms in the same region. The two types of units may exist amicably side by side, and may in fact benefit each other. The complex will develop and introduce new technology, some of which will filter down and be adopted by the local farmers. The complex may produce quality seed of adapted varieties, may act as distributor for fertilizer, farm chemicals, feed supplements for livestock, or other agricultural inputs, or may have surplus machinery and power available for "custom work" for neighborhood farmers. On the other hand, the complex will have need of both permanent and seasonal employees, and members of these local farm families are ideal candidates to meet the personnel needs of the complex while benefitting themselves with secure employment.

### 7.3.2. Small farms and family nutrition.

Il a subsistence - oriented family farm, priority is given to production of food crops. However, as discussed in Chapter 6.5.2., a surplus over actual need for food crops is not desired. Therefore, number of persons in the family is a major factor establishing

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the food requirements of the family, and determining both the minimum quantity of food crops needed and the maximum desired to feed the family. The number of economically active persons, on the other hand, fixes the amount of labor available and thus establishes the maximum area of all crops that can be produced with a given kind of technology.

The typical size of family in the project area is taken as 9 family members, of whom 6 are economically active. This typical size is based on study of families in the project area by SODAGRI's social scientists. In SODAGRI's typical project area family, 67% of the members are economically actives. This compares closely with the proportion shown by official population figures for the Kounkandé arrondissement- 65 percent, or 28,311 actives out of 43,843 inhabitants. If the typical family size holds true, there are about 4,900 families in the Kounkandé arrondissement.

While each family represents a number of workers, it is normal for an individual to make decisions for the family and for the family to act as a unit. Thus, it is appropriate to use the terms "a family", "a farmer", a family group interchangeably when speaking of the organizational unit in agriculture.

The success of the family group relative to the objective of producing adequate food can be shown by calculating the calorie value and the protein content of the food crops produced by the average family. Using crop area per family observed in a sample studied by the SODAGRI team and average yields in Velingara department, 6,736 kg of food crops would be produced (Table 7.3.2.). After allowing 10% for next years' seed, 30% of rice and peanuts for hulls, and half the remaining peanuts for marketing, 4,207 kg of food crops would remain available in an average year to feed the family. This amount of the specified crops contains about 16 million calories and about 555 kg of protein of which about 269 kg would be assimilable. This would provide over 4,900 calories and 82 grams of assimilable protein for each of the 9 family members.

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TABLE 7.3.2. Calculation of Nutritional Adequacy of Family Food Production

| Crop | Area of crop per family (ha) | Yield kg/ha | Production kg | Addumed availability for fam. consumption | Calories per kg | Calories available | Protein g/100 g | Gross protein avlbl. for cns. | Net protein utilisation (NPU)% | Net protein assimilable kg |
|---|---|---|---|---|---|---|---|---|---|---|
| Cotton | 1.82 | 1220 | 2220 | - | - | - | - | - | - | - |
| Peanuts | 2.6 | 1081 | 2811 | 885 | 5640 | 4991400 | 260 | 230.100 | 42.7 | 98.3 |
| Sorghum | 1.78 | 1027 | 1828 | 1545 | 3320 | 5451400 | 110 | 180.950 | 50[2] | 90.5 |
| Millet | 0.7 | 955 | 668 | 601 | 3270 | 1965270 | 99 | 59.499 | 56 | 33.3 |
| Maize | 0.78 | 833 | 650 | 585 | 3480 | 2035800 | 89 | 52.065 | 55 | 28.6 |
| Rice | 0.65 | 1198 | 779 | 491 | 3630 | 1782330 | 67 | 32.897 | 57,2 | 18.8 |
| Total | 8.33 | | 8956 | 4207 | - | 16236200 | - | 555.511 | | 269.5 |

1. Production less 10% for seed, less 30% of rice and peanuts (for hulls) less one-half of peanuts (marketed).
2. Estimated.

Source : Calories, protein content : Watt, B.K. and Merrill, A.L., USDA Handbook No. 8, Composition of Foods, 1963

NPU : Amino Acid Content of Foods and Biological Data on Protein, FAO/UN, Rome 1963.

Nutritional requirements may be estimated, using a hypothetical but probably typical composition of the family. Caloric requirement ranges from 1,300 for a child of 1-3 years to a maximum of 3,000 for a young man, while protein need ranges from 23 grams for a small child to 56 grams for a mature man and 78 grams for a pregnant woman. The weighted average requirement for a typical family is about 2,300 calories and 50 grams of protein per person.

Thus there appears to be neither caloric nor protein deficiency in an average family in an average year. They probably could sell half their production and still be adequatly fed, assuming additions to the diet of some meat, milk and vegetables. In years of low production, of course, a different situation prevails. It is probably for precisely this reason that millet and maize remain important crops in the economy of the region : their yields do not fluctuate as much - particularly, they do not drop as much in bad years - as the other crops.

### 7.3.3. Characteristics and community impact of large farms.

In constrast to small family farms, large fully mechanized units are totally oriented toward maximizing production and profit. The agro-industrial complex of Projest SENERIZ will be such a unit, operating with experienced management and efficient equipment.

The complex foresseen for the Basin would provide storage and drying facilities for grains, as well as primary processing. Ultimately in the period beyond the scope of this development plan, final processing and packaging might be added to the functions of the projet.

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The labor needs of the complex will be met by permanent employees, who will become customers of nearby markets, increasing the demand for locally produced food and meats.

The employment provided by the large mechanized farm may have the effect of encouraging and aiding the independence of some of the employees. To some of the employees, their salaries or wages will provide capital with which they can expand their own agricultural production, launch other business ventures, or provide more education or other benefits to sons and daughters. Local employment, whether full- time or seasonal, will also have an effect on the migration patterns of the local people. The magnitude of Project SENERIZ's effect on the rural exodus would be difficult to determine in advance, but it is certain that the large mechnized farm will offer an attraction that will at least tend to counter the attraction of the big cities.

The large farm would carry out research and experimental activities and variety improvement trials. The results of this work will have effects beyond the farm itself, as the varieties and other technology developed may be used by local farmers, and entire new horizons may be opened up by success of planned introduction and experimental culture of vegetables for canning, sugar cane for sugar production, etc...

## 7.4. CROP AND ENTERPRISE SELECTION.

### 7.4.1. Budgets for small farms.

The role of food crops in the nutrition and self sufficiency of a typical family in the project area has been discussed. The monetary value of the product did not enter into that discussion. Yet in view of the increasingly commercial orientation of the farmers, especially as it relates

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to sale of food crops surplus to their immediate need, one should evaluate the crops on a commercial or sale basis.

Under the most primitive technology, crops are produced with no out-of-pocket costs being incurred. Unpaid family labor does the work ; seed is saved from last year's crop ; no fertilizer or other purchased inputs are used. The value of the crop is the product of yield and opportunity price. The opportunity price might under some circumstances be the cost of purchased replacement of these crops by other cereals, but because Senegalese villagers who would practise such costless subsistence production do not have monetary income with to buy food, the price of such food is irrelevant. Therfore, opportunity price in this case is the price at which the crops could be sold, i.e., the government-controlled price.

Average yields in Velingara and gaovernment prices give the following values per hectare :

| | |
|---|---|
| Rainfed rice | 49,800 CFA |
| Millet | 33,250 |
| Sorghum | 36,050 |
| Maize | 29,050 |

These values of a hectare's production in the local context permit an explanation of cropping patterns. Despite the high value of rice and local preference for it as a family food, production cannot be increased with primitive technology because only limited areas of suitable land are available. The relatively high return from rice helps to explain the increasing interest of men in the production of a crop previously considered to be strictly the domain of women. The low yield of maize is partly explained and offset by the harvest of green corn for consumption as a vegetable. Millet and maize tend to yield better (i.e.,their yields decline less) in adverse years than is true of sorghum or rice. In addition, a preference for the taste of millet and maize over sorghum may have the effect of increasing the value of these crops. Thus the distribution of cropland among the potential crops seems to be rational.



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Under improved technology, a different set of budgets must be considered. Table 7.4.1. presents such budgets, which include labor and power requirements of Le Modele "4 S" : Programme lineaire pour les exploitations agricoles du Sine Saloum au sud du Sénégal, a study by J.F. Richard et al, of Institut de Recherches agronomiques tropicales (IRAT). This study is based in an agro-climatic zone that is different from the Anambe Basin, and certain of the costs shown are estimated from other data. Consequently, the results do not necessarily parallel the findings of the 4-S study and are only illustrative of relationships for project SENERIZ.

In the illustrative budgets of Table 7.4.1., crop yields are higher than for primitive technology, but the increases are not uniform for the different crops. Costs are increased in proportion to additional inputs. The surplus of return over costs now favors maize by a wide margin, with rice intermediate and millet and sorghum about equal.

Considering the budgeted profitability of maize with improved technology, one is hard pressed to justify continuation of millet and sorghum culture wherever the budgeted relationships prevail. In many parts of Sénégal, there is in fact increased interest in culture of maize, but hardly to the extent that this budget of costs and returns would support. Two reasons are evident. One is that the out-of-pocket expenses are approximately 50% higher than those of the traditional crops of millet and sorghum, and farmers who are incompletely oriented to commercial agriculture may be reluctant or even unable to make such an investment in the more profitable crop. The other reason is that the production resulting from the package of practices represented by this budget does not seem to be appropriate. Maize has the potential for yields of 3,500 kg per hectare, but sorghum can also yield well, and it is doubtful that the improved pratices would quadruple local average maize yields while only doubling.

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TABLE 7.4.1. Costs and returns in production of cereal crops on small farms (synthesized data).

| Labor and power inputs (hours) | RICE (Rainfed) | | MILLET | | SORGHUM | | MAIZE | | AVERAGE | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Labor | Power | Labor | Power | Labor | Power | Labor | Power | Labor | Power |
| Preparation | 12 | 6 | 12 | 6 | 12 | 6 | 12 | 6 | | |
| Plowing | 60 | 30 | 60 | 30 | 60 | 30 | 60 | 30 | | |
| Spread fertilizer | 17 | - | 17 | - | 17 | - | 17 | - | | |
| Apply seed | 12 | 6 | 18 | - | 6 | 3 | 6 | 3 | | |
| Cultivation | - | - | 12 | 6 | 12 | 6 | 12 | 6 | | |
| Weeding | - | - | 100 | - | 100 | - | 80 | - | | |
| Hilling up | - | - | - | - | - | - | 16 | 8 | | |
| Harvest | 260 | - | 170 | - | 265 | - | 250 | - | | |
| Threshing | 200 | - | 180 | - | 200 | - | 105 | - | | |
| TOTAL : | 561 | 42 | 569 | 42 | 672 | 45 | 558 | 53 | 590 | 45,5 |
| CASH COSTS : | | | | | | | | | | |
| Power[1] | 8400 | | 8400 | | 9000 | | 10600 | | | |
| Fertilizer | 3625 | | 3625 | | 4500 | | 6000 | | | |
| Seed | 4150 | | 255 | | 220 | | 1600 | | | |
| TOTAL CASH COSTS | 16175 | | 12290 | | 13720 | | 18200 | | 15096 | |
| Yield, kg | 2000 | | 1800 | | 2000 | | 3500 | | 2325 | |
| Value of crop, (CFA) | 83000 | | 63000 | | 70000 | | 122500 | | 84625 | |
| Margin/cash costs | 66825 | | 50710 | | 56280 | | 104300 | | 69529 | |
| Return/hr of labor | 119 | | 89 | | 84 | | 187 | | 120 | |

1) Cost of a team of bullocks and the implements estimated at 200 CFA per hour of use.



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yields of other crops. Limitations imposed by lack of rainfall in some years would hurt maize relatively more than it would hurt the drought-resistant sorghum.

At any rate, the justification for expansion of production is evident, as each additional hectare would give an average of about 85.000 CFA return in excess of cash expenses, which amounts to, on the average, 120 francs per hour of work. Also, this budget shows that the best crop, and the crop which should receive emphasis and major attention in the context of commercialised agriculture may not be the same crop that was accorded priority at the subsistence level.

### 7.4.2. Choice of crops for large farms.

Just as there was observed to be a different set of costs and a different array of preferences for crops between subsistence and commercial agriculture on small farms, so is there a different set of costs for large commercial farms. To evaluate the costs and to compare profitability of alternative crops under agro-industrial conditions, the following budgets are presented (TABLE 7.4.2.) which show the calculated costs of operation of the agro-industrial complex described in chapter 10. The costs shown here are not identical with those presented in chapter 12, as they are based on preliminary estimates; yields, fuel costs and other elements were adjusted later. Those changes would modify the level of cost, return and profit per hectare, but they would not change significantly the relationship among these figures, which is the important matter for the present analysis.

TABLE 7.4.2. Cost and returns in production of cereal crops on agro-industrial complex. (In CFA per hectare).

Despite the use of a quite different approach to calculation of costs, and different assumed yields of crops, the results are in agreement

.../...

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with earlier presented figures as to the value of millet. At expected yields, probable production costs and government - fixed prices, millet is not a competitive crop. Its value is so low that its inclusion in the cropping plan cannot be justified. Discovery of this fact led to complete reorganization of the cropping program for the agro-industriel complex. In the revised program millet was excluded ; rainfed rice - the second lowest value crop - was eliminated after significant production of irrigated rice was achieved, and the balance between sorghum and maize was shifted slightly to favor sorghum.

TABLE 7.4.2. Costs and returns in production of cereal crops on agro industrial complex (in CFA per hectare)

| ITEM | Rice rainfed | Rice irrigated | Millet | Sorghum | Maize |
|---|---|---|---|---|---|
| Seed | 3320 | 4150 | 210 | 280 | 1200 |
| Fertilizer, Mixed | 1875 | 3750 | 1875 | 1875 | 2500 |
| " Urea | 1750 | 5250 | [illegible] | [illegible] | 3500 |
| Chemicals | 5000 | 5000 | [illegible] | 5000 | 5000 |
| Machinery Costs | 8293 | 8293 | 8293 | 8293 | 8293 |
| Labor 1 | - | - | - | - | - |
| Total Cost | 29995 | 36200 | 27759 | 27829 | 30249 |
| Yield of crop, kg/ha | 2200 | 3110 | 2000 | 3000 | 3000 |
| Value of crop | 91300 | 129065 | 70000 | 105000 | 105000 |
| Return over Costs | 61305 | 92865 | 42241 | 77171 | 74751 |
| Profit ranking | 4 | 1 | 5 | 2 | 3 |

1) Under mechanized production, labor is assumed to be a uniform cost for all crops; its omission merely simplifies calculations.

.../...

## 7.5. ECONOMIC ANALYSIS IN PROJECT ADMINISTRATION.

The example in section 7.4.2. of the use of economic analysis in modification of a program or a project is illustrative of the way that management of project SENERIZ should and will operate. Even the most carefully made forecasts or estimates will be subject to review, and operating decisions will be subject to change based on the results of economic analysis.

The budgetary figures in table 7.4.2., yields as well as costs, are only estimates. When production gets under way, actual production records can be substituted for the estimates, and reevaluation may restore millet to the rotation, subordinate sorghum or maize, or justify emphasis on a crop such as soybeans or sugarcane that will be tested in the project's research program.

Economic analysis should also be applied to the choice of technology, and to decisions on how much of certain inputs to use. For example, despite the plan for harvesting all grains with self-propelled harvesting machinery, the project should and will perform field-scale trials of harvesting by seasonally employed labor. If costs are competitive, and if problems of labor availability, labor supervision and management, etc. are not too severe, project SENERIZ should definitely opt for the hand-labor alternative, which would have the benefits of providing additional employment and reducing expenditures of foreign exchange for machinery and fuel. The amount of fertilizer that should be used (or the amount of seed or irrigation water or labor or anything else) can and should be decided by applying economic principles : if more fertilizer (or seed, etc) increases the gross return by more than it increases the cost, more should be applied. For these decisions, data from actual trials should be used. Estimations have been used in preliminary budgets, but estimates can and should be replaced by "hard" data when it is available.

.../...

Another option that may be evaluated when actual data are available is the crop on which irrigation water should be expanded. Plans are that practically all the irrigation water would be used for rice production. However, counter-season vegetables, fruits, sugarcane, or even irrigated maize and sorghum may pose effective competition to rice in terms of benefit to the project. In this case, the economic analysis would provide a basis for the administrative (and political) decision of whether to produce rice in a project originally conceived as a rice project, or whether to shift to production of another, possibly more profitable, crop. However, economics cannot make such decisions; economics only provides guidelines and evaluates alternatives, to help administrators make sound decisions.

Constraints on the design of Projet SENERIZ from the point of view of economics can be summed up in a few generalizations :

1. Design of the projet must keep uppermost the real objectives of the project, and strite to maximize achievement of those objectives.

2. Some of the objectives are monetary or financial, but some of the objectives have very little to do with money and are difficult to quantify. Stimulus to local development, impact on national dependence on importation of food, and effect on health and well-being of local residents are difficult to measure, but they are very important reasons for and objectives of the project.

3. Achievement of a project design that shows a reasonable rate of return calls for focussing of resources on high-value crops and using resources as intensively as feasible. Specifically, deletion of millet from the list of crops grown seems to be dictated by economic considerations.

4. It should be recognized that during project implementation, decisions concerning enterprises selected, techniques of production employed, and proportions and amounts of inputs used must be

reviewed periodically in the light of current data on cost and returns. The tentative nature of any project design should be acknowledged.

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x x

# CHAPTER 8

## REQUIREMENTS FOR DEVELOPMENT

8.0. INTRODUCTION.

8.1. IMPROVED INFRASTRUCTURE.

1.1. Roads for External Communication.
1.2. Roads for Communication within the Project Area.
1.3. Domestic Water Supply.
1.4. Power Supplies.
1.5. Telecommunications.
1.6. Air Strip.

8.2. HEALTH PROGRAMS.

2.1. Community Health Programs.
2.2. Livestock Health Programs.

8.3. MARKETS.

8.4. SCHOOLS.

# CHAPTER 8

## REQUIREMENTS FOR DEVELOPMENT.

### 8.0. INTRODUCTION.

The development of a region such as the Anambe Basin requires a multifaceted program including a number of integrated and coordinated activities. Major components of the basin development scheme will include flood protection and drainage of the basin ; provision and distribution of irrigation water ; establishment of an agricultural production complex to produce crops on previously idle land ; agro-industrial capacity for processing or treatment of crops as required ; a livestock production scheme ; and a far-reaching program of teaching and assistance to farmers, to upgrade their technology and thus multiply their productivity in respect to both crops and livestock. These needs are more or less self-evident. How these needs will be met will be discussed at some length in subsequent chapters.

The foregoing components must be accompanied by a number of other activities that may be considered facilitating or even incidental, and which for that reason may not be self-evident or may be overlooked. These activities are nonetheless essential to the success of the overall project of basin development. Included in this list of needs are improved access to and communication with the region from major population centers ; internal communication within the region and among different aspects of the project ; electric power and domestic water

supplies ; support of the local population in terms of governmental administration, medical care and health program ; schools ; improved markets, not only for selling locally produced commodities, but to meet increased local demands for goods from outside the region. Brief comments on these needs for basin development are included in the following sections.

It is important to note that a number of needs for project success are identified which are not proposed to be met by the project itself. External roads, health programs, markets and schools are outstanding in this list.

## 8.1. IMPROVED INFRASTRUCTURE.

The total benefits of the project to the Department of Velingara and also to the Republic of Senegal will be far reaching. Some of the results will be immediate and tangible ; others may not be evident for some time and may be difficult to measure. For this reason, economic rationalization of certain parts of the program, taken separately, may be difficult. It is recommended that the project be considered as a package or entity, with all of its parts integral and inseparable.

### 8.1.1. Roads for External communication.

Communications with other parts of the Casamance will be improved by the metalling (scraping) of the Kolda-Velingara N.6. road.



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The financing for this project has already been assured by the F.E.D. and construction is due to start in October 1977. It should be completed by late 1979.

A similar project on the N.1. road from Maleme Hodar to Tambacounda is badly needed. It is to be hoped that finance will be secured promptly. The Ministry of Public Works has indicated completion of this project by 1979-1980.

The section of the N.2. between Velingara and Tambacounda must be metalled before the construction phase of the project.

These road improvement schemes, although not directly financed by the project, do complement the resulting development of infrastructure.

8.1.2. Roads for Communication within the Project Area.

Such roads are to be constructed principally for the benefit of the project. However, all inhabitants of the Anambe Basin and the surrounding area will profit.

Although precise routes have not yet been chosen, a total of approximately 150 km of primary roads are anticipated. Construction of these roads is necessary and justified within the project's budget, because of the tremendous savings on vehicule and machinery replacement and maintenance that will result.



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Secondary roads will also be required to give access to all cultivated areas. These would not use imported fill, except in exceptional cases of boggy or very sandy ground conditions, but would be cut out of the existing topography, provided with camber and drainage ditches and, where necessary, culverts.

In addition to these immediate project needs, an all-weather road to any proposed quarry site would be required.

8.1.3. Domestic Water Supply.

Domestic water supply is anticipated as follows, in the project headquarters and for any major processing factories. A water treatment plant should be integrated in the factory design ; one treatment plant may serve more than one factory, if these are adjacent. This supply is to be available for all offices, housing complexes and any light industrial use of treated water.

For major centers of population or influence, water should be drawn from the nearest irrigation conveyor and passed through an adequate water treatment plant, probably a settling tank and gravity sand filter, using diesel or electric powered pumps as necessary. Such centers as Kounkané, Diaobé and Anambé should be served in this way.

8.1.4. Power Supplies.

Central generating capacity will be provided by the project, for both industrial and domestic use. All domestic supplies will conform to existing supplies in Velingara, i.e. 220 V. A.C. 500 HZ. Power for pumping stations and any other distant requirement will be carried by overhead high tension lines equipped with appropriate step-down transformers.

8.1.5. Telecommunications.

An internal telephone system within the project area will be installed for project use only. It will connect all project centers, including factories, principal pumping stations, generating station, and administrative headquarters. In addition, a telecommunication system linking the project administrative center directly to Dakar will be necessary ; radio and telex facilities should be provided.

8.1.6. Air Strip.

A project airstrip for use by light aircraft will be provided. This will serve many purposes :

a/ Ease of transport for V.I.P.'s, including government officials, visiting dignitaries, etc.

b/ Speedy evacuation of the sick or injured.

c/ Agricultural use, for aerial application of phyto-



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sanitory products, aerial seeding, and fertilization, etc.

d/ In the event of emergency breakdown and the needs for spares, they may be flown in from abroad via Dakar Airport and dispatched immediately to the project.

## 8.2. HEALTH PROGRAMS.

### 8.2.1. Community Health Programs.

Frequently returns from large-scale capital investments in development projects fail to reach their anticipated goals. Investigations into numerous "less-than-successful" projects reveals that low attainment due to poor health is one of several common denominators.

The project development plans presented in this report attempt to address each of the constraints in evidence. A health center for project employees will be a part of the project infrastructure. However, in SODAGRI's opinion, the Ministry of Health should provide, from its own funds, support to the project area and to local citizens who are not project employees, and should extend the health services presently available in Velingara by providing first-aid and out-patient treatment centers. Village extension agents could distribute anti-malaria drugs throughout their spheres of influence and non-prescriptive medicines in common usage, such as vitamin and mineral supplements, but trained medical assistants should be posted in at least four major villages within the Basin to care for more serious cases. Cases requiring surgery or a doctor's attention, could be brought to the hospital in Velingara for treatment.

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Clearing new farmland, and ridding the improved pastures of low brush would, in itself, aid in the prevention of tsetse fly infestation in the area. Use of crop insecticides also aids in control of flies and mosquitos. Providing access roads throughout the project would greatly aid in transporting serious cases to Velingara or other points where care would be available.

Of primary importance to good health would be the provision of dependable and safe water, which can improve general sanitation and cleanliness significantly, and can drastically reduce water carried diseases such as typhoid fever and cholera and water-borne parasites. Domestic water supplies have already been referred to in section 8.1.3.

### 8.2.2. Livestock Health Programs.

Animal health problems also need attention in a development scheme.

A veterinarian or a trained veterinary assistant should be posted in the project and arrange for periodic dipping and vaccination of all livestock within the area of the Basin.

Trypanosomiasis, while not presently a serious threat in the Basin, is prevalent in nearby areas and could become endemic at any time. Brush clearance is one of the most effective means of control and may be augmented by hand spraying with a suitable insecticide.

In addition to Trypanosomiasis, it is important to control such major animal diseases as Rinderpest, CBPP, Blackleg and Anthrax. Internal parasites can be held under control with drugs, and external parasites and tick-borne diseases by periodic dipping and pasture rotation. Animal rabies, if a problem, can be controlled by eliminating stray dogs and vaccinating pets annually. Such a program mounted by the appropriate government agencies would both support and be supported by the project's program of teaching and facilitating implementation of improved technology.

## 8.3. MARKETS.

Markets for local production. The revenue of the project will be generated largely from the sale of rice and other cereals. Existing institutional arrangements for cereals marketing in Senegal provide only one outlet for the cereals produced by project SENERIZ : ONCAD, an agency of the Government. No other cereals marketing arrangements are planned by the project ; the entire crop will be sold to ONCAD. It follows, of course, that ONCAD's ability to handle the volume of cereals produced and processed by the project is critical to the project's success.

Sales within the region. The project will give seasonal and year-round employment to a number of persons, and participating farms will be expected to have increased income from sale of crops. Both groups of persons will thus have increased disposable income, and they

will want to spend this money.

Certain types of expenditures should be facilitated by the project. Notable among these are expenditures that further increase agricultural productivity : draft animals, implements, fertilizers, etc.

Expenditures for consumer goods - clothing, household goods, foodstuffs not produced in the region - are also perfectly legitimate desires ; however, the provision of such goods will be left to the private sector, and local merchants will be encouraged to meet needs of this type in the market-place.

## 8.4. SCHOOLS.

The opportunity for gainful participation in the family's agricultural and livestock enterprises, and the opportunity for full or part-time employment in the project, may be thought of as giving to young people an attractive alternative to school. The choice between working and studying may arise for some. In reality, the effect of the project is likely to be a significant increase in the local need and even vociferous demand for schools. Disregarding any influx of population at the farmer or laborer level, the local stationing of project personnel - themselves better educated than average - will result in strong demand for schooling of their children. The emphasis on science and knowledge that the project will carry into the villages, compounds and households will increase the desire of local families for

schooling of their children.

The Ministry of Education therefore can depend on a need to increase the number and size of schools needed in the Anambe Basin. Providing such schools should be an undertaking of the government, which will support the project but will not be administratively a part of the project.

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# CHAPTER 9

## ALTERNATIVES CONSIDERED FOR PROJECT STRUCTURE.

9.0. INTRODUCTION.

9.1. DIFFERENT PROPOSED SOLUTIONS.

1.1. Serda Proposal.
1.2. A double ended dam on the Anambe Valley.
1.3. A dam downstream of the confluence of the Anambe and Kayanga Rivers.
1.4. Deep ground water development.
1.5. A development program involving no major investments in facilities.

9.2. SELECTED ENGINEERING SOLUTION.

2.1. Maximum storage of run-off.
2.2. Irrigation Supply.
2.3. Drainage and flood protection in the Anambe Basin.

# CHAPTER 9

## ALTERNATIVES CONSIDERED FOR PROJECT STRUCTURE.

### 9.0. INTRODUCTION.

Foregoing chapters have described and discussed constraints placed on the design or operation of the Anambe Basin development project for reasons of pedology, sociology, meteorology, etc. It remains for the engineers to evaluate the resources available, the constraints on their use, and the objectives of the project, and to design ways of using resources that best achieve the objectives. In such process of design, a number of possibilities are normally considered. That is indeed the case here ; six distinct and different designs were considered. Five of these were discarded, and the sixth was chosen for presentation in greater detail in the following chapters. Because SODAGRI's choice of basic project design is different from the choices of earlier studies of the basin, it seems desirable to describe the other possible designs that were evaluated, and to state why they were discarded. Following sections 9.1. through 9.5. describe the altervatives.

Design Criteria. In certain chapters of this report, the lack of precise data and the need for improved measurements and additional investigations have been stressed. Nowhere is this problem more conspiciously present than in respect to rainfall.

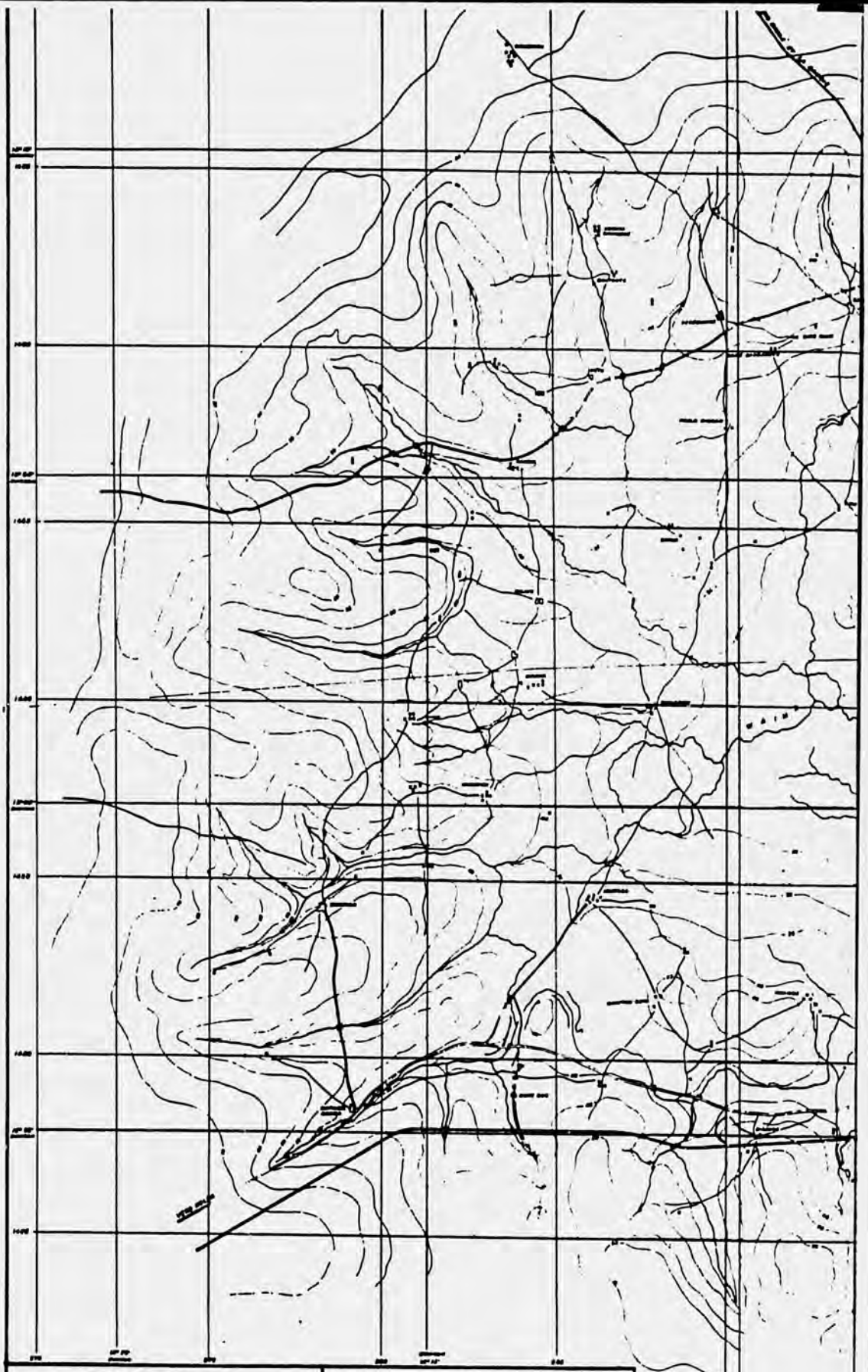
The basic reason for gathering historical data is to predict the future. But because of the grave and prolonged Sahelian drought, the future is obscured.

During an interview in Mountoumba, a village on the western side of the Anambe Basin, a local farmer described the "exceptional" flood of the previous year. Compared to recent years of 1968-1974, his assessment was correct , for those years had only 65 to 80 percent of normal rainfall. But compared to the long-term average, 1975 was certainly not an exceptionally wet year.

In outlining the design of the water storage and irrigation needs of the [illegible] project, one is faced with precisely the same dilemma · whether to assume that the Sahelian Drought will continue or that in the long term climatic conditions as recorded in 32 of the last forty years will return.

This decision becomes extremely important when the hydrogeological regime of the area is considered. A reduction of rainfall to 20 % below average results in a 75 % reduction in runoff, and a lowering of the ground water table. The volume of deep water percolation is also reduced, thus affecting the possibility of using groundwater as a source of irrigation water.

Another constraint on the overall design of the water storage and irrigation facilities is evaporation.Earlier in this report an estimated water surface evaporation for a reservoir on the Kayanga River



PROJECT SENERIZ
PROJET SENERIZ

THE ANAMBE BASIN
LE BASSIN DE L'ANAMBE

SODAGRI CONTRACTORS ENGINEERS CONSULTANTS

WEITZ HETTELSATER CORP.

Drawn By | Checked By | Drawn By | Scale | Dwg No. 01.3

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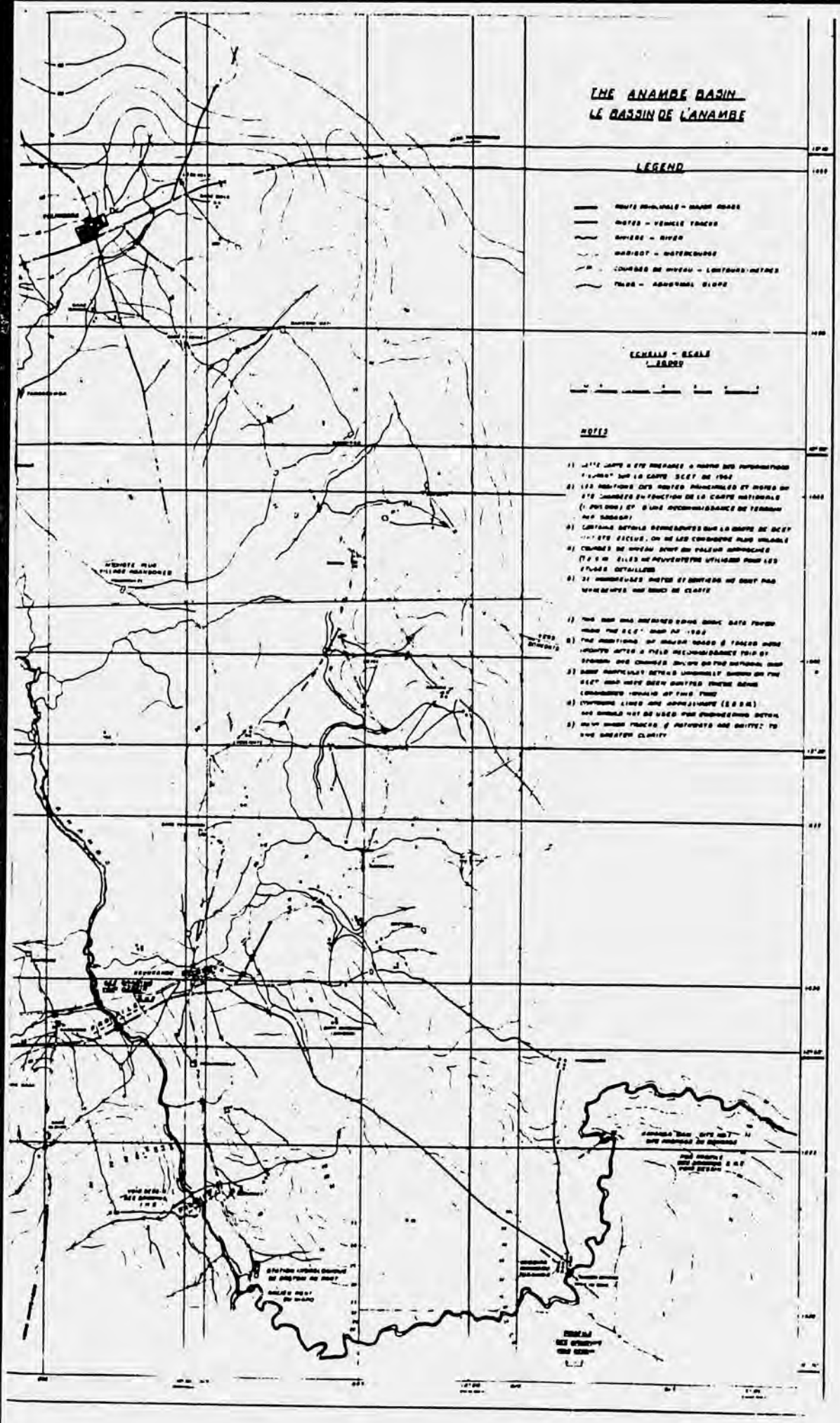
THE ANAMBE BASIN
LE BASSIN DE L'ANAMBE
LEGEND
NOTES

of 1,710 mm has been suggested. Considering the storage capacity rating for any reservoir, this value of evaporation is critical.

Despite the uncertainties, the following hydrological criteria are established for evaluation of the alternative project designs.

Rainfall (average)

- Velingara 1,072.5 mm
- Kayanga Watershed 1,250 mm

Storm intensity

- Velingara Department - 237 mm in 24 hours
- 100 year design storm - 300 mm in 24 hours
- Maximum run-off per 24 hours -60 % of 100 year storm at 40 % run-off coefficient.

Evaporation

- Pan A Evaporation (Anambc) - 2,425 mm/year
- Actual Lake Evaporation (Kayanga) - 1,710 mm/year.

## 9.1. DIFFERENT PROPOSED SOLUTIONS.

### 9.1.1. Serda Proposal.

The essential hydrological feature of the SERDA proposal were : (1) a reservoir in the center of the basin, where water backed up from

the Kayanga River would be contained by a dike 48 km. long and requiring earthworks of 3.5 million cubic meters ;

(2) a dam of 80.000 cubic meters at the lower end of the Anambe River, that could stop the flow of water in either direction as desired, thus retaining water for irrigation but avoiding excessive flooding from the Kayanga. This dam would be supplemented by pumping stations to evacuate excessive flood water from the Kayanga, should floods be insufficient to fill the central reservoir ;

and (3) a series of dikes of 2 meters/height around the shallow upper valleys (thalwegs) creating storage basins for irrigation water.

The following difficulties are evident in this proposal :

(1) The proposed storage of 188.000.000 cubic meters of water would not be sufficient to irrigate the proposed 32.000 hectares of rice.

(2) The depth of water in the central reservoir would average about 2 meters. Considering the Pan Evaporation rate of 2,425 mm (proposed by GERCA 1962), virtually all stored water would be lost by evaporation. Supposing a little shallow water remained, the designing of pump station inlet works for such minimal heads would be difficult.

(3)The storage basins in the upper valleys have a design depth of 1.5 meter. Considering the permeability of the soils in the upper part of the basin, losses to infiltration and evaporation would leave little or no water for irrigation.

(4) The permanent flooding of the central zone of the basin



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would prevent the use of at least 5,000 ha. of the prime agricultural land. Although this land is at present undulating and hummocky, laboratory analysis shows this region to have the highest potential productivity of any soils in the basin.

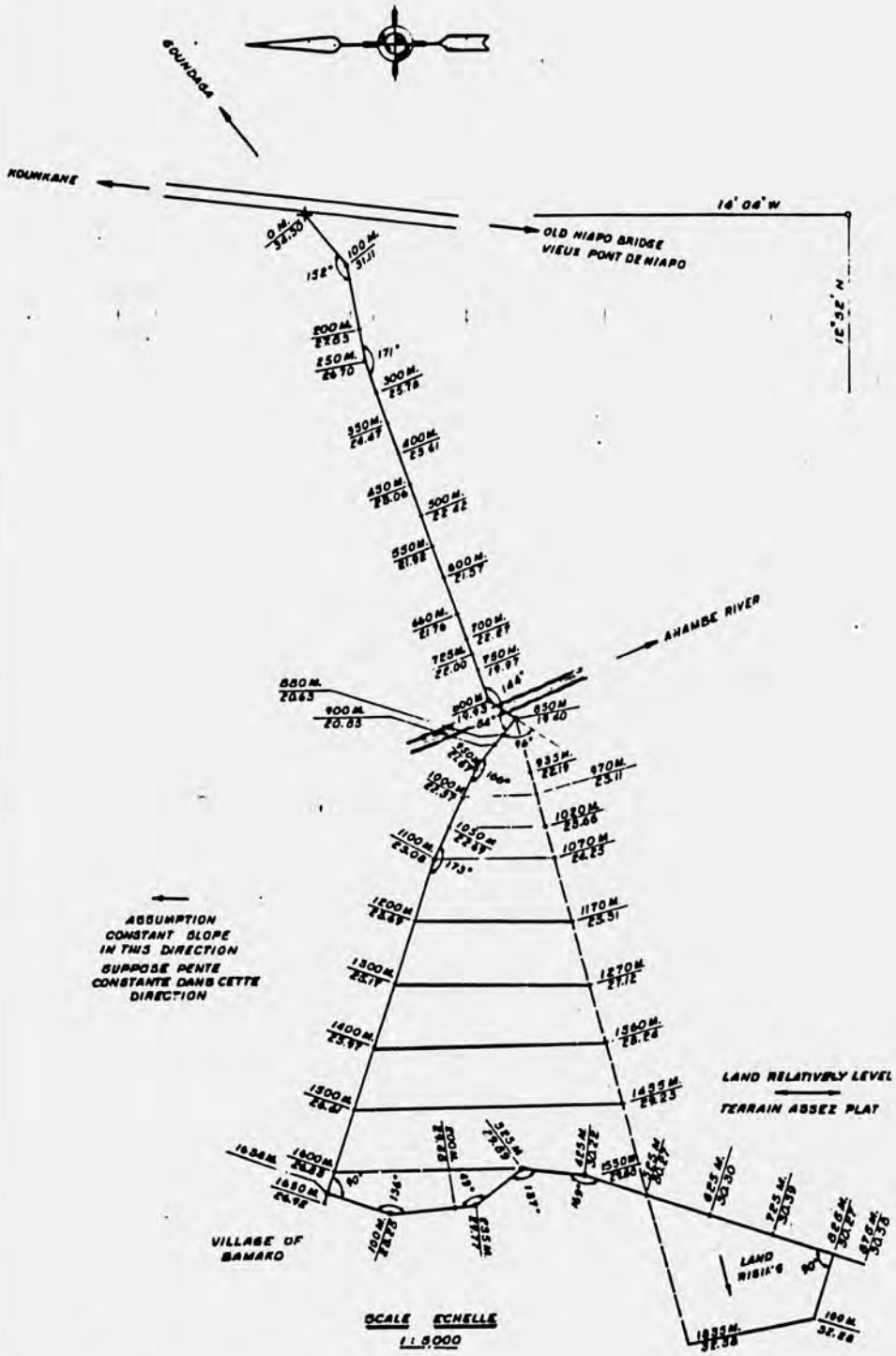
In summary, insufficient water would be available for irrigation, and the best lands would remain unused.

9.1.2. A Double Ended Dam On The Anambe Valley.

In the attempted overall design concepts, aimed to reduce evaporation losses to a minimum, conserve available water and to make the maximum amount of good agricultural land available to the SENERIZ project, the possibility of a double ended dam on the Anambe Valley was considered. (It should be noted that the Anambe Valley is considered as the broad valley, 11 km long, which exits from the Anambe Basin to the South).

At the south end of the Anambe Valley, the most suitable dam site is the slight natural constriction between Goundaga on the east and Bamako on the west. (Figure 9.1.2.A.). This site was quite rightly proposed previously by both GERCA and SERDA , but at the north end no particular location seems favorable and thus the cross section at the northern limit of the valley was considered.

Such an impounded reservoir with a maximum normal storage level of 28 m would give 100 million $m^3$ of water (maximum) and using a




DATUM CU PROJECT
PROJECT GROUND LEVEL 18.00

| |
|---|
| NATURAL GROUND LEVEL M. COTE DU TERRAIN |
| ACCUMULATED DIST. M DISTANCE CUMULEE |

DATUM
PROJECT

| |
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| NATURA COT |
| ACCU DIS |

## NOTES

1) ALL ABSOLUTE POINT LEVEL VALUES ARE DEDUCED, & MAY NOT CORRESPOND TO ABSOLUTE I.G.N. VALUES, BUT ARE USED OWING TO THE LACK OF ANY BETTER INFORMATION.
2) A TWO-WAY LEVEL TRAVERSE WAS MADE & CHECKED EXTREMELY WELL : THUS ALL LEVEL DIFFERENCES ARE CORRECT.
3) THE UNBROKEN LINE SHOWS THE ACTUAL TRAVERSE LINE, WHICH IN GENERAL FOLLOWED THE TRACK.
THE BROKEN LINE SHOWS CALCULATED LEVELS ON THE REQUIRED TRAVERSE LINE.
4) RED & WHITE SURVEY STAKES LEFT IN PLACE AT 0, 100 M., 800 M. 850 M. 900 M. 1600 M. 1634 M. 1650 M. 1634 M + 625 M. 1634 M + 625 M. + 100 M.

## NOTES

1) EN RAISON DU MANQUE DE REPERES I.G.N., LES ALTITUDES ONT ETE MESUREES A PARTIR D'UN POINT PARTICULIER DONT L'ELEVATION AVAIT ETE DETERMINEE PAR GERCA AU COURS DE SES TRAVAUX TOPOGRAPHIQUES DE 1962.
2) LE PROFIL A ETE OBTENU PAR UN DOUBLE CHEMINEMENT.
3) LA LIGNE DOUBLE DONNE LA DIRECTION SUIVIE, NORMALEMENT, LONGEANT LE SENTIER. LA LIGNE POINTILLEE MONTRE DES COTES CALCULEES SUR LA LIGNE DE PROFIL DESIREE.
4) DES JALONS ROUGES ET BLANCS RESTENT EN PLACE A 0 M., 100 M., 800 M., 850 M., 900 M., 1600 M., 1634 M., 1650 M., 1634 M + 625 M., 1634 M. + 625 M + 100 M.

| NO | DESCRIPTION | DRAWN BY | APPD BY | DATE | NO | DESCRIPTION | DRAWN BY | APPD BY | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | 10 | | | | |
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REVISIONS

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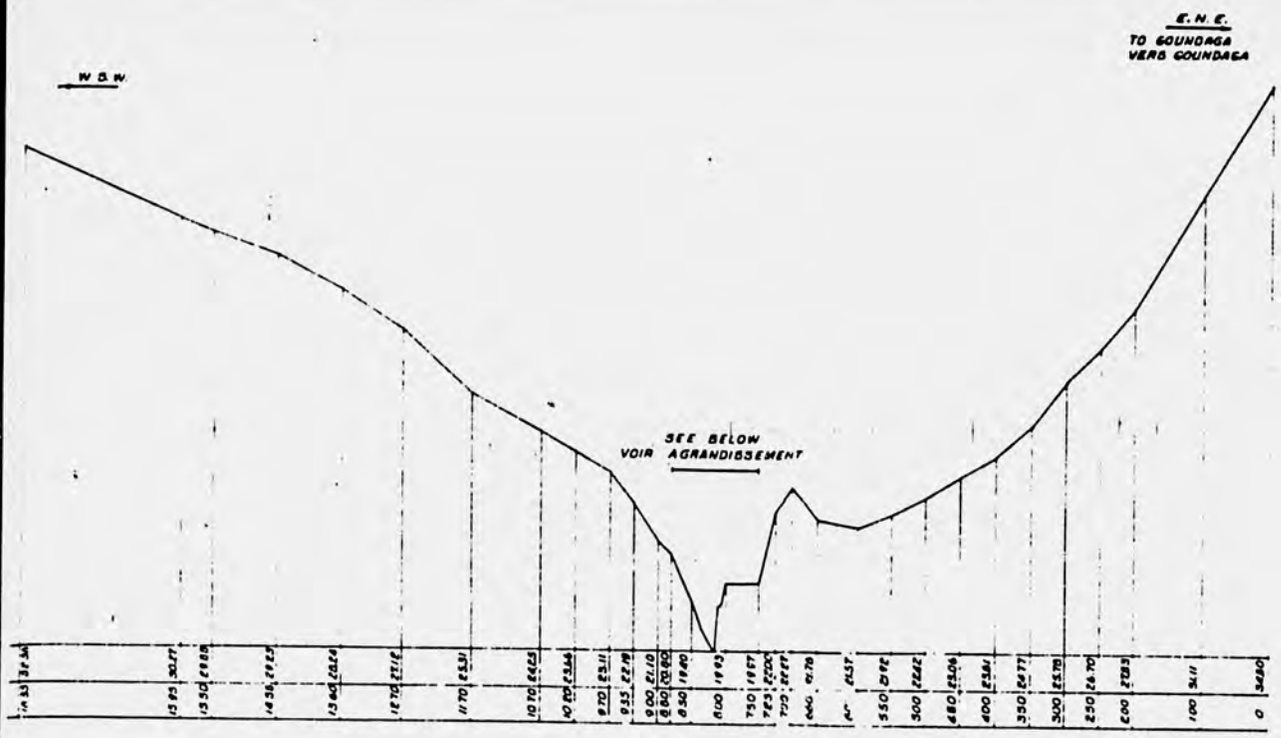
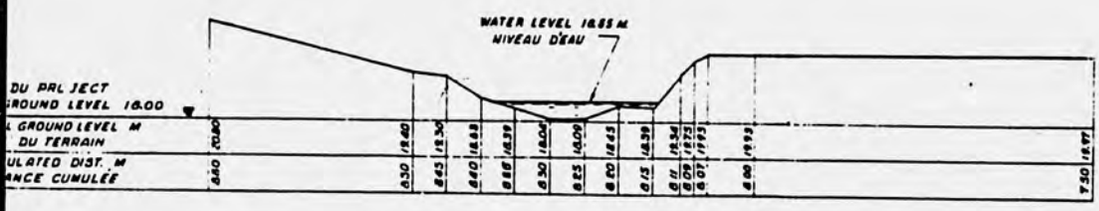



SCALE ECHELLE
HORIZOTAL 1:5000
VERTICAL 1:100

ENLARGEMENT OF VALLEY BOTTOM
AGRANDISSEMENT DU BAS FOND




SCALE ECHELLE
HORIZONTAL 1:500
VERTICAL 1:50

FIGURE - 9·1·2A

| | |
|---|---|
| PROJECT SENERIZ<br>PROJET SENERIZ | CROSS SECTION OF THE SOUTH END OF THE ANAMBE VALLEY.<br>PROFIL EN TRAVERS DE LA VALLEE DE LANAMBE (EXTREMITÉ SUD) |
| SODAGRI CONTRACTORS ENGINEERS CONSULTANTS | WEITZ HETTELSATER CORP.<br>Leadership in Agriculture & Nutrition<br>A Subsidiary of International Systems & Controls Corporation |

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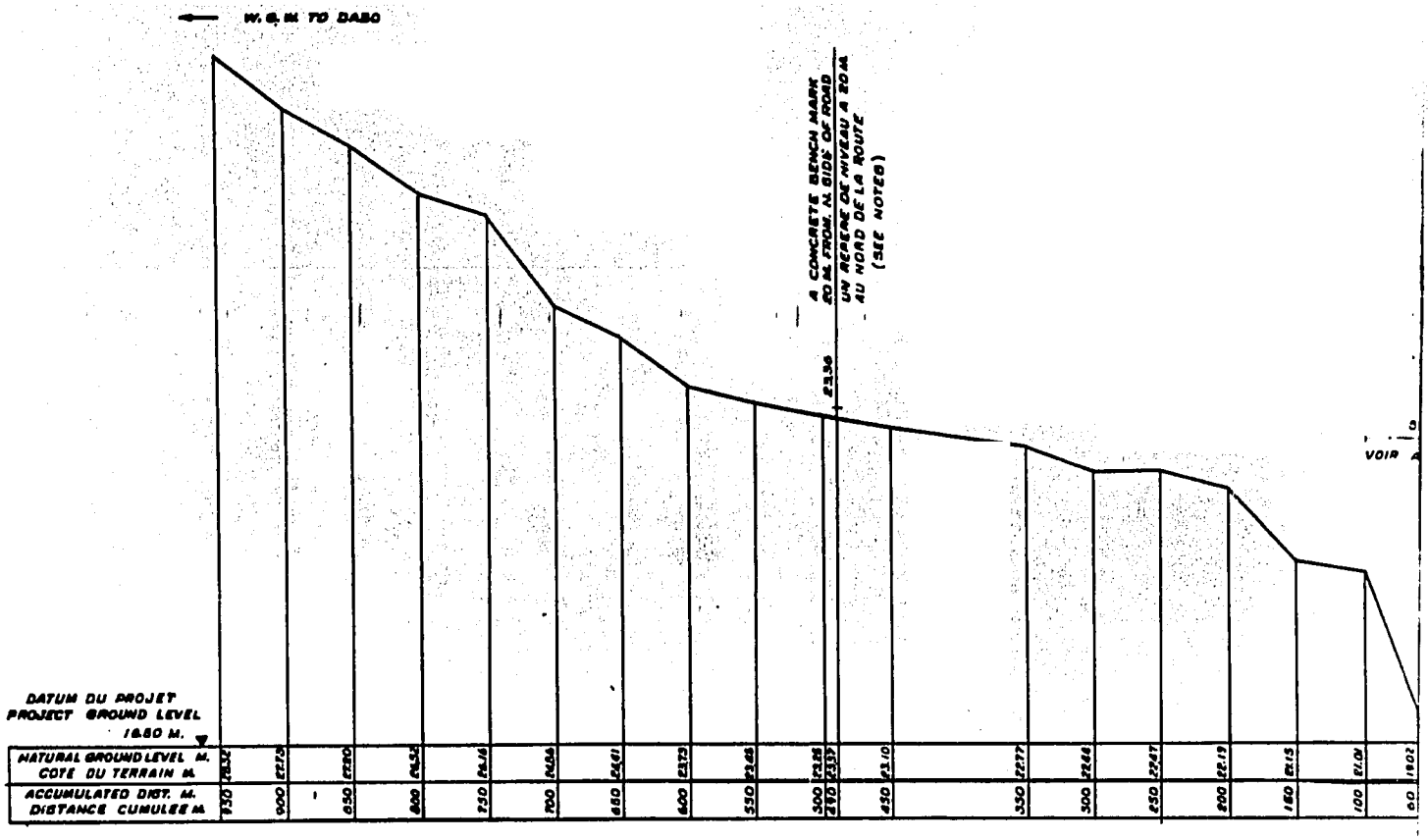


CALCULATE
PROFIL

SCALE
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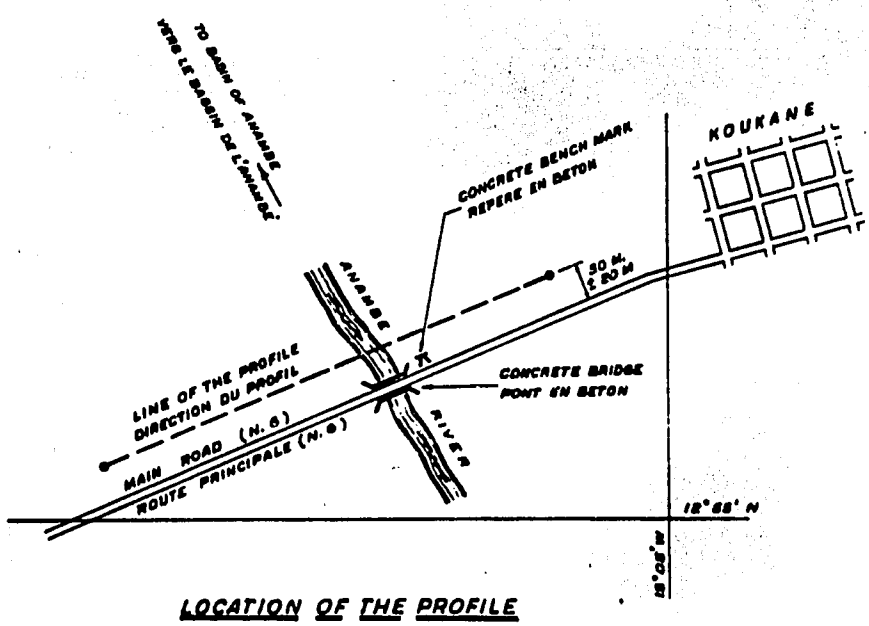
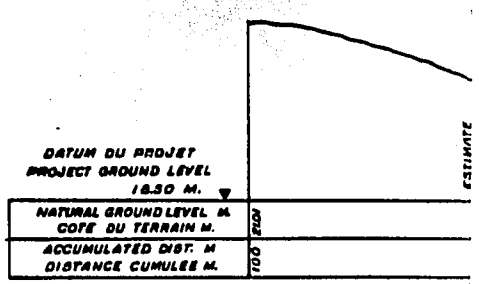
HORIZO

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**LOCATION OF THE PROFILE**
**EMPLACEMENT DU PROFIL**

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REVISIONS

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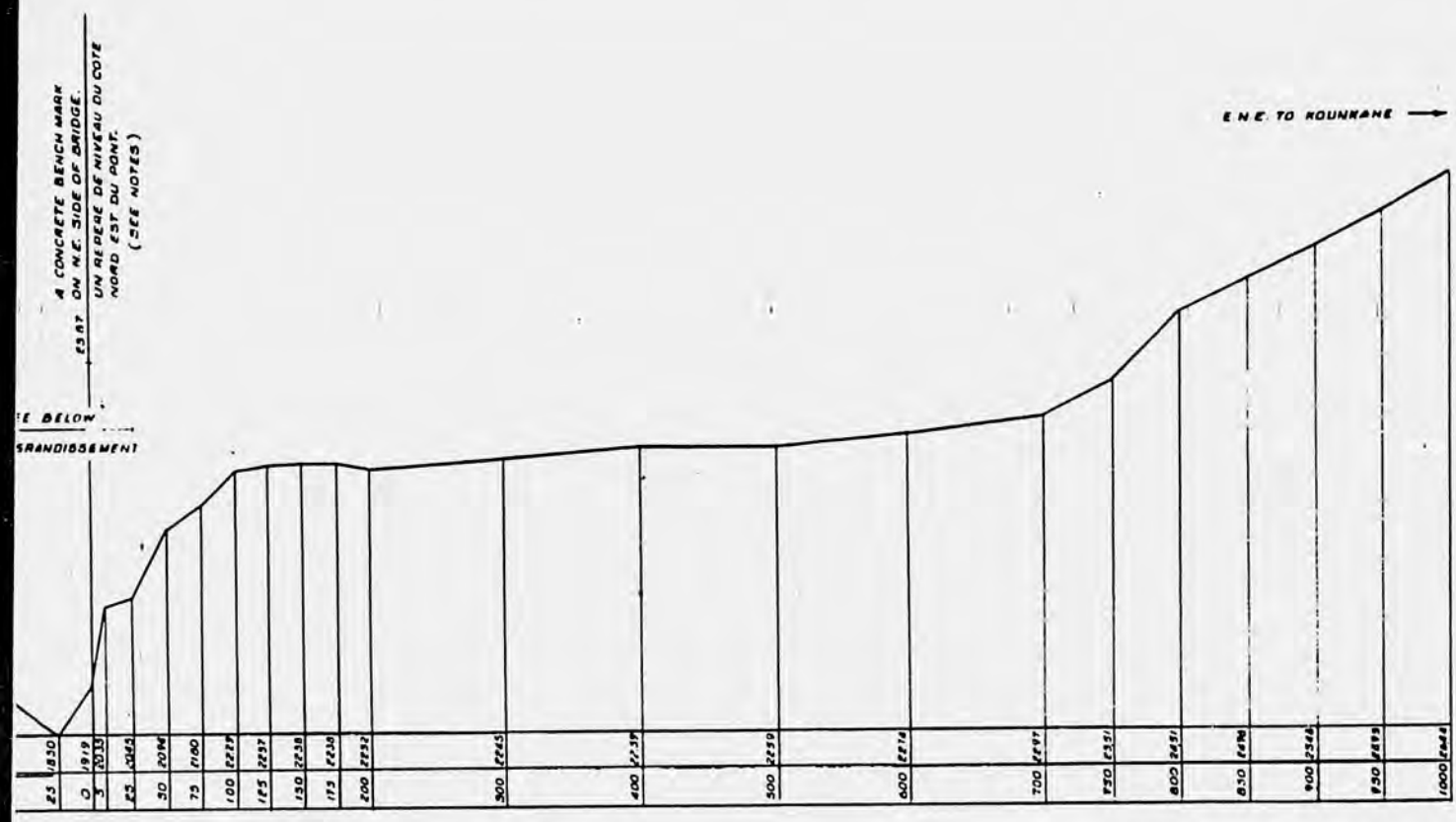


D PROFILE
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ECHELLE
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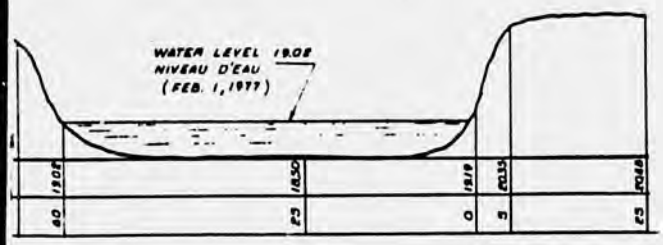
NOTES

1) PROJECT GROUND LEVEL A LEVEL DATUM DEDUCED FROM COMPARISONS WITH CROSS SECTIONS OF THE GERCA 1962 STUDY, USED OWING TO THE LACK OF I.G.N. BENCH MARKS
2) AT A FUTURE DATE THE BENCH MARK AT CHAINAGE 0 SHOULD BE TIED IN TO THE I.G.N. SYSTEM
3) A ONE-WAY TRAVERSE ONLY WAS MADE.
4) RED WHITE SURVEY STAKES WERE LEFT IN PLACE AT 0, 1000 E 950 W

NOTES

1) DATUM DU PROJET EN RAISON DU MANQUE DE REPERES I.G.N., LES ALTITUDES ONT ETE MESUREES A PARTIR D'UN POINT PARTICULIER DONT L'ELEVATION AVAIT ETE DETERMINEE PAR GERCA AU COURS DE SES TRAVAUX TOPOGRAPHIQUES DE 1962.
2) A L'AVENIR ON DOIT RATTACHER LE NIVELLEMENT AU SYSTEME I.G.N.
3) CE PROFIL A ETE OBTENU PAR UN SEUL CHEMINEMENT.
4) DES JALONS ROUGES ET BLANCS RESTENT EN PLACE A 0, 1,000 M A L'EST 950 M. A L'OUEST.




RGEMENT OF VALLEY BOTTOM
ANDISSEMENT DU BAS FOND

SCALE ECHELLE
VERTICAL 1:5000
HORIZONTAL 1:50

FIGURE - 9.1.2B

| | |
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| PROJECT SENERIZ<br>PROJET SENERIZ | CROSS SECTION OF THE NORTH END OF THE ANAMBE VALLEY<br>PROFIL EN TRAVERS DE LA VALLEE DE L'ANAMBE EXTREMITE NORD |
| SODAGRI CONTRACTORS ENGINEERS CONSULTANTS | WEITZ HETTELSATER CORP.<br>Leadership in Agriculture & Nutrition<br>A Subsidiary of International Systems & Controls Corporation |

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normal freeboard of 2 m to give dam crest heights of 30 m., would require earthworks of 320,000 $m^3$ at the southern end and 1 million $m^3$ at the northern end. If a detailed design were made, possibly the maximum total storage could be increased to 130 million $m^3$ by a reduction of normal freeboard, and without an increase in dam crest levels. In any case, the stored volume would not equal the total average run-off of the Anambe Basin, but the percentage of stored water lost by evaporation would be reduced compared to the previous scheme.

Another advantage would be the reduction in flooding of the central part of the Basin, and the liberation of the low lying lands for cultivation, assuming of course the installation of a drainage scheme in the basin.

The principal disadvantages would be the relatively small volume of storage, and the pumping necessary to drain the Anambe Basin and subsequently to fill the reservoir. These pumps would have to be capable of pumping 31 $m^3/s$ at an estimated 13 m head, giving power requirements of 4.15 M.W. Pumping of such magnitude during the wet season could hardly be justified economically in this situation.

It is possible that saving could be effected on initaal investment in hardware by careful selection of the pumps to perform the dual purpose of drainage and reservoir supply in the wet season and irrigation supply in the dry season. However, the annual operating cost would still remain high, and considering that no cheap source of power would be available in Senegal, impractical.

9.1.3. A Dam Downstream of the Confluence of the Anambe and Kayanga Rivers.

A dam on the Kayanga between Sintian Maoundé and Kountada would create a storage reservoir extending into both the Kayanga and Anambe Valleys. A great advantage of such a scheme would be the collection of the maximum amount of run-off, that is from both the Anambe and the Kayanga watersheds. In a normally wet year this could amount to 650 million $m^3$.

However, investigation of aerial photographs and available topographic maps indicate the lack of a suitable dam site. Any dam sited within 5 km of the Anambe-Kayanga confluence would necessarily be very long, principally because of the very gentle relief of the South bank.

The relatively shallow reservoir formed would have great evaporation losses, possibly negating the obvious advantages of the high storage potential.

The normal maximum storage level of the reservoir would exceed the ground level of the lower parts of the Anambe Basin. Thus, dam and pumping facilities, with all the disadvantages as discussed in the previous section, at the north end of the Anambe Valley would be necessary. Thus, the combination of technical difficulties makes this scheme impractical.

### 9.1.4. Deep Ground Water Development.

In most parts of Senegal, wells tapping the phreatic water table are commom. However, yields are very low being generally adequate only for domestic water use and for animal drinking supplies.

Deep water bored wells have been developed in many parts of Senegal, the most productive deep ground water aquifer being the sands of the Maestrichtien beds. It is noteworthy that in some more recent cases, shallower deposits have given sufficient capacity.

General experience in Senegal has shown that an average deep well, possibly up to 300 m deep, may yield 100 $m^3$/hr. When one considers the cost of such wells and the number of wells which would be required to produce comparable amounts of water to that which could be obtained by reservoir storage, it appears most unlikely that the total water needs of the SENERIZ Project could be supplied economically from this source.

However, in the absence of detailed data on deep bored wells in the Anambe Basin, specialist help should be secured and exploratory deep wells drilled, and the exact potential observed.

### 9.1.5. A Development Program Involving no Major Investments in Facilities.

Significant increases in yields of agricultural crops can be obtained from application of improved farming techniques, such as better

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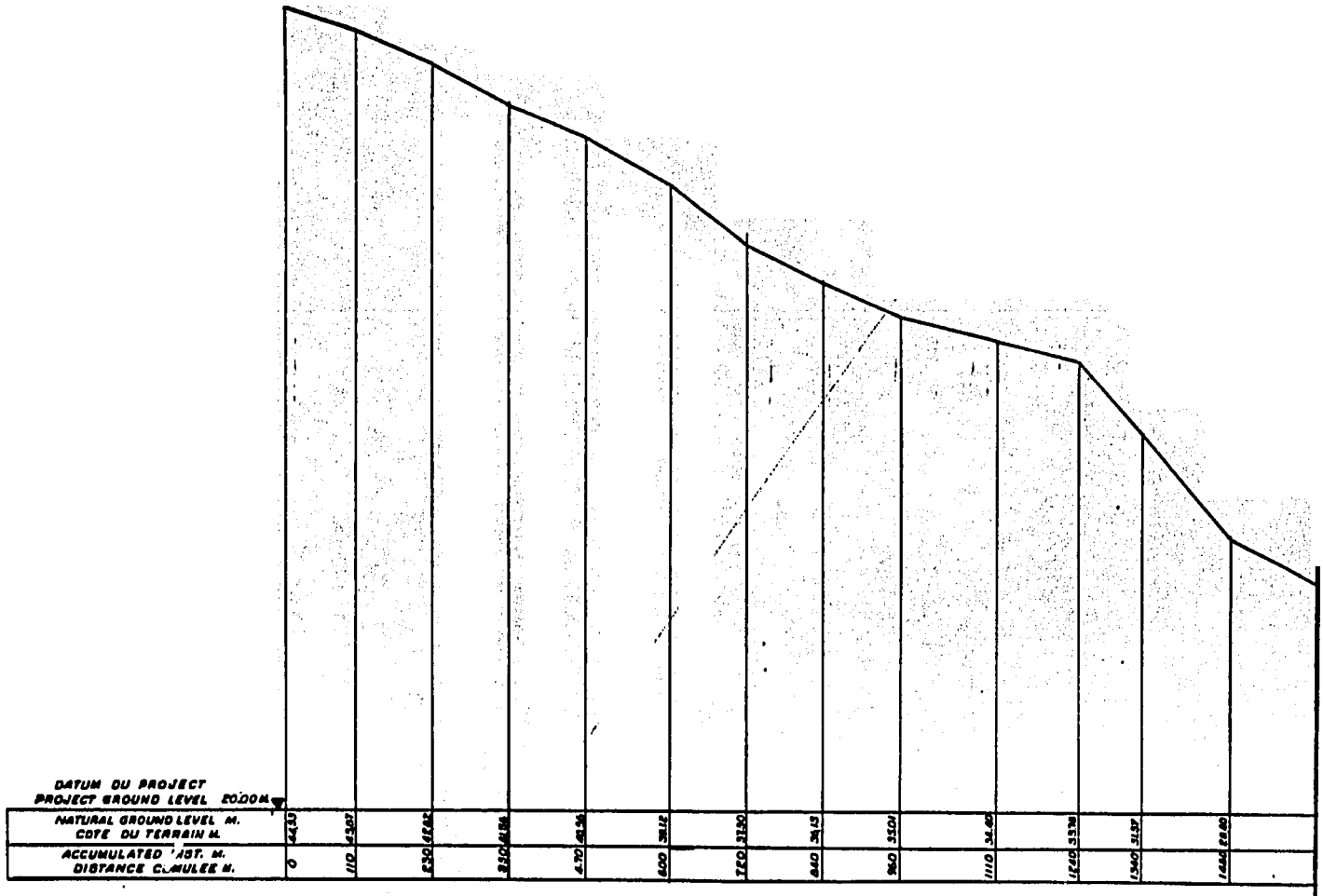


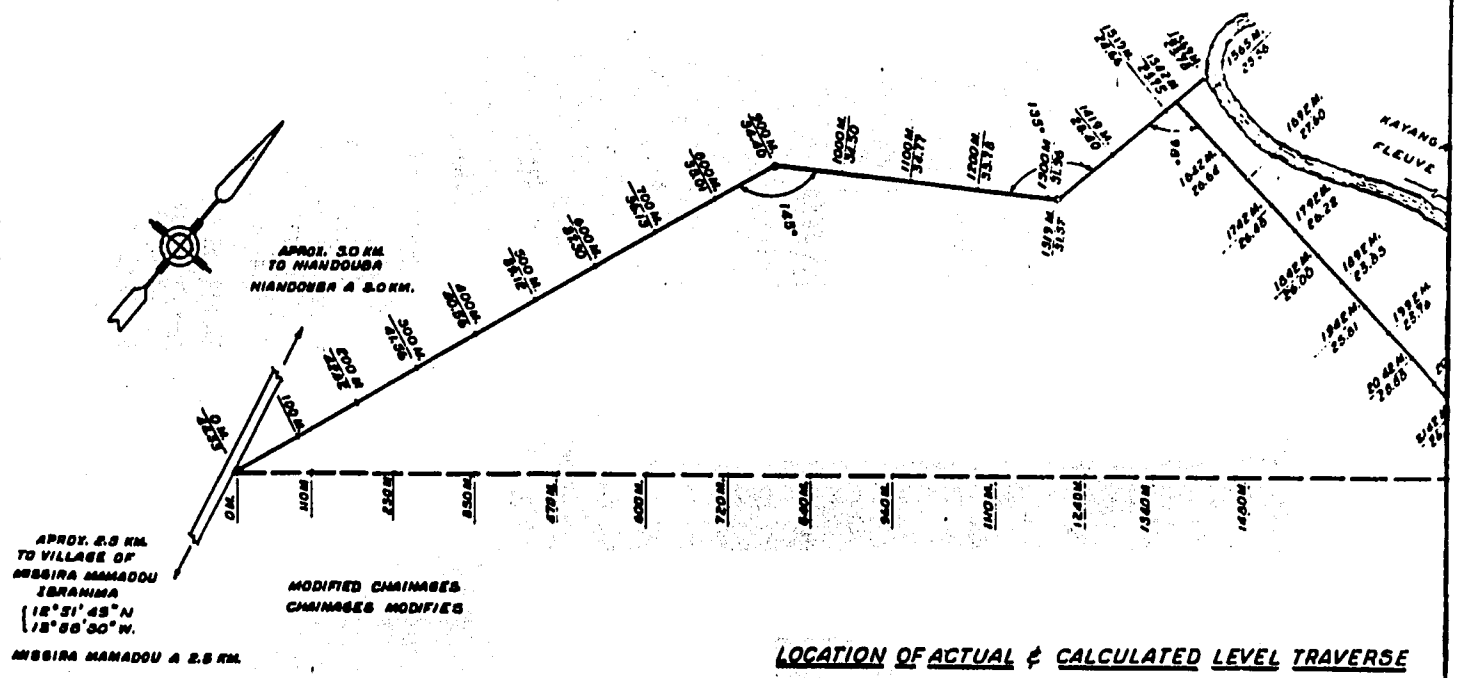


**LOCATION OF ACTUAL & CALCULATED LEVEL TRAVERSE**
**EMPLACEMENT DU PROFIL REEL ET CALCULE**

SCALE ECHELLE
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REVISIONS

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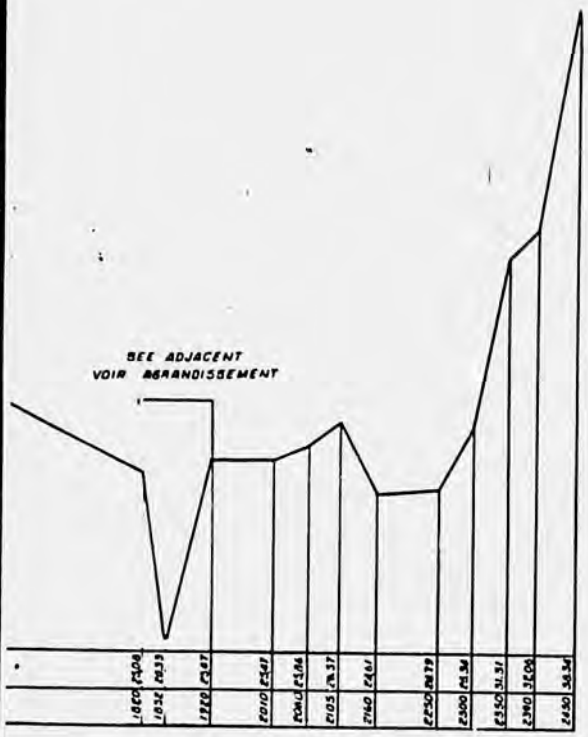
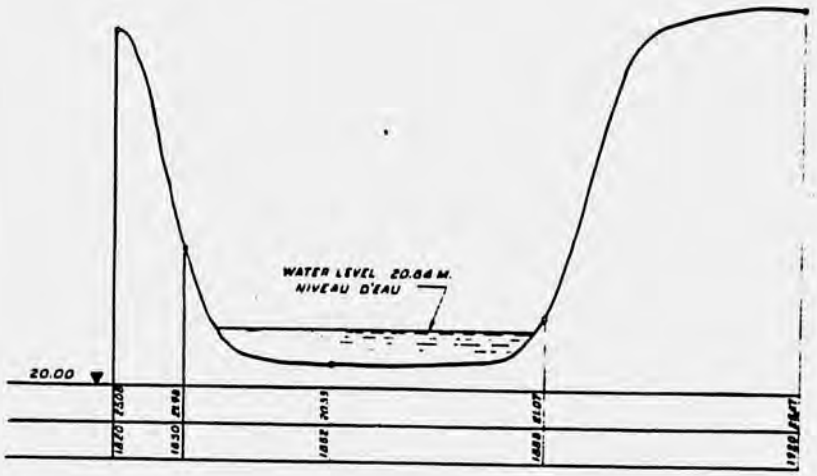


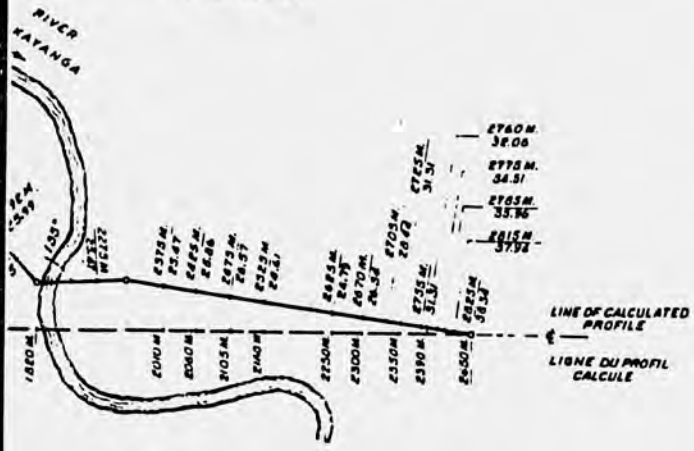

## CALCULATED PROFILE
## PROFIL CALCULE

SCALE ECHELLE
VERTICAL 1:30000
HORIZONTAL 1:50




## ENLARGEMENT OF VALLEY BOTTOM
## AGRANDISSEMENT DU BAS FOND

SCALE ECHELLE
VERTICAL 1:3000
HORIZONTAL 1:50




### NOTES

1) PROJECT GROUND LEVEL. A LEVEL DATUM DEDUCED FROM COMPARISONS WITH CROSS SECTIONS OF GERCA 62 STUDY, USED OWING TO LACK OF IGN BENCH MARKS.
2) THIS PROFILE WAS PRODUCED WITH ONLY A ONE WAY LEVEL TRAVERSE.
3) FROM 0 M. TO 1820 M., LEVELS ON ℄ OF CALCULATED PROFILE WERE DEDUCED.
4) RED & WHITE SURVEY STAKES WERE LEFT IN PLACE AT ALL CHAINAGES ON ACTUAL LINE.

### NOTES

1) DATUM DU PROJET: EN RAISON DU MANQUE DE REPERES IGN, LES ALTITUDES ONT ETE MESUREES A PARTIR D'UN POINT PARTICULIER DONT L'ELEVATION AVAIT ETE DETERMINEE PAR GERCA AU COURS DE SES TRAVAUX TOPOGRAPHIQUES DE 1962
2) CE PROFIL A ETE OBTENU PAR UN SEUL CHEMINEMENT.
3) DE 0 M. A 1820 M, LES COTES DE LA LIGNE MEDIANE ONT ETE CALCULEES INDIRECTEMENT.
4) DES JALONS ROUGES ET BLANCS RESTENT EN PLACE LE LONG DU CHEMINEMENT.

FIGURE- 9.2.1A

| | |
|---|---|
| PROJECT SENERIZ<br>PROJET SENERIZ | CROSS SECTION OF KAYANGA RIVER VALLEY AT 12°53'30" N, 13°57'30" W.<br>PROFIL EN TRAVERS DE LA VALLEE DE KAYANGA A 12°53'30" N, 13°57'30" W. |
| SODAGRI CONTRACTORS ENGINEERS CONSULTANTS | WEITZ HETTELSATER CORP.<br>Leadership in Agriculture & Nutrition<br>A Subsidiary of International Systems & Controls Corporation |

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REPRODUCTION IS PROHIBITED

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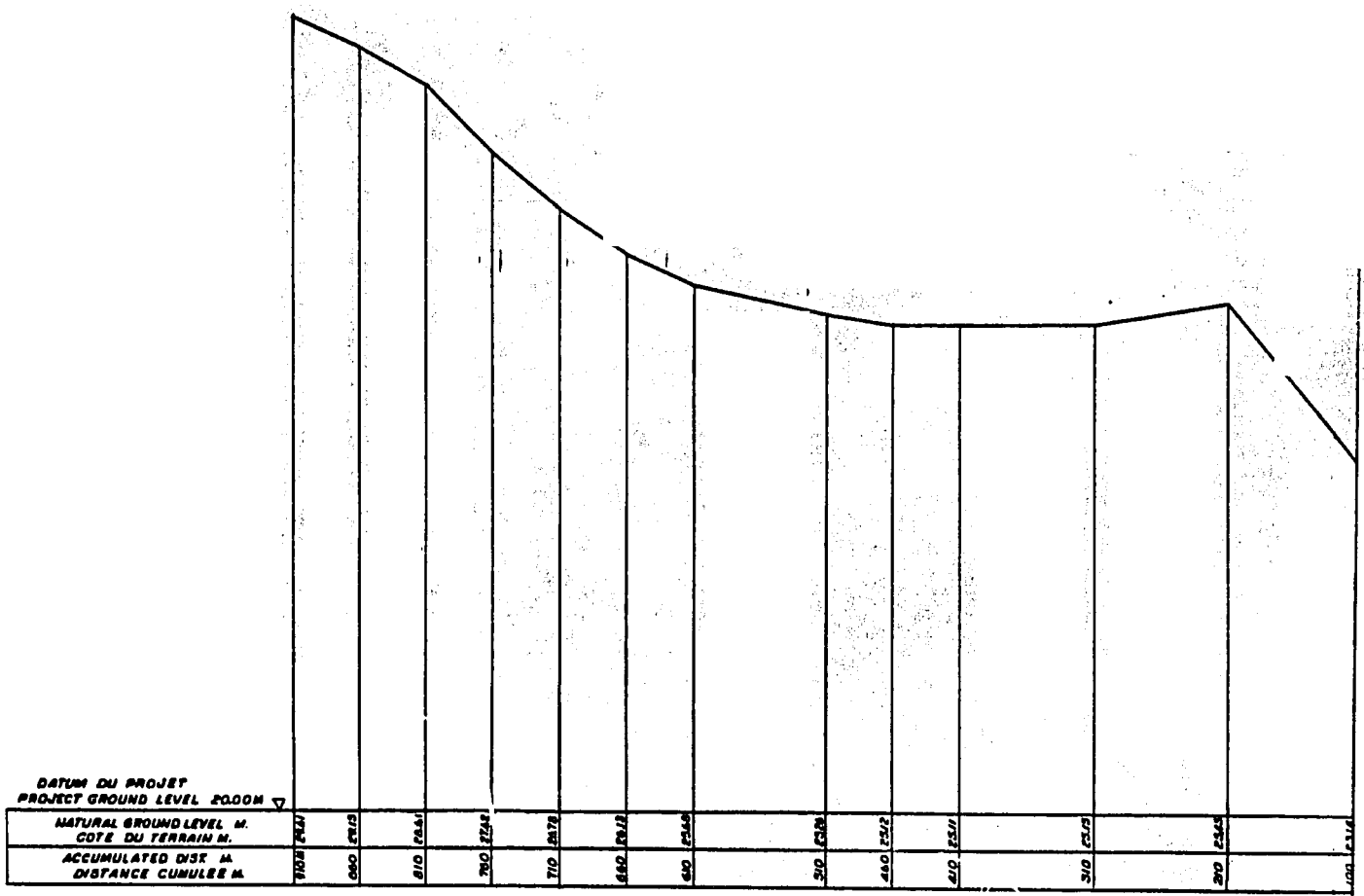
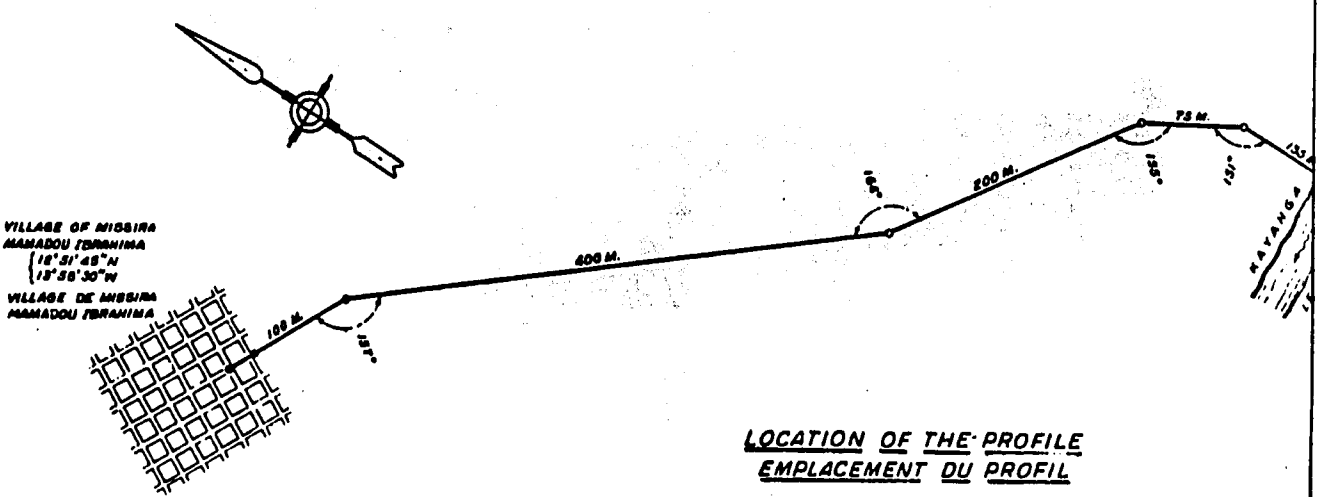



## CALCULATED PROFILE
## PROFIL CALCULE

SCALE ECHELLE
VERTICAL 1:2500
HORIZONTAL 1:80




## LOCATION OF THE PROFILE
## EMPLACEMENT DU PROFIL

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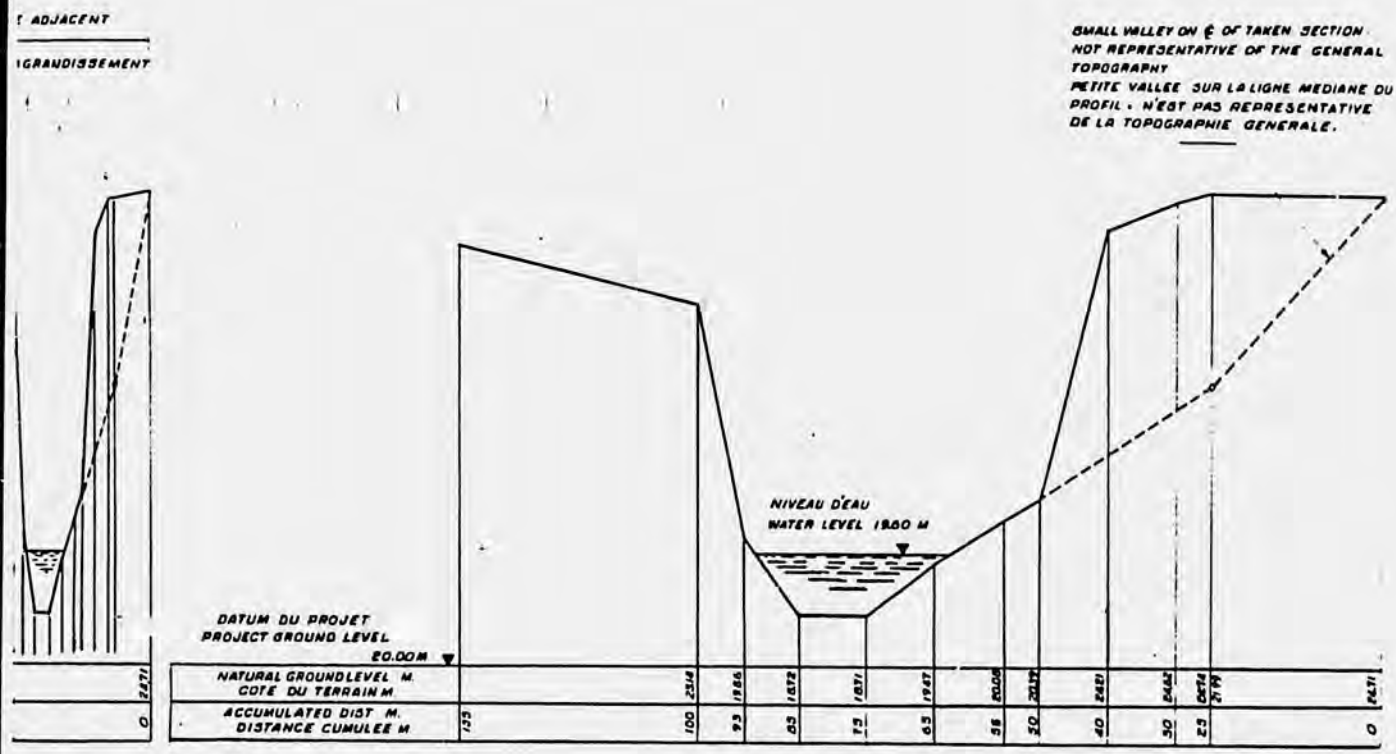


## ENLARGEMENT OF VALLEY BOTTOM
## AGRANDISSEMENT DU BAS FOND

SCALE ECHELLE

VERTICAL 1:3000
HORIZONTAL 1:50

— DRY SEASON WOODEN BRIDGE
PONT LOCAL EN BOIS IMPASSABLE A L'HIVERNAGE.

CONCRETE BENCH MARK I.G.N. VALUE UNKNOWN
REPERE DE NIVEAU EN BETON

### NOTES

1) PROJECT GROUND LEVEL : A LEVEL DATUM DEDUCED FROM COMPARISONS WITH CROSS SECTIONS OF THE GERCA GE STUDY, USED OWING TO THE LACK OF I.G.N. BENCH MARKS.
2) AT A FUTURE DATE, THE BENCH MARK AT CHAINAGE 0 SHOULD BE TIED IN TO THE I.G.N. SYSTEM.
3) A TWO WAY LEVEL TRAVERSE WAS MADE & ALL LEVEL DIFFERENCES ARE CORRECT.
4) RED & WHITE SURVEY STAKES WERE LEFT IN PLACE AT 0 M., 135 M., 610 M. & 910 M.

### NOTES

1) DATUM DU PROJET : EN RAISON DU MANQUE DE REPERES I.G.N., LES ALTITUDES ONT ETE MESUREES A PARTIR D'UN POINT PARTICULIER DONT L'ELEVATION AVAIT ETE DETERMINEE PAR GERCA AU COURS DE SES TRAVAUX TOPOGRAPHIQUES DE 1962.
2) A L'AVENIR ON DOIT RATTACHER LE NIVELLEMENT AU SYSTEME I.G.N
3) CE PROFIL A ETE OBTENU PAR UN DOUBLE CHEMINEMENT.
4) DES JALONS ROUGES ET BLANCS RESTENT EN PLACE A 0 M., 135 M., 610 M. ET 910 M

FIGURE - 2 - 2 - 18

| | |
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| PROJECT SENERIZ<br>PROJET SENERIZ | CROSS SECTION OF W HALF OF KAYANGA VALLEY AT VILLAGE OF MISSIRA MAMADOU IBRAHIMA.<br>PROFIL EN TRAVERS DE LA VALLEE DE LA KAYANGA A MISSIRA MAMADOU IBRAHIMA. |
| SODAGRI — CONTRACTORS ENGINEERS CONSULTANTS | WEITZ HETTELSATER CORP.<br>Leadership in Agriculture & Nutrition<br>A Subsidiary of International Systems & Controls Corporation |

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REPRODUCTION IS PROHIBITED

land preparation,use of fertilizer, improved crop varieties, etc. The "Green Revolution" has testified to the success of this approach in a number of countries. A program of teaching farmers better methods and helping them to use these methods could be proposed as an alternative development scheme.

The major objection to such a program in the Anambe Basin is simply that it doesn't go far enough, and fails to take advantage of existing opportunities or to use available resources to the limit of their potential. In addition, a program of encadrement requires an infrastructure which itself would be less than fully utilized by an agricultural program limited to the rainy season.

Thus, despite the desirability of a program of teaching and assisting farmers, a project design based solely on that concept, must be rejected simply because it leaves important resources idle or under-utilized. The basic problems of flooding in the wet season and lack of water in the dry season can only be resolved by major investments in a properly engineered drainage/storage/irrigation project.

## 9.2. SELECTED ENGINEERING SOLUTION.

The ideal solution must fill the following criteria : maximum availability and proper delivery of irrigation water ; drainage and flood protection of the Anambe Basin. The solution for project SENERIZ meets these criteria by construction of a dam and reservoir on the Kayanga upstream of the confluence with the Anambe, delivery of water

by pump and gravity flow to the basin, and installation of a drainage system in the Anambe basin. Profiles of the Kayanga Valley at 2 points are shown in Figures 9.2.1.A. and 9.2.1.B.

### 9.2.1. Maximum Storage of Run-off.

An earthfill dam on the Kayanga is proposed with a maximum normal water storage capacity of 388 million $m^3$ at an elevation of 38 m Allowing a normal freeboard of 2 m. gives a dam crest height of 40 m. The earthworks necessary for such a dam would be 1,51 million $m^3$, the maximum dam height being 15 m above the valley, 19 m above existing river bed level, crest length approximately 2.2 km., crest width 6 m., and provisional upstream and downstream slopes of 1 in 3. Useful storage capacity would be 240 million $m^3$.

The provisional site for this dam is at the natural constriction in the Kayanga Valley 2 km south of Niandouba.

### 9.2.2. Irrigation Supply.

Pumping stations would be installed just upstream of the dam, to feed into a concrete lined principal conveyor channel. This would be routed to the agricultural lands via a slight saddle to the W.N.W. of the dam, and then divide. The left hand channel would cross the north end of the Anambe Valley near Kabendou by aqueduct or probably syphon, whichever proved the cheaper, and then continue more or less on the



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contour and supplying to west side of the Anambe Basin. The right hand principal conveyor would supply the eastern side of the Anambe Basin.

It is anticipated that these two principal conveyor channels will be of the gravity flow type, but should detail topography or the distribution of the agricultural land impose restrictions, provision for intermediate pumping stations would be made.

A system of secondary and tertiary concrete lined canal will be provided ; total length of principal carriers being 46 km ; of secondary canals 47,5 km ; tertiary canals 166 km.

Future development of the Project might include commercial market gardening, in particular tomatoes. The use of double walled drip feed irrigation from a secondary low pressure system, supplied through pumps from the principal open flow gravity system, could be envisaged.

The maximum yearly total irrigation supply will be in the order of 240 million $m^3$. At this point in the discussion the question of the Sahelian Drought must again be raised. In a typical dry year since 1965 run-off figures for the Kayanga Basin were 120 million $m^3$. Allowing 2 m for evaporation and infiltration, the useful reservoir storage and hence the total irrigation supply would be 60 million $m^3$.

.../...

9.2.3. Drainage and Flood Protection in the Anambe Basin.

Any drainage system in a developing country which involves the use of pumps must be regarded suspiciously, from the economic viewpoint. SODAGRI proposes a drainage system that avoids the need for pumps.

The first step in draining the Anambe Basin, is to prevent its flooding. The dam on the Kayanga, by retaining all or most of the run-off, will avoid the floods that backed up into the Anambe and permit more orderly evacuation of run-off waters from the Anambe.

Considering the total retention of flow in a normal year in the Kayanga Valley upstream of the dam, flow in the Kayanga emanating from the watershed between the dam and the confluence of the Anambe and Kayanga would be 7.1 $m^3/s$, and flow from the Anambe Basin would be 31 $m^3/s$. A flow of 38 $m^3/s$ in the Kayanga downstream of the confluence with the Anambe would result in a probable water level of 21,9 m. As this would be a little higher than permissible, improved flow characteristics would have to be achieved both in the Kayanga Valley downstream from the confluence and in the Anambe Valley. This would be effected by removal of the trees and other flow impeding vegetation in the river beds, and in addition by grading of the Anambe Velley bed.

A collector drainage system would be constructed in the Anambe Basin by clearing and enlarging the existing natural drainage ways, and possibly by increasing the grade on the central drainage way.

If the latter step is necessary, a small dike would be essential at the south end of the Basin, equipped with a pumping unit to operate at very low head (3 m), but high volume (31 $m^3/s$). Detailed topography of the central basin will dictate the final design.

Additional detail on the dam and reservoir, the irrigation and water conveyance system, flood prevention and drainage is presented in subsequent chapters.

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# CHAPTER 10 / A PROGRAM OF DEVELOPMENT FOR THE ANAMBE BASIN.


10.0 INTRODUCTION.

10.1. STUDIES AND RESEARCH.
- 1.1. Meteorology.
- 1.2. Hydrology.
- 1.3. Exploratory Deep Wells.
- 1.4. Tenure and Land Use Survey.
- 1.5. Soil Surveys.
- 1.6. Agronomic Studies.

10.2. CIVIL ENGINEERING WORKS.
- 2.1. Topographical Mapping.
- 2.2. Geological Study.
- 2.3. Dam and Reservoir Design and Construction.
- 2.4. Irrigation and Drainage System Design and Construction.
- 2.5. Design and Construction of Roads.

10.3. LAND DEVELOPMENT AND CULTIVATION.
- 3.1. General Characteristics.
- 3.2. Establishment and Expansion.
- 3.3. Intensification.
- 3.4. Livestock.

10.4. AGRO-INDUSTRIAL COMPLEX.
- 4.1. Headquarters Unit.
- 4.2. Cereals Center.
- 4.3. Seed Plant.
- 4.4. Rice Mill.
- 4.5. Feed Plant.

10.5. TEACHING AND ASSISTANCE PROGRAM.
- 5.1. Nature of the Program.
- 5.2. Growth and Impact on Crops.
- 5.3. Livestock.
- 5.4. Health.
- 5.5. Summary of Personnel and Costs.

10.6. BUILDING TOWARD SENEGALIZATION.
- 6.1. In-service Training.
- 6.2. Training Not at the Site.
- 6.3. Senegalization.

# CHAPTER 10 : A PROGRAM OF DEVELOPMENT FOR THE ANAMBE BASIN.

## 10.0 INTRODUCTION.

A program of development for the Anambé Basin is proposed in this report. The program proposed is more than an engineering plan for management of water resources, and it aims for the attainment of broader objectives than merely the production of cereals. SODAGRI envisions the development of agriculture in the Anambé basin under both small, family operated farms and large mechanized farms or agricultural complexes. New crops and new cultural methods will be introduced. Irrigation, expansion of the area under cultivation, and use of modern technology will significantly increase agricultural production. After-harvest storage and processing of cereals will be assured. Livestock production will be increased. Opportunities for employment will be made available to local people. Communications and contact both within the Anambé basin and with the "outside world" will be expanded. The project will result in significant improvement in the levels of living and of health of the local inhabitants.

In recognition of the probability that funds for the implementation of this project will become availably incremently (i.e. in steps), and that the confidence to undertake and continue the proposed program will be a function of observed successes or progress, the program is designed so that it can be implemented in phases.

The three phases of the development program are natural divisions in its implementation : preparation, contruction, and use, for example, or establishment, expansion, and intensification. These phases are not rigid divisions, and overlap will naturally occur between the end of one phase and the beginning of the next. For convenience in scheduling,

a uniform period of two years per phase is assumed.

The first phase can be implemented without delay. As soon as the funds are available, the several components of Phase One can be undertaken. This phase will yield information, conserve resources, and train personnel, thus providing a solid foundation for the later phases of the project. At the same time it will begin exploitation of agricultural resources in a manner consistent with available information.

The basic components of the first phase are threefold :

1) The building of a foundation for sophisticated agricultural and engineering works, through studies in the fields of meteorology, hydrology, land tenure, soils, and agronomy.

2) Civil engineering studies of topography and geology, and design of a dam and reservoir, an irrigation and drainage system, and a roads network serving the Anambé Basin.

3) Establishment of an agricultural productions complex to exploit under-utilized agricultural resources, with the nucleus of an agro-industrial complex, and

4) A training program to prepare Senegalese nationals for technical and administrative posts in the project.

The second phase follows naturally after the first phase, beginning a program of construction and initiating new programs of resource use based on the information sought in the first phase, and expanding the exploitation of agricultural resources as justified by experience.

In the second phase, the basic components are as follows :

1) Construction of a dam on the Kayanga river making a reservoir to store irrigation water.

2) Construction of an irrigation system and drainage

to permit more intensive use of the most productive soils of the basin.

3) Construction of a network of roads in the Anambé Basin.

4) Expansion of the agricultural production complex, with development and cultivation of additional land.

5) Continued development of the agro-industrial complex, with addition of of facilities for milling rice and preparing livestock feed.

The third phase adds a new dimension to development of the basin, with irrigation of crops using water from the reservoir, intensification as well as expansion of the agriculture of the region, and greater benefits for local residents in the form of social and health programs.

The third phase of the development program includes these components :

1) Accelerated development of the land resources of the central Anambé Basin, as a result of flood protection and availability of irrigation water.

2) Intensification of the production of the mechanized farm, with higher value crops and with livestock.

3) Senegalization of the project, including the top-level administrative posts and all technicians.

Each of these three phases represents a set of more or less simultaneous events. These events, considered in their normal time sequence, make up programs of action. These programs will be described, component by component, in the following sections.

## 10.1. STUDIES AND RESEARCH.

The design of the program for the development of the

Anambé basin was hampered and limited by the relative lack of dependable data on meteorology, surface and ground hydrology, soils, and agronomic data on crops exotic to the region. The first order of business for the project, therefore, is to upgrade the available basic information, in order to be able to utilize that information base in design of civil engineering and agricultural works.

10.1.1. Meteorology Studies.

A vital component of the proposed first stage development program for immediate implementation would be the establishment of first-class weather stations in Vélingara and Kounkandé. The magnitude of the proposed investment, and the prospects for eventual expansion, fully justifies this action. Future refinements to the irrigation and drainage network operations, pumping requirements and dam storage release schedules, and adjustments to crop selections and rotations require an improved knowledge of the basin's present temperature regime, pan evaporation, wind pattern and relative humidity, and changes thereto following development. Permanent rainfall gauges should also be installed at three sites in the catchment area above the Kayanga damsite; suggested locations are at Vélingara Pakane, Patin Kounka, and Linkiring.

These weather stations and rainfall gauges may eventually be incorporated in the network of existing stations, but their original installation and operation should be undertaken as a part of the Anambé Development Project.

Installation will cost 450,000 francs CFA, and operation will cost 1,500,000 francs CFA per year.

10.1.2. Hydrology Studies.

Of equal importance would be an expanded program of hydrologic investigations and measurements. ORSTOM has permanent automatic stream gauge recorders at the Niapo Bridge and at the new bridge over the Kayanga on the Kabendou-Wassadou road (which stations are respectively upstream and downstream from the confluence with the Anambé) and on the Anambé River at the bridge on the Kounkandé-Dabo road. These stations will yield invaluable information on runoffs and provide firm data for refining dam designs and calculating reservoir operation curves. In addition to these new stations, a temporary staff gauge upstream from the Niapo Bridge at the proposed dam site on the Kayanga should be installed immediately, to accumulate as much short-term data as possible at that location prior to beginning construction.

Installation of some of these gauges has been done by ORSTOM, before the implementation of the project SENERIZ. The cost of the remaining gauges is estimated at 700,000 CFA, with maintenance and operation costs of 900,000 CFA per year.

10.1.3. Exploratory Deep Wells.

An inventory of subterranean water resources will be undertaken, by drilling two small-bore holes in the basin. These test wells will be so distributed in the basin, and drilled to such depth (400 meters) as to permit full evaluation of the potential for supplying irrigation water in the Anambé Basin from the Continental Terminal or Maestrichtian or other aquifers. The drilling program and full pumping tests will be supervised and the results evaluated by a qualified hydrogeologist.

The cost of this work, as quoted by SASIF, will be 18,500,000 CFA for each well, subject to escalation. Two wells will cost 37 million francs.

These small-bore wells will subsequently be enlarged

and equipped in a fashion appropriate to the productivity of the aquifers tapped. Assuming that aquifers lying no more than 300 meters deep are found to yield 100 $m^3/h$, the cost for well enlargement, casing, and installation of pumps will be 40 millions francs CFA.

In addition, four other wells approximately 70 meters deep will be drilled. In essence, these will be commercial wells supplying water for the various tracts of the agricultural production complex, but tests will be made immediately after completion of the wells and before their commercial use. These wells will in this way contribute to the inventory of subterranean water resources, which will indicate the feasibility of using wells as the source of irrigation water over large areas of the Upper Casamance.

The drilling and lining of these four wells will cost 40 million francs, plus 36 million francs for pumps and installation, for a total of 76 million francs. The work should be completed within five months of its beginning.

All these wells will serve a role continuing beyond inventory. One or more of the wells will supply water for irrigation of crops produced by that complex. The widely-scattered spacing of the wells will provide irrigation water that will facilitate research on crop production on soils representing different parts of the basin, thus permitting refinement of the design of the irrigation system planned for the basin. Because of the importance of water in both infrastructure and irrigation, it is important that well drilling begin as soon as possible.

Upon implementation of the planned gravity-flow irrigation system using water from a reservoir, these wells will be pumped to provide supplementary water for delivery through the network of distribution canals.

Where convenient, such wells may also supply water for village water points or cattle watering stations.

10.1.4. Tenure and Land Use Survey.

The system of land tenure should be studied and the land ownership rights recorded. A cadastral survey using aerial photography would document claims to land which will become increasingly important as the potential value of the land is increased through development. Analysis of farm structure and scale will help to guide selection of participants in the Teaching and Assistance Program, and will establish a benchmark against which to measure change that may result from infusions of technology in the basin.

The study of tenure and land use is estimated to cost 25 million francs CFA.

10.1.5. Soil Surveys.

The existing soil survey is at less than reconnaissance level and only serves to indicate the relative location and extent of major soil associations and their principal characteristics. An irrigation development project of the magnitude proposed in this report requires, at the minimum, a semi-detailed soil survey identifying soils to the level of Grand Groups within the guidelines of the USDA 7th Approximation Classification System. These semi-detailed and detailed soil surveys are indispensible for the final selection of the recommended crop patterns, predicting future yields, sizing irrigation canals and calculating accurate irrigation requirements throughout the basin.

The final stage of soil mapping would be the preparation of irrigated land use capability classification maps and final land use zoning of the area commanded by the primary

irrigation system.

The survey and mapping of soils will be done under contract, probably by ISRA (Institut Sénégalais de Recherches Agronomiques) or by a private commercial firm. SODAGRI could, alternatively, recruit its own team of soils specialists, establish its own laboratory facilities, etc. Using the more favorable approach, it is estimated that the cost of the soils survey will be 35 million francs.

10.1.6. Agronomic Studies.

To correct the severe lack of practical research on a variety of crop production questions, a program of agricultural research should be undertaken, with sufficient facilities and resident staff to permit real progress. Among the questions to which well-researched answers should be sought on a priority basis are the suitability and the response of various crops to irrigation, the water requirements for irrigation of crops, and the optimal combination or sequence of crops, under local conditions and on the soils of the Anambé Basin.

Results of the research program, in combination with soils mapping and topographic surveys, will permit the identification of optimal cropping and land use patterns, thus permitting design of irrigations systems and leading to maximum efficiency and intensity of use of irrigation facilities.

The research activity will be carried out on the agricultural production complex to be established, and thus will use land already developed and mechanical equipment already available for agricultural use. Additional investment of 10 million francs for research will be required for offices, laboratories, and staff facilities. Annual operating expenses will be made up primarily of salaries and benefits of personnel, plus modest amounts for supplies and maintenance.

These annual expenses are estimated at 5.5 millions francs CFA.

## 10.2. CIVIL ENGINEERING WORKS.

Development of the Anambé Basin in an engineering sense means the construction of a dam and reservoir for flood control and irrigation, provision of an irrigation and drainage system, and construction of a network of roads. The program of gathering more information and improving the data base, described in sections 10.1.1. through 10.1.6. of this chapter, will permit detailed study, design and scheduling of construction and installation of these engineering works. The study and design constitute a first phase; the actual construction represents Phase Two, and use of the resulting facilities is the third phase.

### 10.2.1. Topographic Mapping.

Existing topographic maps are inadequate for detailed design of the irrigation and drainage infrastructure for the Anambé Basin.

For detailed layout of infrastructure, including penetration roads and irrigation and drainage networks, accurate base maps are required, at the 1:10,000 scale with 1 meter contour intervals. For the dam site, pump sites and along the route of principal canals and drains, maps at the 1:1000 scale with 0.50 meter contour intervals are needed.

New aerial photography and photogrammetry will provide the necessary accuracy of contours for most of the project area. Such work will be supplemented by ground survey to give the level of precision needed at the dam site and certain other locations, including the routes of canals and

principal roads. Total costs of topographic studies and mapping are estimated at 69,500,000 francs CFA.

10.2.2. Geological Study.

All sources of stone, sand, and construction fill are to be investigated. Sand and laterite fill are known to be available, but the availability of sound construction stone is to be thoroughly researched.

At the dam site, test holes should be made, and the engineering properties of the soils of the dam site determined, for both in situ and placed soils.

The geological study is estimated to require equipment costing 25 million francs, and to have personnel costs of 20 million francs, for a total cost of 45 million francs, or about one percent of dam cost.

10.2.3. Dam and Reservoir Design and Construction.

The annual flooding of the central basin has been estimated to inundate 7,500 hectares lying at an elevation lower than 24.5 meters during years of average precipitation. SODAGRI's estimate, based on soil types, indicates some 8,400 hectares of land subject to regular flooding. Some of the flood waters come from the Kayanga River, and most of the remaining flooding takes place because the flooded condition of the Kayanga prevents the normal drainage of the waters of the Anambé.

Flooding of the Anambé Basin will be drastically reduced by the construction of a dam on the Kayanga River. Holding back the flood waters of the Kayanga to fill the reservoir will prevent engorgement of the Kayanga channel below its confluence with the Anambé, permitting better

drainage and much less backing up of water in the Anambé valley. At the same time, the reservoir will store water for irrigation during the dry season. Since the capacity of the reservoir will be less than the normal wet-season runoff of the watershed, the best available predictions of the streamflow must be utilized in management of the reservoir and of the level of water therein, in order to give the optimal combination of flood control and water storage.

Reduction of the volume of water carried by the Kayanga will prevent incursion of Kayanga waters into the Anambé, and will allow the waters of the Anambé to drain out rather than accumulate. As a result, the serious flooding that has long characterized the Anambé basin should be reduced to not more than 1100 hectares in most years. Thus, 7300 hectares of land formerly flooded each year will be available for use as cropland on a regular and dependable basis. Agricultural development and use of this land will be undertaken when it has been protected against floods.

Design of the dam and reservoir should begin in the second year of the project and construction should be planned for the third year. Costs of design and construction are estimated at 6 billion francs. Additional details concerning technical aspects of the dam and reservoir are presented in Chapter 11.

### 10.2.4. Irrigation and Drainage System Design and Construction.

A system of water conveyance and delivery will be designed that will utilize effectively the waters stored in the Kayanga reservoir for irrigation of the Anambé Basin. In general, the water will be conveyed from the reservoir by a concrete-lined main channel to a point near Kounkandé, from which point two channels will convey the water north to the eastern portion of the basin, and west to the western portion of the basin. The general features of this scheme

can be seen in Drawing 01.11.3.2. in Chapter 11.

A drainage system will also be designed to permit prompt drainage of floodwaters, and to facilitate avoidance of salt build-up in the areas of the basin that are to be irrigated.

Design and construction of the irrigation and drainage system will follow a schedule comparable to that of the dam and reservoir. Costs for the irrigation and drainage system are estimated at 4 billion francs.

10.2.5. Design and Construction of Roads.

The difficulty of access into the basin has been one of the obstacles to its development. This obstacle will be reduced by construction of a network of roads. Pending availability of soils and topographic data necessary for a detailed planning of roads (see section 10.2.1.) a network is suggested as illustrated in Figure 10.2.5. This network would provide for linking of the administrative centers for the seven rural communities to be established under the reform of 1978, and other strategically located villages. Construction of these roads would place all of the agriculturally usable land in the basin within about three kilometers of an improved road. The network of roads suggested would require approximately 150 kilometers of roads. The roads should in all cases pass outside of the villages, so as to avoid destruction of their African character.

The first stage of road development, after decisions on location and design to be taken in the first phase, should be construction of a reasonably straight and sloped roadway, with provision for drainage of water from the road surface itself and from the roadsides. This work can be done with earth moving machinery including bulldozers,

graders, and compacters. Surfacing of the roads with laterite (or gravel if it is available) will also be done, and this will necessitate a fleet of trucks and loaders. The basic intention of this road program is to establish for the basin a program of roads construction, and for the project a nucleus of road-building equipment that will construct as priority project the most important roads and will then continue to build new roads and to repair earlier-built roads as needed.

The roads could be constructed under contract. While only crude estimates can be provided before location is determined and design completed, the network would probably cost at least 300 million francs, if constructed under contract. SODAGRI's recommended program of establishing and equipping a road-building unit would cost 60 million francs in original investment, mostly roadbuilding equipment. Operations annually would cost 40 million francs CFA.

## 10.3. LAND DEVELOPMENT AND CULTIVATION.

Development and cultivation of agricultural land is central to the objectives of project SENERIZ; all the other components of the project are either contributory to or based on increasing the area and yield of agricultural crops. It is therefore appropriate to begin land development and cultivation as soon as possible, and to undertake cultivation under a variety of combinations of soils, water mastery, mechanization and project control.

### 10.3.1. General Characteristics.

SODAGRI's land development and cultivation will include the following features :

- clearing and levelling of the land to give a high level of efficiency in production.

- emphasis on using soils that the local peasants cannot use for crops.
- use of modern agronomic technology, to produce high yields.
- continual refining of technology, and development of better-adapted varieties and methods, through experimentation and research.
- exploration of exotic crops which may broaden agriculture's base.
- use of irrigation to improve yields and reduce risks.
- double culture, or year-round production, to the maximum extent of the availability of water.

Production of agricultural crops will be supported by and carried out with the aid of a "farm center" or headquarters unit, including offices, agricultural machinery and transport facilities, repair workshops, storage for supplies, etc. This installation will be discussed under the next section, the Agro-industrial Complex.

10.3.2. Establishment and Expansion of Area.

Initially, 1000 hectares will be demarcated for the agricultural production unit. Additional land will be added later. The schedule for development of "raw" land into cropland is shown in Table 10.3.2.A. In that table, as elsewhere in this report, the general terms "upland" and "lowland" are used to refer to specific soils groups. "Lowlands" are the soils of groups 6, 7, and 8, which have been regularly flooded and which can be properly developed only when flood protection is available. "Uplands" refers generally to any non-flooded land, but in this context it refers to land of soils groups 3, 4a, and 4b (see soils map, Chapter 4). All of the soil of these groups will be developed by the project, giving a total of 25,000 hectares

of land under control of the agricultural production unit. Of this area, a total of 17,000 hectares will be irrigated, 15,000 using reservoir water and 2,000 using local sources (see Table 10.3.2.B.).

Land development costs, apart from provision of irrigation water, buildings, and infrastructure, are estimated at 250,000 francs CFA per hectare. Costs of 6,250 million francs CFA, as shown in Table 10.3.2.A., will thus be incurred over the several years during which the land is being developed.

TABLE 10.3.2.A. Schedule for Development of Cropland, Anambé Basin (area in hectares).

| Land development by years : | PROJECT YEAR 1 | 2 | 3 | 4 | 5 | 6 | Total |
|---|---|---|---|---|---|---|---|
| Uplands : Soils 3, 4a, 4b | 1000 | 1600 | 3700 | 5700 | 4300 | 4300 | 20600 |
| Lowlands*: Soils 6, 7, 8. | - | 400 | 300 | 300 | 1700 | 1700 | 4400 |
| Total | 1000 | 2000 | 4000 | 6000 | 6000 | 6000 | 25000 |
| Accumulated land development: | | | | | | | |
| Uplands : Soils 3, 4a, 4b | 1000 | 2600 | 6300 | 12000 | 16300 | 20600 | 20600 |
| Lowlands : Soils 6, 7, 8. | - | 400 | 700 | 1000 | 2700 | 4400 | 4400 |
| Total | 1000 | 3000 | 7000 | 13000 | 19000 | 25000 | 25000 |
| Land development costs (millions of francs) : | 250 | 500 | 1000 | 1500 | 1500 | 1500 | 6260 |

* Major development of lowlands must await flood protection.

TABLE 10.3.2.B. Irrigated Land in the Anambé Basin.
(Area producing dry season crops).

| Soils group | Source of water | PROJECT YEAR 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Incremental development : | | | | | | | |
| 4b | Local* | 200 | 300 | 500 | 1000 | - | - |
| 4b | Reservoir | - | - | - | - | 6300 | 4300 |
| 6, 7, 8 | Reservoir | - | - | - | - | 2700 | 1700 |
| Cumulative area irrigable : | | | | | | | |
| Total : | | 200 | 500 | 1000 | 2000 | 11000 | 17000 |

* Local sources include drilled wells, dug wells, pits. and river water.

Soils mapping will identify the various soils groups or subgroups in the project farm, and pilot production plots will be laid out to determine the adaptability of the various soils to mechanized agriculture. Cereals will be emphasized in the cropping pattern, and a variety of agronomic practices will be tested for production of rice, sorghum, millet, and maize. Soybeans, wheat, and barley will be grown experimentally. In addition, forage crops will be tested.

The program of adaptive research will be aimed at any and all aspects of crop and livestock production that pose problems : tillage methods, fertilization practices, crop and variety selection, weed and pest control, harvesting methods, soil conservation, animal health, animals for draught or for meat or other purposes, or other topics.

Irrigation water will be available in limited quantities from the wells drilled in the exploratory program. Additional water may be pumped from streams or from

the shallow water table, using shallow wells or pits dug in the lowest areas of the basin. Using these sources of water, a limited area of counterseason crops can be grown. An exploratory program will investigate various crops including rice and other cereals, sugar cane and various vegetables including tomatoes, to determine their potential for emphasis when completion of the reservoir makes water available for irrigation on a commercial scale.

The exploratory program will include trials of crops for home use as well as for sale. If crops such as vegetables are found to be well-adapted, a program to popularize vegetable production for home use and sale will be developed. Carrying out such a program would be a task for the Teaching and Assistance (T and A) unit to be described in a later section.

It is estimated that an area of 1,000 hectares of floodplain can be incorporated in the production complex before completion of the dam and reservoir. This land will be used for production of cereal crops, principally rice, in the rainy season, using contour dikes to retain rainwater so that the effect of irrigation will be approximated. When irrigation water is made available to this area, production of rice and other cereals on a year-round basis will be undertaken. Testing of varieties of rice, fertilizer treatments, irrigation regimes and other alternative production practices will be an integral and continuing part of the program of the "Rice Branch" of the agro-industrial complex.

As agronomic practices for cereals production are found suitable for use on this farm, the area of each crop will be expanded to the limits established by feasible management, considering the seasonality of labor and machinery requirements, the economics of alternative crops, etc.

Planned areas of crops are shown in Table 10.3.2.C. It must be recognized that any crop raised the same year that the land is developed is likely to suffer from the effects of soil compaction, lack of timeliness, etc. associated with clearing, leveling, etc. of the land, resulting in lowered yield or even failure of the crop in the first year.

Because production of agricultural crops on the production complex will be according to modern technology, continuously refined and improved by applied research, the per-hectare yield of crops produced on this mechanized farm is expected to increase over time. Even initially, yields will be higher than what local peasants normally get, because of mechanized (and thus better) tillage and fuller use of modern technology. As problems of varieties, machinery adaptation, timing, etc. are resolved, the yield obtained will improve and approach maximum potential yields for the resources available. Table 10.3.2. D shows the projected yields by years. Programs of training and technical support for peanuts and cotton are already available through ONCAD and SODEFITEX. These crops, therefore, will not be accorded research or "encadrement" by SODAGRI.

10.3.3. Intensification Phase.

When the dam and reservoir are completed and in use, a very important expansion of area will be made in the agricultural production complex : the lowlands of the basin will be converted to cropland. However, that giant step made possible by flood protection will be dwarfed by the simulteneous increase in the intensity of cropping made possible through irrigation with reservoir water : double culture or year-round production will be possible on some 15,000 hectares, in addition to about 2000 already irrigated from local sources.

TABLE 10.3.2.C. Projected Area of Crops by Years.
(in hectares)

| | YEAR OF PROJECT 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| **Rice, uplands :** | | | | | | |
| Rainfed | 500 | 1500 | 3300 | 6300 | 1200 | 1500 |
| Irrigated | - | 300 | 600 | 1000 | 8000 | 10000 |
| Dry season | 200 | 300 | 500 | 1000 | 10000 | 12600 |
| **Rice, lowlands :** | | | | | | |
| Wet season | - | - | - | - | 2700 | 4400 |
| Dry season | - | 400 | 700 | 1000 | 2700 | 4400 |
| Subtotal, rice : | 700 | 2500 | 5100 | 9300 | 24600 | 32900 |
| **Sorghum :** | | | | | | |
| Rainfed | 150 | 300 | 1000 | 2000 | 3000 | 4000 |
| Irrigated | - | - | - | - | 2000 | - |
| **Millet :** | 100 | 100 | 300 | 600 | 1000 | 1000 |
| **Maize :** | | | | | | |
| Rainfed | 150 | 300 | 1000 | 2000 | 3000 | 4000 |
| Irrigated | - | - | - | - | 2000 | - |
| Research and experimental crops | 100 | 100 | 100 | 100 | 100 | 100 |
| Total, all crops | 1200 | 3300 | 7500 | 1400 | 35700 | 42000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Rainy season crops (ha.) | 1000 | 2600 | 6300 | 12000 | 19000 | 25000 |
| Dry season crops | 200 | 700 | 1200 | 2000 | 16700 | 17000 |
| Intesity of culture | 120% | 127% | 119% | 117% | 188% | 168% |
| Rice, % of total crops | 58% | 76% | 68% | 66% | 69% | 78% |

TABLE 10.3.2.D. Projected Yield of Crops on the Anambé Basin Agro-industrial Complex by Years.
(yield in tons per hectare)

| Crop | Pre-project year 0 | YEAR OF PROJECT 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Rice, rainfed (A) Soil group 4 | 1.0 | 1.8 | 1.9 | 2.0 | 2.1 | 2.2 | 2.2 |
| Rice, irrigated (B) : Soil group 4 | --- | 2.4 | 2.6 | 2.8 | 2.9 | 3.0 | 3.0* |
| Rice, irrigated (C) : Soil groups 6 and 7 | --- | 2.4 | 2.6 | 2.8 | 3.0 | 3.2 | 3.2* |
| Sorghum, rainfed | 1.0 | 1.4 | 1.9 | 2.3 | 2.6 | 2.8 | 3.0 |
| Sorghum, irrigated (dry season) | --- | 2.2 | 2.5 | 2.8 | 3.1 | 3.3 | 3.5 |
| Millet | 0.9 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 |
| Maize | 0.8 | 2.0 | 2.2 | 2.4 | 2.6 | 2.8 | 3.0 |

* Rice in counterseason : 0.1 ton higher yield.

.../...

TABLE 10.3.2.E. Production of Crops by years.
(in tons)

| | PROJECT YEAR 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Rice, uplands : | | | | | | |
| Rainfed | 900 | 2850 | 6600 | 13230 | 2640 | 3300 |
| Irrigated | - | 780 | 1680 | 2900 | 24000 | 30000 |
| Dry season | 500 | 810 | 1450 | 3000 | 31000 | 39086 |
| Rice, lowlands : | | | | | | |
| Wet season | - | - | - | - | 8640 | 14080 |
| Dry season | - | 1080 | 2030 | 3100 | 8910 | 14520 |
| Subtotal, rice : | 1400 | 5520 | 11760 | 22230 | 75190 | 100986 |
| Sorghum | | | | | | |
| Rainfed | 210 | 570 | 2300 | 5200 | 8400 | 12000 |
| Irrigated | - | - | - | - | 6200 | - |
| Millet | 100 | 120 | 420 | 960 | 1800 | 2000 |
| Maize : | | | | | | |
| Rainfed | 300 | 660 | 2400 | 5200 | 8400 | 12000 |
| Irrigated | - | - | - | - | 5600 | - |
| Total, all cereals | 2010 | 6870 | 16880 | 33590 | 105590 | 126986 |

.../...

While the concept of irrigation will be introduced to the basin as early as the first phase, using water from drilled wells, irrigation as a "way of life" and as a major factor in agricultural land management will begin only when water from the reservoir is available. From this time forward, the lack of water need no longer limit crop production activities in the areas of the project that are commanded by irrigation canals. Ploughing and seeding can be timed to take advantage of sunshine and warmth rather than being postponed until rain has softened the soil. Mid-season dry spells need no longer result in crop failure, or even in starting over with replanting the crop. Early cessation of rainfall need not result in poor filling of grains. Crops can be produced in the dry season, when, in fact, certain aspects of the climate are more favorable to high yields and profitable production than in the usual cropping season.

The effect of irrigation can be seen in multiple dimensions. The area of crops increases because of double culture. (see Table 10.3.3.) The yield of crops increases compared to rainfed crops because of avoidance of drought and because of high yields in the counterseason. (see Table 10.3.2.D.).Production of crops (see Table 10.3.2.E.) will increase drastically. The value of crops will eventually go up even more, as industrial crops possible only with irrigation become more important.

10.3.4. Livestock.

Livestock, particularly cattle, are important in the rural economy of the Anambé basin. SODAGRI's development of the basin will increase the importance of livestock.

Livestock projects will contribute to the intensification of production. Initially, oxen will be kept - even on this mechanized farm - so that research in

agricultural technology can be adapted to the needs of local farmers. An effort will be made to develop feeding programs that will support the needed draught cattle from the by-products of culture : maize and sorghum stalks, rice straw, etc. Forage crops in the rotation will be tested. Tests will be made on the growing of young cattle on special forage rations, and of fattening mature cattle on rations based on by-products (peanut vines and hulls, peanut and cotton-seed cake, molasses, etc.). Livestock projects found to be feasible and profitable in small-scale tests will be expanded up to the limit of available feed supplies and project capacity.

The most important livestock of the region being cattle of the N'Dama breed, the main focus of livestock projects in the agro-industrial complex will be cattle. The most important livestock projects are expected to be the growing of young cattle on forage, and the fattening of mature cattle on by-product feeds. Projected scale of these projects is shown in Table 10.3.4.

This table shows the total number of young cattle that could be fed on the forage expected to be available, and the number of mature cattle that could be fattened on by-product feeds. Targets are established at levels far below the maximum fixed by available feed supplies, to allow for diversion of a large proportion of such feed supplies to support of the local cattle population and livestock projects undertaken by local farmers.

A number of additional livestock possibilities suggest themselves, that will be tested on a pilot scale and replicated if found feasible : dairy cattle, for production of fresh milk for project employees; poultry fed on low-quality grain or by-products, for production of meat and eggs and for upgrading local poultry stock; rabbits,

TABLE 10.2.4. Maximum and Targeted Number of Cattle in Project Seneriz.

| | YEAR OF PROJECT 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| **Maximum Numbers :** | | | | | | |
| Growing calves | 280 | 875 | 2360 | 4850 | 14500 | 16200 |
| Feeder cattle | 86 | 340 | 727 | 1375 | 4600 | 6200 |
| **Targets :** | | | | | | |
| Growing calves | 100 | 500 | 1000 | 2000 | 5000 | 5000 |
| Feeder cattle | 50 | 100 | 500 | 1000 | 2000 | 5000 |
| **Projected costs for feed and labor (in thousands of francs CFA)** | 1800 | 7200 | 18000 | 36000 | 84000 | 120000 |

fed on by-products and forages, for production of meat.

Intensification through livestock will be supported and livestock expansion facilitated by a feed mell, which will prepare standardized livestock rations using locally available ingredients and industrial by-products. This feed mill will be established as a part of the agro-industrial complex.

Few costs of the livestock component will be identifiable as such, since the sought-for role of livestock is supplementary. However, some of the buildings and equipment and a portion of operating costs including manpower can be charged to livestock, and are so identified in the

costs of the project. Calves or feeder cattle for feeding or fattening and resale do not figure in expenses or revenue of the project except incrementally : the additional feed or labor cost, or the increase in value of the animal.

## 10.4. AGRO-INDUSTRIAL COMPLEX.

The agricultural production complex, which will begin as a mechanized farm having a headquarters unit, will expand and intensify and grow more complex. It will be useful to separate out the headquarters unit, which will also expand, intensify, and become more complicated.

In addition to the functions necessary for a center of operations (providing offices, housing, water and electricity, transportation, agricultural machinery, and self-maintenance) the farm headquarters will have a seed plant of 5 tons per hour capacity and an installation for receiving, drying, and storing 50,000 tons of cereal grains. These components of the program are described in some detail in an Annex. The operational nucleus of the farm will be enlarged as needed to accomodate additional machinery, more vehicles, more personnel, and vastly increased quantities of cereals. In addition, new functions will be added.

A rice mill will be installed, as a part of the complex. Initially processing only upland rice produced during the rainy season, the same rice mill is expected eventually to receive, treat, store, and prepare for sale in the Senegalese market rice raised under irrigation in both the rainy season and the counter-season. Its capacity will be 10 tons per hour. Deatils of the rice mill are also presented in an Annex.

A feed mill will be installed, to support feasible

livestock projects and to permit their expansion to commercial scale. This feed mill will permit large-scale production (5 tons per hour) of standardized rations for cattle, calves, poultry, and other animals, both for use by the projects of the complex and for sale to local farmers. Additional data on the feed mill is given in an Annex.

The industrial aspect of the agro-industrial complex may be intensified beyond the grain storage, rice processing, seed handling and preparation of livestock feeds already described. A tomato cannery and a sugar extraction plant may be added, depending on findings as to feasibility of production of tomatoes and sugar cane, and on desires of the government and availability of investment funds. To include firm plans for these plants at this time would be premature in view of the highly speculative nature of large scale tomato production, and the fact that sugar cane is not currently produced in the Mambé Basin.

Such plants, if built, should process the tomatoes and the sugar can produced on the large mechanized farm, but should have design capacity to handle an equal amount produced by small farmers on private holdings. The double source of supply would give a number of benefits and advantages, including leadership and demonstration of technology by the mechanized farm, broad distribution of benefits to private farmers, strong support of the private sector and of the concept of small holdings, with support of farmers through supply of inputs on credit by SODAGRI.

The cannery and sugar mill may be located at some distance from the agro-industrial complex, in order to distribute over a wider area the opportunity for employment of workers. Such location should consider the particular resource adaptability, so as to establish the processing plants in the center of the regions where the sugar cane

and tomatoes can be produced efficiently.

Estimated costs of each of the units or combinations of the agro-industrial complex (offices, housing, water and electricity, transportation unit, etc.) as to original investment and expansion are shown in Table 10.4.

TABLE 10.4. Progression of Investment of the Agro-industrial Complex. (in millions of CFA)

| | YEAR OF PROJECT | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | Total |
| Headquarters unit | 200 | - | 200 | 100 | - | - | 500 |
| Cereals center | 500 | - | 1000 | 1500 | - | - | 4000 |
| Seed plant | 70 | - | - | - | - | - | 70 |
| Rice Mill | 50 | 100 | - | 300 | - | - | 450 |
| Feed Manufacturing Plant | - | - | - | 150 | - | - | 150 |
| Farm machinery | 100 | 200 | 200 | 200 | 300 | - | 1000 |
| Total | 920 | 300 | 1400 | 3250 | 300 | - | 6170 |

## 10.5. A PROGRAM OF TEACHING AND ASSITANCE TO FARMERS.

The large scale mechanized farm to be established, expanded and intensified as described in the previous section will have major impact on the production of crops and livestock in the project area. It will also provide employment for a large number of persons. However, it will have no direct impact on the activities or the lives of the majority of the inhabitants of the basin. Another aspect of the Anambé Basin Development Project will bring modern

agricultural techniques, higher crop yields, and new opportunities to practically all of the families in the region. This part of the project is called the Teaching and Assistance Program.

10.5.1. The Nature of the Teaching and Assistance Program.

SODAGRI's program pf Teaching and Assistance (T and A) will be a program of providing technical guidance or training to farmers, to teach them better ways to raise crops, feed livestock, etc. and a program of assistance, or helping the farmers to do what what they are being taught. Assistance may mean distribution of supplies, or aid in organizing into cooperatives or other groups that can more effectively obtain supplies. Assistance may also mean serving as an outlet or buyer for the crops produced by the farmers, or it may mean aiding the farmers to organize into groups so they can more effectively market their own produce.

The foundation of the T and A program is practical knowledge, generated through research and experience. SODAGRI's operation of the agricultural production complex with its research activites will provide the practical knowledge.

The techniques found feasible and profitable by the research on the agro-industrial complex will be taught to farmers in the basin. These farmers will be assisted in applying the new technology; along with technical guidance, seeds, fertilizers, plant protection materials and equipment will be supplied. The value of the supplies and the equipment received by each farmer will be set up as a loan for which the farmer's crop is security, and harvest-time delivery of the crop (or a portion of it) to SODAGRI will be necessary to liquidate the debt.

SODAGRI's T and A program will have many features in common with "encadrement" as practised by SODEFITEX for cotton and by ONCAD for peanuts. SODAGRI hopes to avoid what it considers to be certain problems and disadvantages of those programs, specifically their limits as to scope, rigidities in proportions and use of inputs, and weaknesses in accounting practices that lead to client dissatisfaction. SODAGRI does not plan to require that farmers cultivate a fixed area nor a fixed type of crop, but will leave that choice to the farmer.

10.5.2. Growth and Impact of the T and A program.

The T and A program will begin on a small scale in the first year, involving perhaps 100 farmers. Continued year by year expansion will result in near-saturation in the sixth year of the project, when most of the farmers in the project area will be included in the program. It is recognized that for various reasons one cannot expect and need not strive for 100% participation in a program such as this.

Farmers are typically wary of new practices and seldom are they willing to participate fully at the outset. SODAGRI assumes that 100 farmers can be persuaded to adopt recommended practices on half of their cropland area the first year; and that succeeding groups of new participants will also pass through a trial phase during which they use recommended practices on half of their cropland area. In succeeding years, these farmers will gain confidence on the T and A program and will participate fully. In addition, because of the improved yield and increased income that will result from the program, participating farmers are expected to increase their scale of farming, with greater area of crops as well as improved yields. The calculated average area of crops per family

at the outset is about 12.5 hectares (1.3 hectare per active person x 9.6 activers per family). This area is expected to increase gradually to 20 hectares per participating family in the sixth year. While prosperity is likely to be followed by increases in the size of some of the families, the agricultural methods that will be made available to farmers will permit this increase in cropland area without increase in the number of laborers.

The impact of the T and A program on the agriculture of the project area is summarized in Table 10.5.2.A. The number of participating farmers increases from 100 to 1500, or 88% of total farmers. Area of crops subject to recommended practices will increase from 600 hectares to 23000, or from about 3% to 80% of the total area of crops.

Estimated distribution of the area among the adapted crops is shown in Table 10.5.2.B. Projected yields of crops by participating farmers are shown in Table 10.5.2.C. The yields shown are related to those of the mechanized farm (Table 10.3.2.D.) being comparable at the outset and increasing over time. However, the increases are slower and projected yields are always lower on the farmer's fields than under the more rigorous control of the mechanized farm.

Resulting output or production is shown in Table 10.5.2.D.

The foregoing figures refer to cultivation by local farmers in individual holdings. Crop production from the land under direct control of the project is in addition to this. Combined production from both sources is shown in Table 10.5.2.E.

Table 10.5.2.A. Development and Effect of T and A Program : Number of Farmers and Area of Crops.*

| | PROJECT YEAR 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| No. of farmers | 1700 | 1700 | 1700 | 1700 | 1700 | 1700 |
| New cooperators | 100 | 100 | 200 | 200 | 400 | 500 |
| Established cooperators | 0 | 100 | 200 | 400 | 600 | 1000 |
| Total participants | 100 | 200 | 400 | 600 | 1000 | 1500 |
| T and A area : (in hectares) | | | | | | |
| New cooperators at 6 ha | 600 | 600 | 1200 | 1200 | 2400 | 3000 |
| Established cooperators (average area) | 12.5 | 12.5 | 14 | 16 | 18 | 20 |
| Established cooperators (total) | 0 | 1250 | 2800 | 6400 | 10800 | 20000 |
| Total T and A area (ha.) | 600 | 1850 | 4000 | 7600 | 13200 | 23000 |
| Non T and A area : (in hectares) | | | | | | |
| New cooperators at 6.5 ha. | 650 | 650 | 1300 | 1300 | 2600 | 3250 |
| Non-cooperators | 20000 | 18750 | 16250 | 13750 | 8750 | 2500 |
| Total non-T and A area | 20650 | 19400 | 17550 | 15050 | 11350 | 5750 |
| Total area of crops | 21250 | 21250 | 21550 | 22650 | 24550 | 28750 |

* independent of agro-industrial complex.

TABLE 10.5.2.B. Area of Crops Produced by Farmers in Project Area (in hectares).

| | PROJECT YEAR 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| **Traditional farmers :** | | | | | | | |
| Total area of crops | 21000 | 20650 | 19400 | 17550 | 15050 | 11350 | 5750 |
| Sorghum, 26% | 5500 | 5407 | 5081 | 4596 | 3943 | 2973 | 1506 |
| Millet, 12% | 2600 | 2557 | 2402 | 2173 | 1863 | 1405 | 712 |
| Maize, 8% | 1700 | 1672 | 1570 | 1421 | 1218 | 919 | 465 |
| Rice, 4% | 800 | 787 | 739 | 669 | 573 | 432 | 219 |
| Peanuts, 29% | 6000 | 5900 | 5543 | 5014 | 4300 | 3243 | 1643 |
| Cotton, 21% | 4400 | 4327 | 4065 | 3677 | 3153 | 2378 | 1205 |
| **T and A farmers :** | | | | | | | |
| Total area of crops | 0 | 600 | 1850 | 4000 | 7600 | 13200 | 23000 |
| Sorghum, 30% | 0 | 180 | 555 | 1200 | 2280 | 3960 | 6900 |
| Millet, 10% | 0 | 60 | 185 | 400 | 760 | 1320 | 2300 |
| Maize, 25% | 0 | 150 | 462 | 1000 | 1900 | 3300 | 5750 |
| Rice, 10% | 0 | 60 | 185 | 400 | 760 | 1320 | 2300 |
| Peanuts, 15% | 0 | 90 | 278 | 600 | 1140 | 1980 | 3450 |
| Cotton, 10% | 0 | 60 | 185 | 400 | 760 | 1320 | 2300 |

TABLE 10.5.2.C. Projected Yield of Crops Produced by Participating Farmers, Anambé Basin, by Years. (yields in tons per hectare).

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Rice, soils 1 & 5 | 0.9 | 1.0 | 1.0 | 1.1 | 1.1 | 1.2 | 1.3 |
| Rice, soil 4 | --- | 1.2 | 1.3 | 1.4 | 1.6 | 1.8 | 2.0 |
| Sorghum | 1.0 | 1.2 | 1.4 | 1.7 | 2.0 | 2.3 | 2.5 |
| Millet | 0.9 | 1.0 | 1.2 | 1.4 | 1.5 | 1.6 | 1.7 |
| Maize | 0.8 | 1.0 | 1.3 | 1.6 | 1.9 | 2.2 | 2.4 |
| Peanuts | 1.0 | 1.0 | 1.0 | 1.1 | 1.1 | 1.2 | 1.2 |
| Cotton | 1.2 | 1.2 | 1.2 | 1.3 | 1.3 | 1.4 | 1.4 |

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TABLE 10.5.2.D. Production of Crops by Local Farmers in Project Area (in metric tons).

| | PROJECT YEAR 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| **Traditional farmers :** | | | | | | | |
| Sorghum | 5500 | 5407 | 5081 | 4596 | 3943 | 2973 | 1506 |
| Millet | 2340 | 2301 | 2162 | 1956 | 1677 | 1264 | 641 |
| Maize | 1360 | 1338 | 1256 | 1136 | 974 | 735 | 372 |
| Rice | 720 | 708 | 665 | 602 | 516 | 389 | 197 |
| Total cereals | 9920 | 9754 | 9164 | 8290 | 7110 | 5361 | 2716 |
| Peanuts | 6000 | 5900 | 5543 | 5014 | 4300 | 3243 | 1643 |
| Cotton | 5280 | 5192 | 4878 | 4412 | 3784 | 2854 | 1446 |
| **T and A farmers :** | | | | | | | |
| Sorghum | | 216 | 252 | 2040 | 4560 | 9108 | 17250 |
| Millet | | 60 | 222 | [illegible] | 1140 | 2112 | 3910 |
| Maize | | 150 | 601 | 1600 | 3610 | 7260 | 13800 |
| Rice | | 60 | 185 | 440 | 836 | 1584 | 2990 |
| Total cereals | | 486 | 1260 | 4640 | 10146 | 20064 | 37950 |
| Peanuts | | 90 | 278 | 660 | 1254 | 2376 | 4140 |
| Cotton | | 72 | 222 | 520 | 988 | 1848 | 3220 |
| **All farmers (total) :** | | | | | | | |
| Sorghum | 5500 | 5623 | 5333 | 6636 | 8503 | 12081 | 18756 |
| Millet | 2340 | 2361 | 2384 | 2516 | 2817 | 3376 | 4551 |
| Maize | 1360 | 1488 | 1857 | 2736 | 4584 | 7995 | 14172 |
| Rice | 720 | 768 | 850 | 1042 | 1352 | 1973 | 3187 |
| Total cereals | 9920 | 10240 | 10424 | 12930 | 17256 | 25425 | 40666 |
| Peanuts | 6000 | 5990 | 5821 | 5674 | 5554 | 5619 | 5783 |
| Cotton | 5280 | 5264 | 5100 | 4932 | 4772 | 4702 | 4666 |

TABLE 10.5.2.E Combined Total of Cereals Production by Mechanized Farm and Local Farmers in Anambé Basin (in metric tons).

| | PROJECT YEAR 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Rice | 2168 | 6370 | 12802 | 23852 | 77163 | 104173 |
| Sorghum | 5833 | 5903 | 8936 | 13703 | 26681 | 30756 |
| Millet | 2461 | 2504 | 2936 | 3777 | 5176 | 6551 |
| Maize | 1788 | 2517 | 5136 | 10[illegible]54 | 21995 | 26172 |
| Total | 12250 | 17294 | 29810 | 51386 | 131015 | 167652 |

## 10.5. Livestock : T and A Program.

A T and A program oriented to livestock will be essential at the time of expansion of dry season (irrigated) crop production, because the irrigated crops will use lands formerly used by local inhabitants as cattle range. The farmers must be taught the importance of restraining their cattle to avoid interference with the irrigated crops, and at the same time they must be taught and helped to provide an alternative way of feeding and/or managing their cattle. The T and A program can help by encouraging production during the rainy season of forage crops that can be used for cattle feed in the dry season, and by helping farmers to modify their program of buying, selling, and managing cattle to reduce the need for [illegible] in the dry season. Additional steps requiring action by the agro-industrial complex are : provision of watering points for cattle at a distance from the irrigated fields, thus providing alternative areas for cattle pasture, and production of forage crops using irrigation, to provide feed in the dry season.

A significant expansion of the local livestock

industry is foreseen as a result of SODAGRI's program of training and assistance for livestock, paralleling the program for cereals production. Local farmers who have sufficient feed available will be encouraged and assisted to expand their cattle holdings. SODAGRI will facilitate such expansion by assisting the farmers in bringing young cattle from the sub-Sahelian zone and assisting in the marketing of the fattened cattle, as well as by teaching proper livestock management and feeding and making available supplementary feeds and animal health products. The increase in cattle production that is expected to result from this program is shown in Table 10.5.3.

TABLE 10.5.3. Number of Cattle Kept by Local Farmers in the Anambé Basin.

| | YEAR OF PROJECT 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Growing calves, total[1] | 2186 | 2217 | 2752 | 3676 | 5419 | 8665 |
| Growing calves, increment over base years | 66 | 97 | 632 | 1556 | 3296 | 6545 |
| Feeder cattle[2], increment over base years | 47 | 53 | 65 | 84 | 123 | 198 |

1. Maximum fixed by fodder production.
2. Maximum fixed by rice by-products.

See calculations in Annex 2 of Chapter 10.

## 10.5.4. Health Program.

The economic growth and increasing population expected in the basin by this time should justify allocation of increased resources from other agencies of the government. It is reasonable to expect additional health centers and schools to be opened in the basin by or during the third

phase of the development program. In addition to any such installations set up by the government, project SENERIZ will have health centers or dispensaries established to care for the health of project employees.

The health centers of both categories will be reinforced and their effectiveness increased by SODAGRI's program of health and nutrition education. In this program, similar in concept to the training and assistance programs planned for cereals and livestock (except that no marketing program would be planned) women will be taught - largely by women - how to improve their families nutrition by better use of available foods and through family production of vegetables. The teaching of vegetable raising will be based on the research done by SODAGRI at the agro-industrial complex.

The scope and impact of the health program is shown in Table 10.5.4.

TABLE 10.5.4. Magnitude and Impact of the Health Programs of Project SENERIZ, by Years.

| | PROJECT YEAR | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| Number of health centers in the agro-industrial complex | - | 1 | 1 | 2 | 3 | 3 |
| Paramedical personnel | - | 1 | 3 | 6 | 8 | 9 |
| Other personnel | - | 2 | 3 | 4 | 6 | 6 |
| Nutrition and health teachers | - | 1 | 2 | 4 | 7 | 10 |
| Client families per teacher | - | 25 | 35 | 50 | 50 | 50 |
| Client families, total | - | 25 | 70 | 200 | 350 | 500 |

## 10.5.5. Summary of T and A Personnel and Costs.

To carry out the program of teaching and assistance for farmers in production of cereal crops and livestock, and for farm families in health and nutrition, a staff of extension teachers and other supporting personnel will be required. The number of this personnel is shown in Table 10.5.5.

TABLE 10.5.5. Personnel of the Training and Assistance Program, Projet SENERIZ.

| | YEAR OF PROJECT 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| **Agricultural Program :** | | | | | | |
| New farmer cooperators | 100 | 100 | 200 | 200 | 400 | 500 |
| Established farmer-cooperators | - | 100 | 200 | 400 | 600 | 1000 |
| Total cooperators | 100 | 200 | 400 | 600 | 1000 | 1500 |
| New clients per teacher | 25 | 30 | 35 | 40 | 40 | 40 |
| Established clients per teacher | - | 50 | 60 | 70 | 80 | 80 |
| Total agricultural teachers | 4 | 6 | 10 | 11 | 18 | 25 |
| Livestock teachers | 1 | 2 | 3 | 4 | 6 | 8 |
| Supply and records personnel | 2 | 4 | 7 | 10 | 12 | 15 |
| **Health and nutrition Program :** | | | | | | |
| Health and nutrition teachers | - | 1 | 2 | 4 | 7 | 10 |
| Support personnel | - | - | 1 | 2 | 2 | 3 |
| **Administration** | | | | | | |
| Supervisory personnel | 1 | 2 | 3 | 4 | 5 | 6 |
| Office staff | 1 | 2 | 3 | 4 | 5 | 6 |

## 10.6. BUILDING TOWARD SENEGALIZATION.

The level of technology that will be introduced into an underdeveloped region, the eventual Senegalization of the entire project, and the ambitious program of teaching and assistance and health education planned for later stages calls for training of Senegalese personnel in many skills and at all levels, including skills and levels not available in Senegal. To meet the need for qualified personnel, a training program will be implemented, beginning in the first year of the project.

### 10.6.1. In-Service Training.

A comprehensive program of training on-the-job will be inaugurated. This in-service training is not seen as a separate program, but as an underlying principle and characteristic of employment throughout the project. Mechanics, carpenters, equipment operators, repairmen, accountants, etc. will all be developed through an informal but well-organized apprenticeship program. Employees who show aptitude and ambition will thus have the opportunity to work their way to positions of more responsibility.

### 10.6.2. Training Not at the Project Site.

Success of this project will require personnel having knowledge and understanding of agronomy, irrigation, machinery, farm management, cereals processing, and other specialities. In order to be assured of the availability of personnel with the required qualifications, a program of training must be undertaken at the beginning of the project. A major portion of such training will be at sites apart from the project site, and foreign training in Europe and the U.S. will figure importantly.

Candidates for this training will be chosen by

the implementing agency of the project (SODAGRI) on the basis of the applicant's previous academic records, performance in a "concours" (written and oral examinations), previous experience and employment if any, and recommendations from previous teachers, employers, and others.

Training will be for varying periods of time depending on the subject matter, but ranging from a few weeks to several years. Trainees will be registered as employees of the project from the inception of their training and will be paid appropriate salaries enabling them to contribute to support of their families. Their entire expenses of the training period, including subsistence, will be paid by the project. The cost of training will be paid directly to the training institution in most cases, while the trainee will receive an allowance for living, the amount of which will be tailored to the actual need. The support and financing of the training will be patterned after the program of USAID. Trainees will be required to sign contracts committing themselves to employment in the project after completion of training, for a period of time not less than, and up to twice, the period of training.

The fields of training and the number of trainees are shown in Table 10.6.2.A. All of these trainees will be needed in subsequent stages of the project, and the training is designed to synchronize the availability of trained personnel with the need for them.

The cost of this training program is shown in Table 10.6.2.B.

10.6.3. Senegalization.

The final step in implementation of this phased development is its Senegalization. All administrative and

TABLE 10.6.2.A. Training Program of Project SENERIZ.

| No. | Specialization | Duration | Location | Year 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|
| Operators : | | | | | | | |
| 2 | Reservoir management | 9 months | Calif. USA | | | | 2 |
| 6 | Irrigation technology | 6 months | Calif. USA | 2 | 1 | 1 | 2 |
| 4 | Rice production | 12 months | Philippines | 2 | 2 | | |
| 2 | Cereals production | 12 months | India/ Mexico | 1 | 1 | | |
| 6 | Machinery maintenance | 6 months | France | 3 | 3 | | |
| 2 | Grain handling and Storage | 3 months | USA | 1 | 1 | | |
| 2 | Rice Milling | 3 months | Japan | 1 | 1 | | |
| 2 | Seed processing | 3 months | USA | 1 | 1 | | |
| 2 | Feed manufacturing | 3 months | USA | | 1 | 1 | |
| 2 | Livestock Health and Production | 9 months | Texas | | 1 | 1 | |
| 2 | Project Management | 12 months | USA | | 1 | 1 | |
| T and A Program : | | | | | | | |
| 15 | Agricultural extension | 6 months | USA | 3 | 4 | 4 | 4 |
| 5 | Livestock extension | 6 months | Texas | 2 | 2 | 1 | |
| 10 | Health and nutrition education | 6 months | USA | 1 | 2 | 3 | 4 |
| 5 | Extension administration | 12 months | USA | 1 | 2 | 1 | 1 |
| 67 | Total trainees | | | 18 | 23 | 13 | 13 |
| | Total months of training | 468 months | | | | | |

TABLE 10.6.2.B. Costs of Training Program. (in francs CFA)

| Item | Unit cost | No. | Total |
|---|---|---|---|
| Travel | 300,000 CFA per round trip | 67 | 20,100,000 |
| School and living | 150,000 CFA per month | 468 | 70,200,000 |
| Preparation (language training) | 50,000 per month x 4 months | 61 | 12,200,000 |
| Total | | | 102,500,000 CFA |

managerial posts and most of the technical posts, which will be staffed by expatriates during the early stages of the project, will finally be turned over to Senegalese nationals. Of course, Senegalese will be employed from the outset at the highest level of post for which they are qualified. Those qualifications will be continually improved through programs including in-service training, informal apprenticeship or trainee arrangements, and full-time training both in Senegal and abroad. The products of these training programs - the trained Senegalese - will be assisted to develop their competency by challenging assignments. Ultimately expatriate management personnel will be phased out, as Senegalese with sufficient competency are found or trained to replace them.

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ANNEX 1, CHAPTER 10. Refer to Section 10.3.4.

## Calculation of the Maximum Number of Grazing Calves and Feeder Cattle in the Anambé Basin Project.

| | YEAR OF PROJECT 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Fodder available : | | | | | | |
| Rice production (tons) | 1380 | 5450 | 11640 | 22030 | 73920 | 99260 |
| Other cereals (tons) | 610 | 1350 | 5120 | 11360 | 30400 | 26000 |
| Rice straw[A] (tons) | 690 | 2725 | 5820 | 11015 | 36960 | 49630 |
| Cereals stalks[B] (tons) | 610 | 1350 | 5120 | 11360 | 30400 | 26000 |
| Total fodder (tons) | 1300 | 4075 | 10940 | 22375 | 67360 | 75630 |
| Rice by-products[C] (tons) | 138 | 545 | 1164 | 2203 | 7392 | 9926 |
| Feeder cattle[D], maximum fixed by rice by-products | 86 | 340 | 727 | 1375 | 4600 | 6200 |
| Feeder cattle, forage needs (tons) | 34 | 136 | 290 | 550 | 1840 | 2480 |
| Remaining fodder (tons) | 1266 | 3939 | 10650 | 21825 | 65520 | 73150 |
| Calves[E], maximum fixed by forage | 280 | 875 | 2360 | 4850 | 14500 | 16200 |
| Targets : Calves | 100 | 500 | 1000 | 2000 | 5000 | 5000 |
| : Feeders | 50 | 100 | 500 | 1000 | 2000 | 5000 |

A. Rice straw is produced at 0.5 ton per ton of paddy rice.

B. Fodder (stalks of sorghum, millet and maize) produced at 1.0 ton per ton of grain.

C. By-products of milling rice in the amount of 10% of paddy rice considered as available for livestock feeding.

D. Feeder cattle requirements per head : 1.6 tons of rice by-products, 0.4 tons of fodder, 100 kg protein-mineral supplement.

E. Growing calves requirements per head : 4.5 tons of fodder, 100 kg of supplement.

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ANNEX 2, CHAPTER 10. Refer to Section 10.5.3.

## Cattle Production by Local Farmers.

| (in tons) | YEAR OF PROJECT 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Fodder available: | | | | | | | |
| Rice production | 720 | 768 | 850 | 1042 | 1352 | 1973 | 3187 |
| Other cereals | 9200 | 9472 | 9574 | 11888 | 15904 | 23452 | 37479 |
| Rice straw[A] | 360 | 384 | 425 | 521 | 676 | 986 | 1593 |
| Cereal stalks[B] | 9200 | 9472 | 9574 | 11888 | 15904 | 23452 | 37479 |
| Total fodder | 9560 | 9856 | 9999 | 12409 | 16580 | 24438 | 39072 |
| Rice by-products[C] | 72 | 76 | 85 | 104 | 135 | 197 | 318 |
| Feeder cattle[D], maximum fixed by cereal products | 45 | 47 | 53 | 65 | 84 | 123 | 198 |
| Feeder cattle, forage needs (tons) | 18 | 19 | 21 | 26 | 34 | 49 | 79 |
| Remaining fodder (tons) | 9542 | 9837 | 9978 | 12383 | 16546 | 24389 | 38993 |
| Calves[E], maximum fiwed by forage | 2120 | 2186 | 2217 | 2752 | 3676 | 5419 | 8665 |
| Increase over base year : no. of calves | | 66 | 97 | 632 | 1556 | 3296 | 6545 |

A. Rice straw is produced at 0.5 ton per ton of paddy rice.

B. Fodder (stalks of sorghum, millet, and maize) produced at 1.0 ton per ton of grain.

C. By-products of milling rice in the amount of 10% of paddy rice considered as available for livestock feeding.

D. Feeder cattle requirement per head : 1.6. tons of rice by-products, 0.4 tons of fodder, 100 kg protein-mineral supplement.

E. Growing calves requirement per head : 4.5 tons of fodder, 100 kg of supplement.

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# CHAPTER 11 : SUPPORTING DETAIL FOR THE THREE-PHASE PLAN


11.0. INTRODUCTION

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## 11.6. PERSONNEL

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# CHAPTER 11 : SUPPORTING DETAIL FOR THE THREE-PHASE PLAN

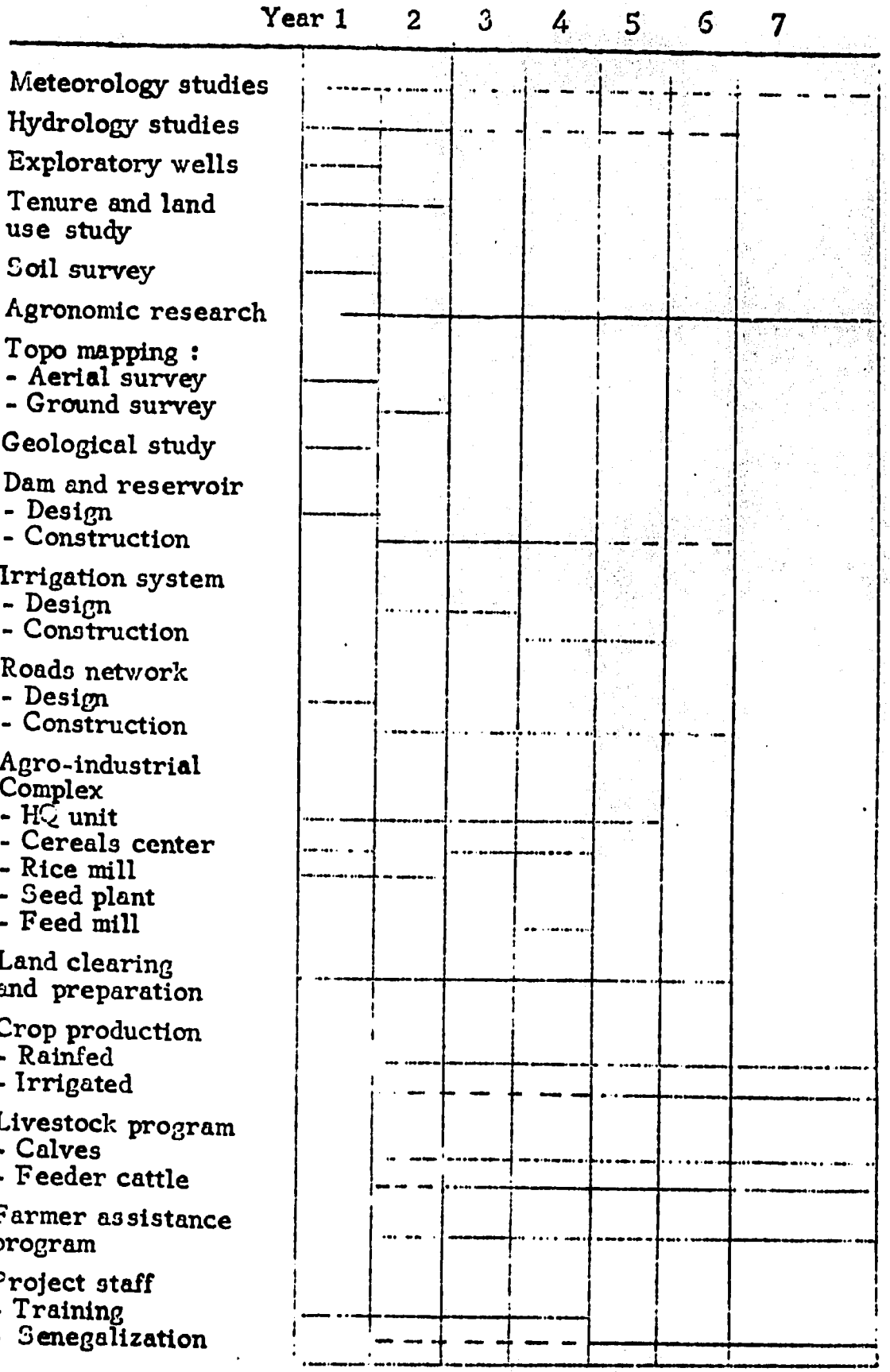
## 11.0. INTRODUCTION.

In the foregoing chapter, SODAGRI has presented the form — configuration of the proposed project for development of the Anambé Basin. Much of the detail has been deliberately omitted from that chapter, so as to avoid obscuring an overall view of the project. However, such detail is needed in order to support calculations of costs and benefits. In this chapter, the supporting details are presented.

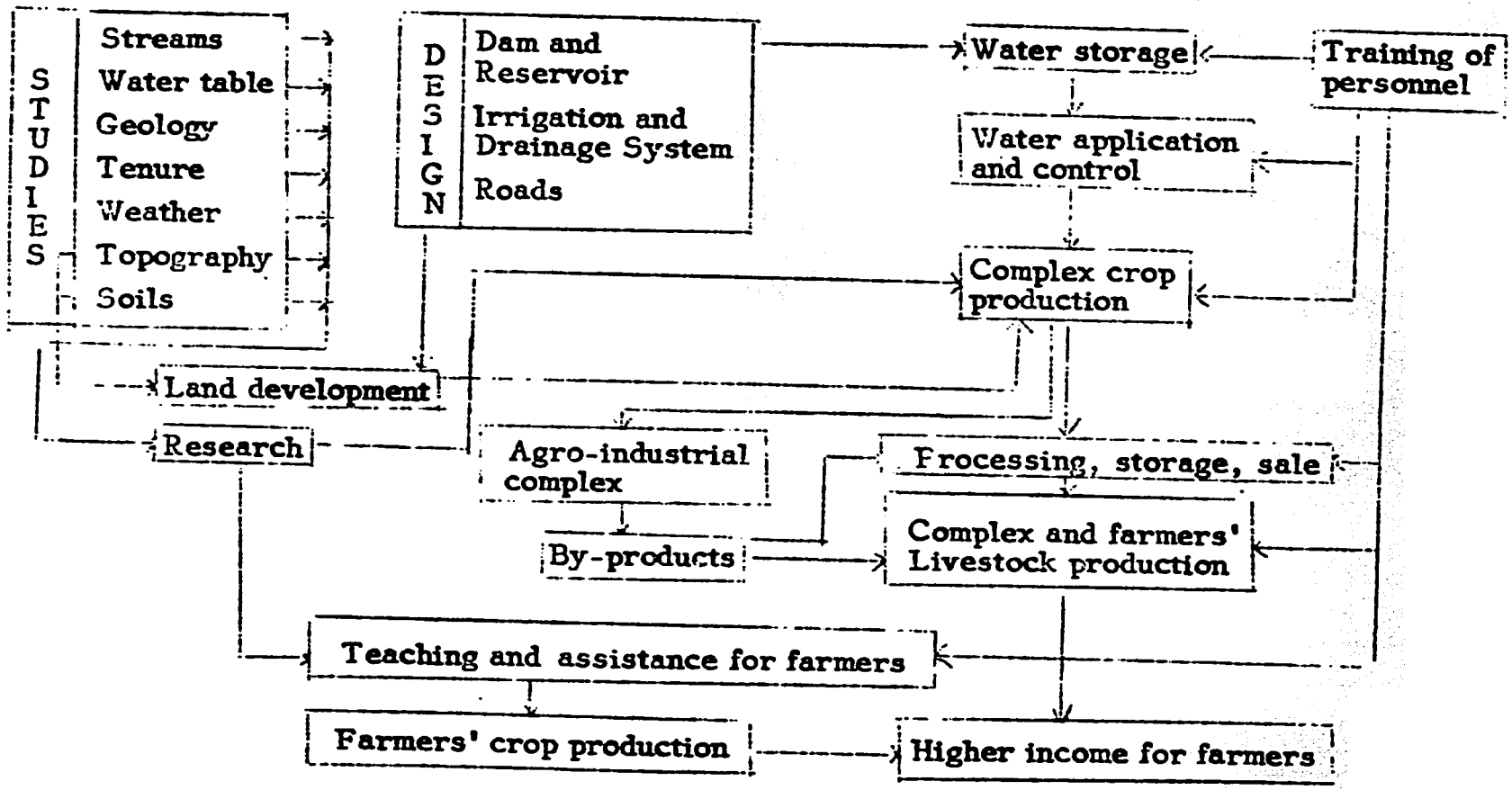
## 11.1. FLOW CHARTS.

The relationship among the various components of the project, in terms of preparation for subsequent steps, has been mentioned frequently in the foregoing chapter. Figure 11.1.A. shows the timing of the activities and events of the development program, and Figure 11.1.B. presents graphically the relationships among these activities.

FIGURE 11.1.A. IMPLEMENTATION SCHEDULE FOR PROJECT SENERIZ



INTERRELATIONSHIPS AMONG ELEMENTS OF PROJECT SENERIZ



## 11.2. DAM AND RESERVOIR

A discussion of the merits of possible flood/drainage/irrigation schemes was presented in Chapter 9 of this text. The present chapter deals only with the engineering concepts of the proposed dam and reservoir.

### 11.2.1. Site selection

The general terrain of the project area is of very limited relief and the possibility for natural dam sites are limited to the Anambé basin, the Koulounto valley and the Kayanga valley. As already discussed, the problems of evaporation and the necessity to construct retaining dikes to form a reservoir in the Anambé discount this possibility on cursory examination. Although the Koulounto River carries more water than the Kayanga, from the topographical maps available it appears to have a very wide shallow valley which on initial appraisal would involve extensive earthworks. Also, the long water conveyance network from the Koulounto valley to the project area would be a disadvantage in the economic analysis of such a scheme. Finally, the project area was already broadly defined as the department of Vélingara.

A storage dam in the Kayanga valley would obviously reduce the amount of flooding in the Anambé valley by decreasing the tailwater level of the Kayanga downstream of the dam, thus providing a greater hydraulic gradient to the flood waters of the Anambé valley, and reducing the extent of flooding.

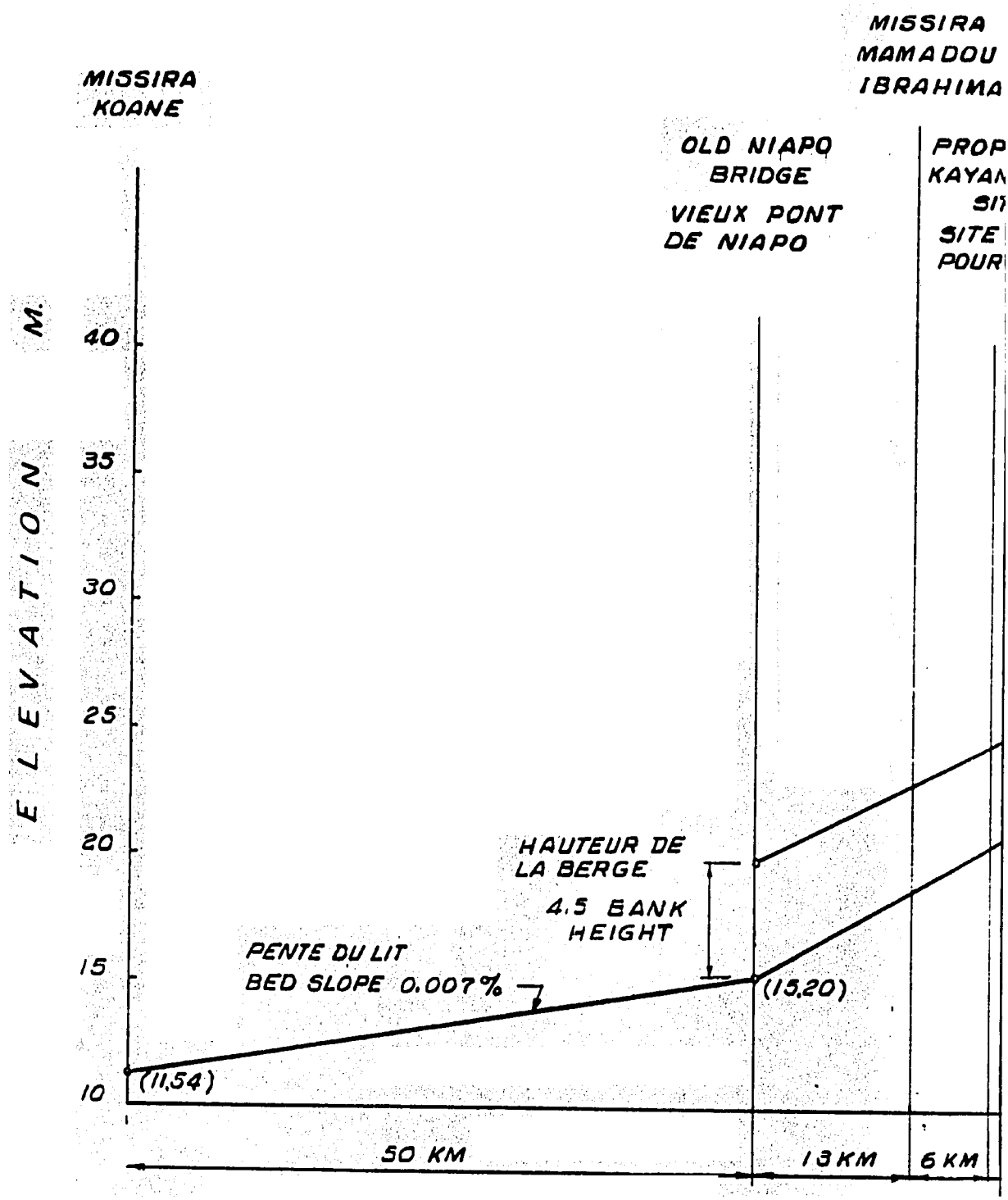
Aerial photographs at 1:40,000 taken in 1970 were examined together with existing topographic maps at 1:200,000 and a partial map at 1:50,000. It was noted that the Kayanga valley is rather broad and flat, the river meanders but not so markedly as in its lower reaches downstream of the Niapo bridge, and natural constrictions are markedly absent.

However, an inital proposed dam site was chosen two kilometers southeast of Niandouba, at location 12°53'30" N, 13°57'30" W. At this point the Kayanga valley narrows, the western bank being a rounded spur whose highest point, at a little over 50 meters, is three kilometers from the valley bottom. From surface exploration, the subsurface would appear to be laterite soil with several outcrops of laterite rock, some appearing as boulders and others as intact lenses. No hard rock outcrops were visible and considering the general geology of the area, would be unlikely to exist.

The east bank of the proposed dam site differs considerably. A laterite ridge leading from the southeast narrows to 300-400 meters at the 40-meter-contour measured 600 meters from the valley bottom. Dropping steeply at 7%, this slope is made of developed laterite rock; occasional samples of poorly consolidated sandstone were found on the surface.

In the flat valley bottom, the river bed meanders through its floodplain which is 400 meters wide on the average. One shallow trial pit was dug and showed continuous fluvial deposits of grey clayey silt over its depth of one meter. It should be noted that these deposits are expected to continue over several meters, but only more detailed investigations could determine this fact with certainty. The river bed itself is typically 55 meters wide and 45 meters deep with very steep banks. It is very heavily encumbered by tree growth, and deposits of organic matter cover the river bottom. The organic matter is mixed with fines, clays, and silts, indicating that even in flood the river is very slow-moving at this point.

It is felt that any site on the upper Kayanga would have similar ground conditions, that is, laterite soils or rock on the higher slopes with a pronounced river bed and a floodplain covered with silts and clays, but this site, Kayanga No. 1, has the advantage of the most prominent constriction of the valley, coupled with readily available laterite soils for dam fill and laterite rock for




PROJECT SENERIZ

PROJET SENERIZ

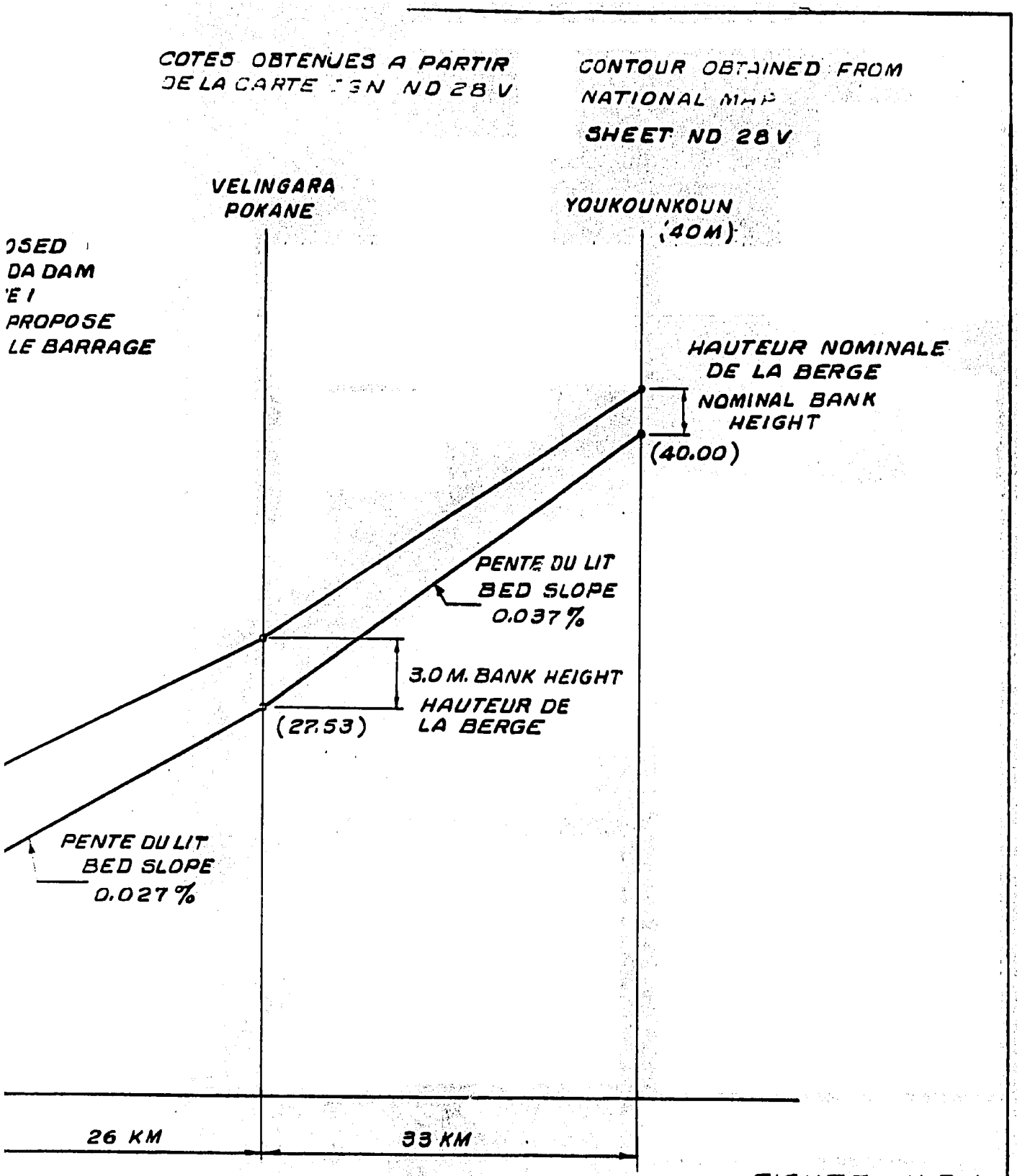
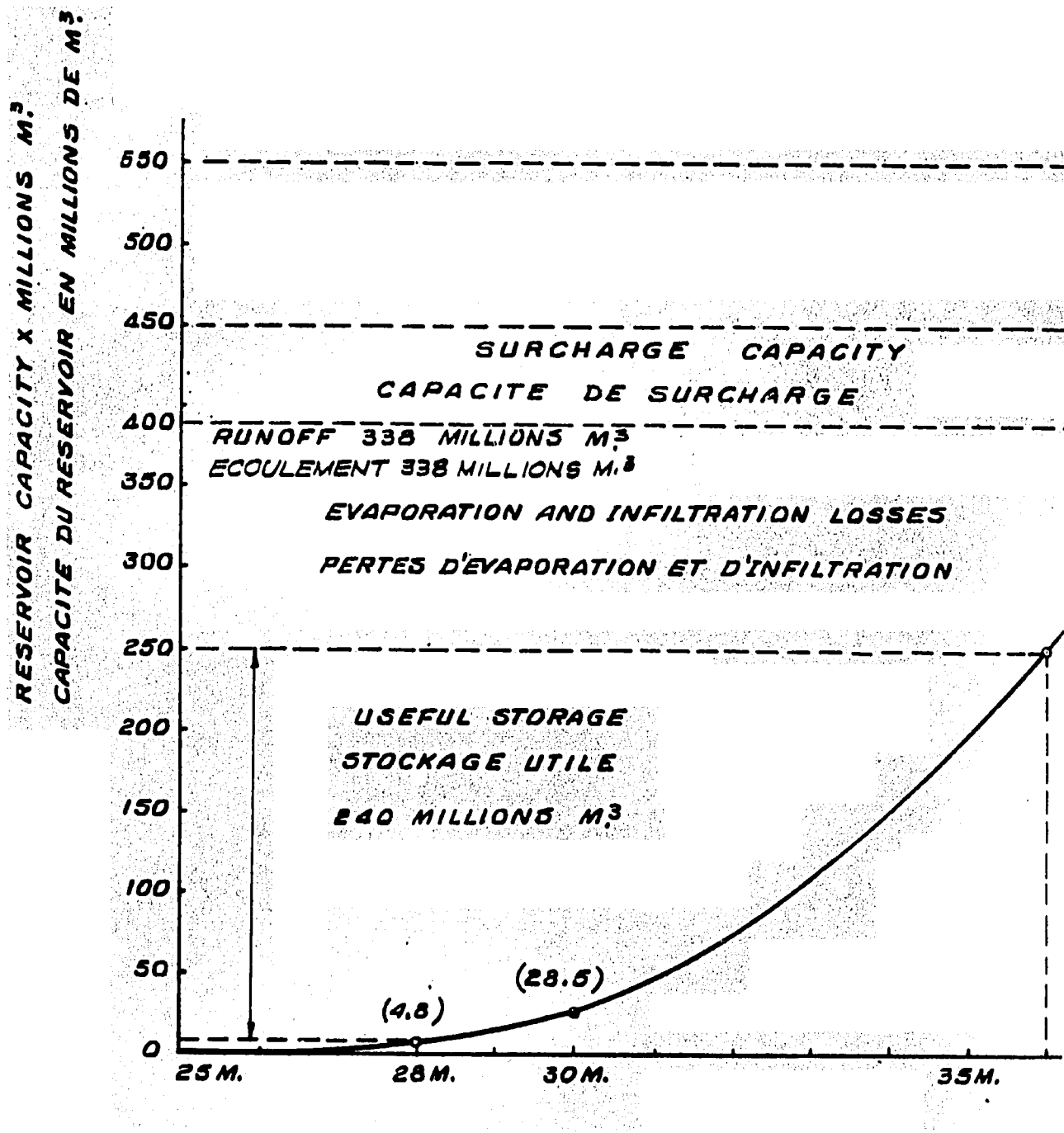


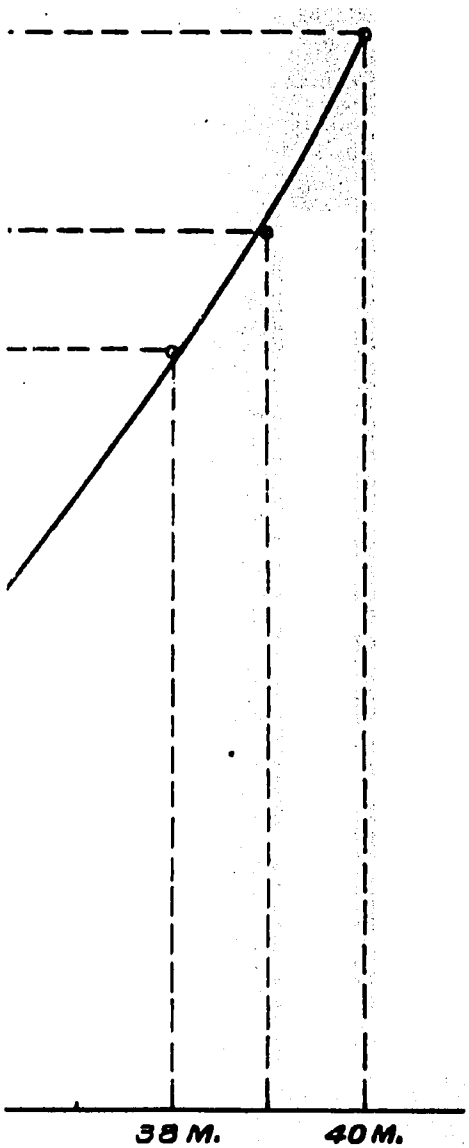

FIGURE - 11·2·1

WEITZ HETTELSATER CORP. - SODAGRI

KAYANGA RIVER. BED & BANK
KAYANGA-PROFIL EN LONG-LIT & BERGE

DRAWING NO. 11.2.2
PREPARED BY P.D. BUNTING
DRAWN BY E.J. CAYO DATE 4-1-1977


RESERVOIR CAPACITY X MILLIONS M.³
CAPACITE DU RESERVOIR EN MILLIONS DE M.³
550
500
450
400
350
300
250
200
150
100
50
0
SURCHARGE CAPACITY
CAPACITE DE SURCHARGE
RUNOFF 338 MILLIONS M.³
ECOULEMENT 338 MILLIONS M.³
EVAPORATION AND INFILTRATION LOSSES
PERTES D'EVAPORATION ET D'INFILTRATION
USEFUL STORAGE
STOCKAGE UTILE
240 MILLIONS M.³
(4.8)
(28.5)
25 M.
28 M.
30 M.
35 M.




**NOTE**

ALL VALUES BASED ON LIMITED EXISTING TOPOGRAPHICAL AND HYDROLOGICAL INFORMATION.

CES VALEURS ONT ETE CALCULEES A PARTIR DES INFORMATIONS TOPOGRAPHIQUES ET HYDROLOGIQUES EXISTANTES.

FIGURE- 11·2·2

WEITZ HETTELSATER CORP.-SCDAGRI

KAYANGA RESERVOIR - CAPACITY CURVE

COURBE DE CAPACITE DU RESERVOIR

DRAWING NO. 06 - 11.2

PREPARED BY P.D BUNTING
DRAWN BY E. J. CAYO DATE 4-5-1977

rip-rap (it should be noted that this material is suggested in the present absence of any other economically available stone).

The topography of the narrow ridge of the east bank, assuming that the countours of existing maps are reasonably correct, suggests that an overflow spillway might be constructed at reasonable cost, the excavated material being transported directly for use as dam fill.

From an irrigation supply viewpoint, a principal canal would probably head from just upstream of the dam site to the northwest, cutting across the Anambé/Kayanga watershed via a very indistinct saddle four and one-half kilometers west of Niandouba.

11.2.2. Reservoir Characteristics.

(N.B. : All figures are based on limited topographic detail).

Using the Kayanga No. 1 as a dam site and the limited topographic detail available on the Kayanga valley, a capacity rating curve has been developed. This shows total storage of 550 million $m^3$ at 40 meters through to 4.8 million $m^3$ at 28 meter elevation.

For a long-term average year of normal rainfall and runoff in the Kayanga, one can expect 425 million $m^3$, measured at the Niapo bridge, but this is reduced to 388 million $m^3$ because the effective watershed decreases from 1,750 to 1,600 $km^2$.

Thus, the normal freeboard elevation would become 38 meters. Evaporation losses have already been estimated at 1,710 mm per annum, thus, an estimated total reservoir loss of 2 meters is assumed. Seepage losses in the lower elevations of the reservoir are likely to be low, but the magnitude of infiltration losses at higher elevations, i.e., in the laterite soils, should be investigated more thoroughly.

Applying this loss of two meters most conservatively, i.e., at maximum normal storage conditions, useful storage is 250 million $m^3$.

Allowances for minimum pump positive suction head are estimated at two meters and thus a total useful storage of approximately 240 million $m^3$ is achieved.

The maximum surcharge storage available in times of exceptional runoff would be 52 million $m^3$, this representing a one-meter increase to a maximum freeboard level of 39 meters. The provided spillway would also be operating at this time to evacuate the flood waters.

According to local information, the strongest and most persistent winds occur from January through April, coming from the northeast. These winds are known as the Harmattan. At this period of the year, the reservoir would normally be at 31-33 meters elevation and the problems of wave action on the upstream face of the dam would not be serious, assuming adequate rip-rap is provided, and the problem of wave break over-topping the dam would be non-existent. In the wet season, the winds are predominantly from the west, which would blow along the length of the reservoir but in an upstream direction. Thus, general information indicates that wave action would not be a serious problem, except in exceptional circumstances.

Although no detailed study has been made, aerial photographs show that a considerable area of cultivated land lies beneath the 38-meter contour and also many villages. All this would be lost, but the long-term social and financial benefits for the local people would more than offset their temporary loss. In years of exceptional rainfall, the flooding could reach the 39 meter elevation.

11.2.3. Dam Design.

Choice of dam type : The principal constraints of this choice are topography and construction materials, since the only construction materials presently known to be available locally are laterite rock, lateritic soils, and sands. The degree of difference

.../...

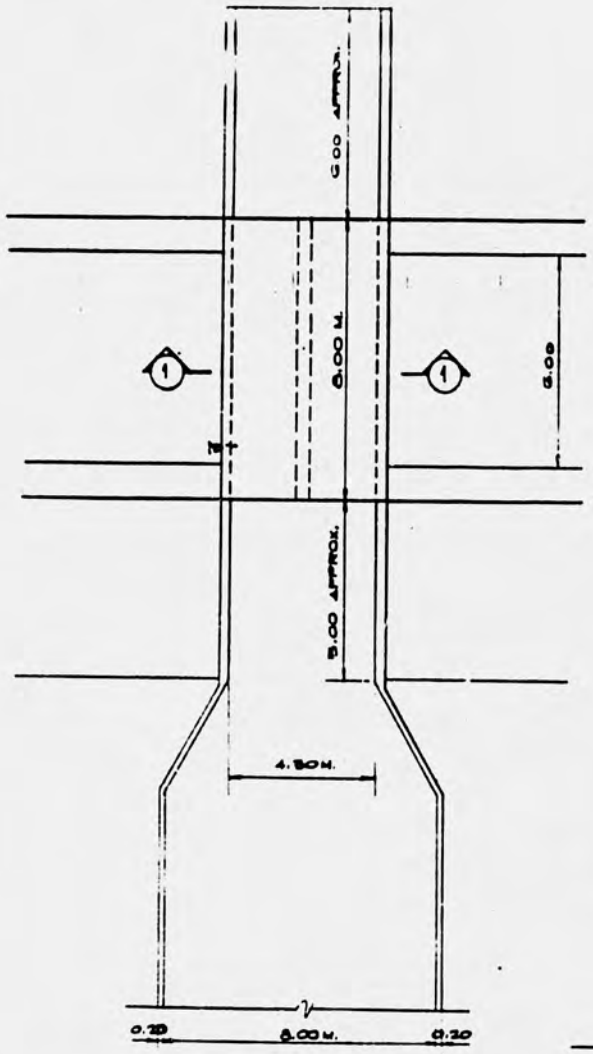
in engineering soil properties for the laterites available is not known, nor is the exact availability of hard rock. The need for investigations on possible quarry sites close to the project area cannot be overemphsized. Initial information would indicate a preliminary geological survey of the area between Carrefour and Kankoyama on the Tambacounda-Sambayel road. The availability or otherwise of igneous rocks such as rhyolites and microgranites should be thoroughly investigated. The absence of available rock, or the aggregates necessary for concrete, virtually preclude the consideration of a rockfill or any type of concrete dam.

The rather low relief of the Kayanga valley and the limited major construction materials available, and the possibility of weak foundations, indicate the use of an earthfill dam to be preferable.

General design considerations : Three typical earthdams are available : the diaphragm, the zoned embankment, and the modified homogeneous. Both the diaphragm and zoned embankment types seem unlikely possibilities because of the lack of suitable construction material. Requiring an impermeable earth or concrete core and permeable filler, and considering the present dearth of clay, cheap concrete or suitable stone, the diaphragm dam can be discounted.

A zoned embankment dam still remains a possibility, but only future engineering soils investigations could ascertain whether this or a rolled-fill homogeneous earthfill dam would be the most suitable. Cursory considerations indicate that the latter would be the most suitable.

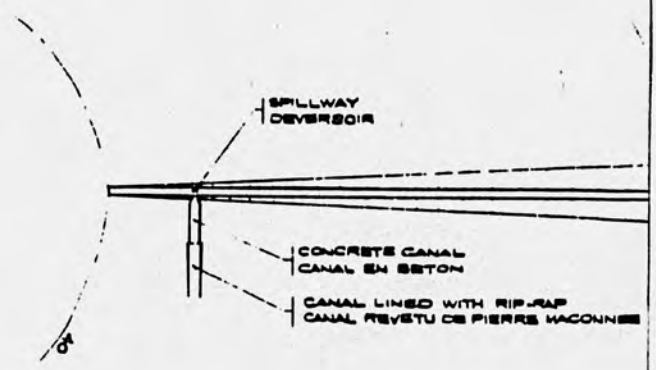
Fill material : Selected laterite soil compacted to the optimum Procter density at a specified water content should be laid in 15 cm layers. Any increase over 15 cm, with standard compaction equipment, risks lenses of poorly compacted fill, which inevitably lead to undesirable settlement.

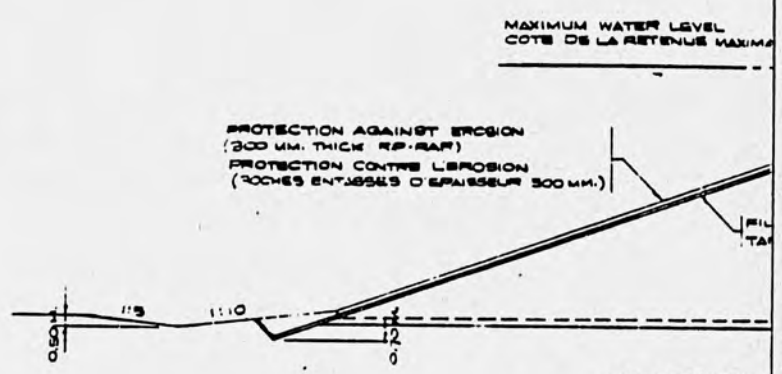



SPILLWAY PLAN VIEW

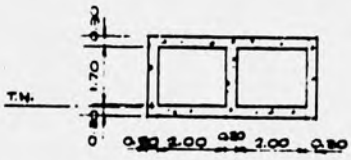
PLAN DU DEVERSOIR DE SECURITE

SCALE 1:10 M ECHELLE 1:10 M.



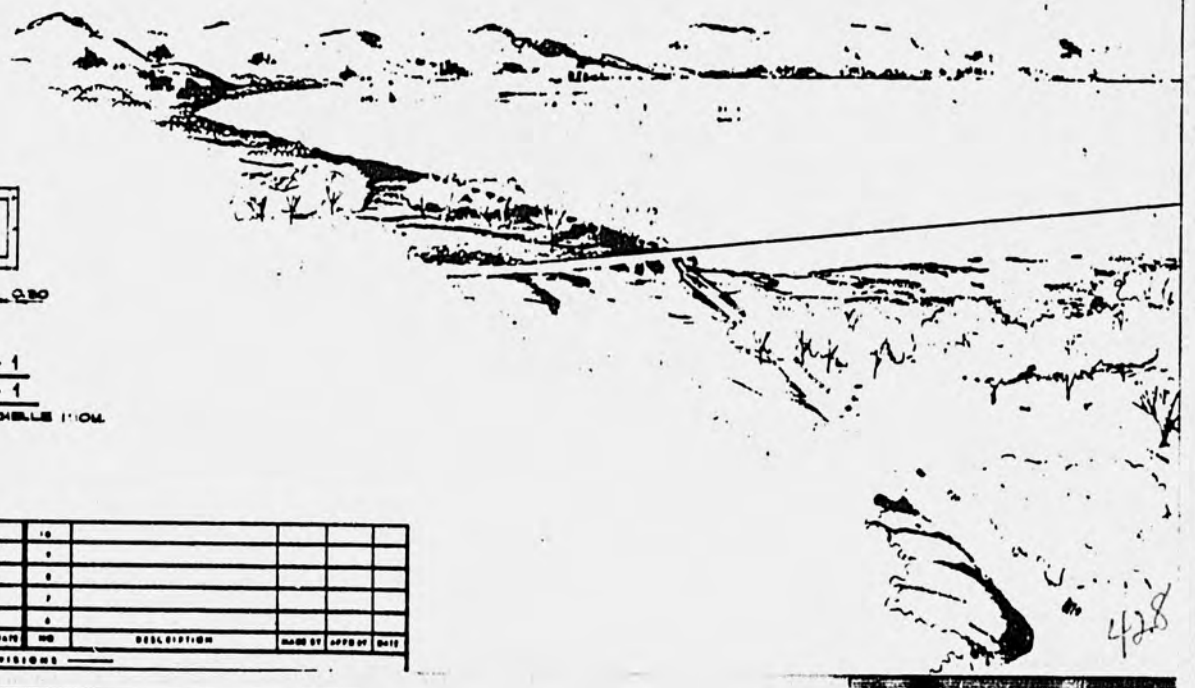

THE IMPERVIOUS
TO THE ROCK OR
DENSITY OF 95
THAN $10^{-7}$ M/SEC
LA TRANCHEE D'ET
LA ROCHE OU DANS
PROCTOR OPTIMU
MOINS DE $10^{-7}$ M




SECTION 1 - 1

COUPE 1 - 1

SCALE 1:10 M. ECHELLE 1:10 M.

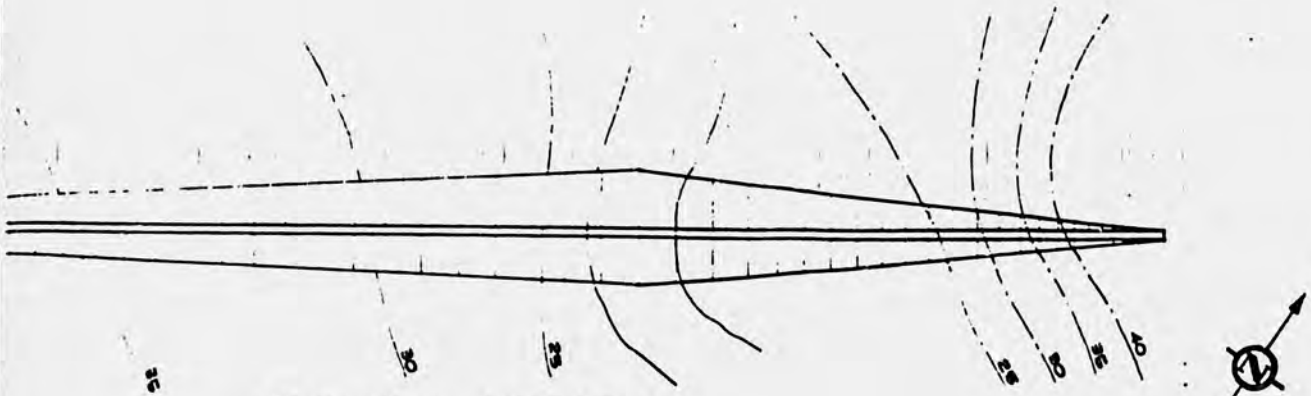


| NO | DESCRIPTION | MADE BY | APPD BY | DATE | NO | DESCRIPTION | MADE BY | APPD BY | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 5 | | | | | 10 | | | | |
| 4 | | | | | 9 | | | | |
| 3 | | | | | 8 | | | | |
| 2 | | | | | 7 | | | | |
| 1 | | | | | 6 | | | | |

REVISIONS

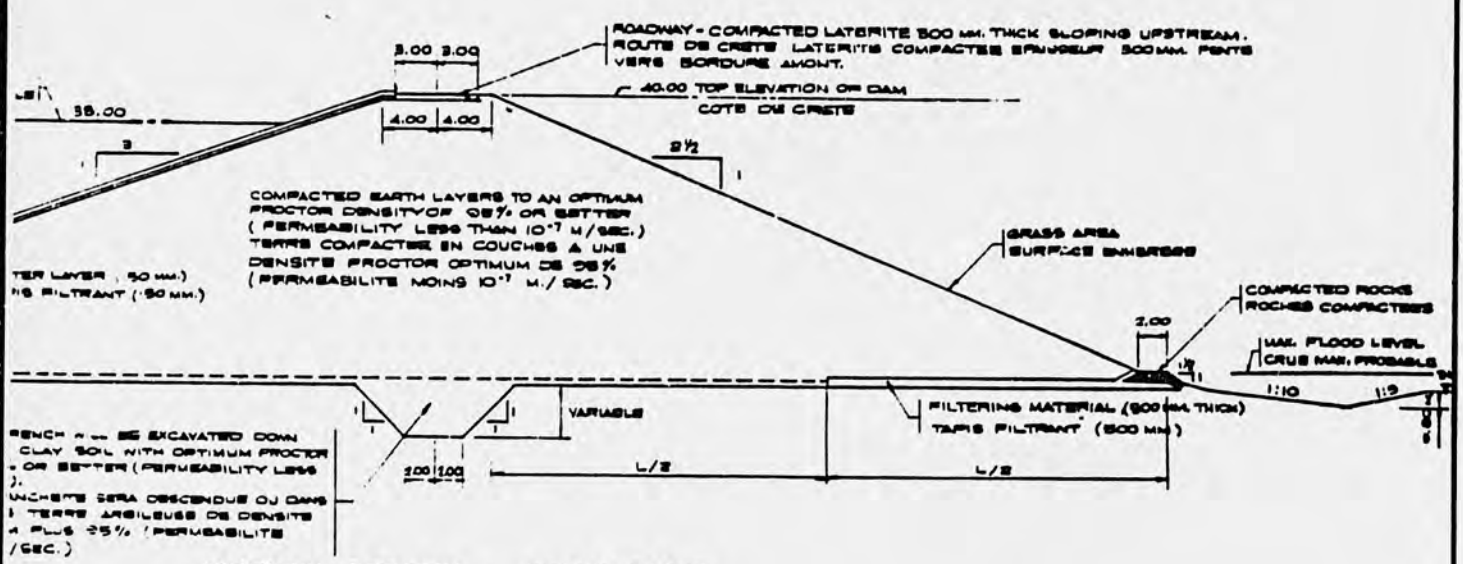
428

428



PLAN VIEW - VUE EN PLAN

SCALE 1:4000 M. ECHELLE 1:4000 M.



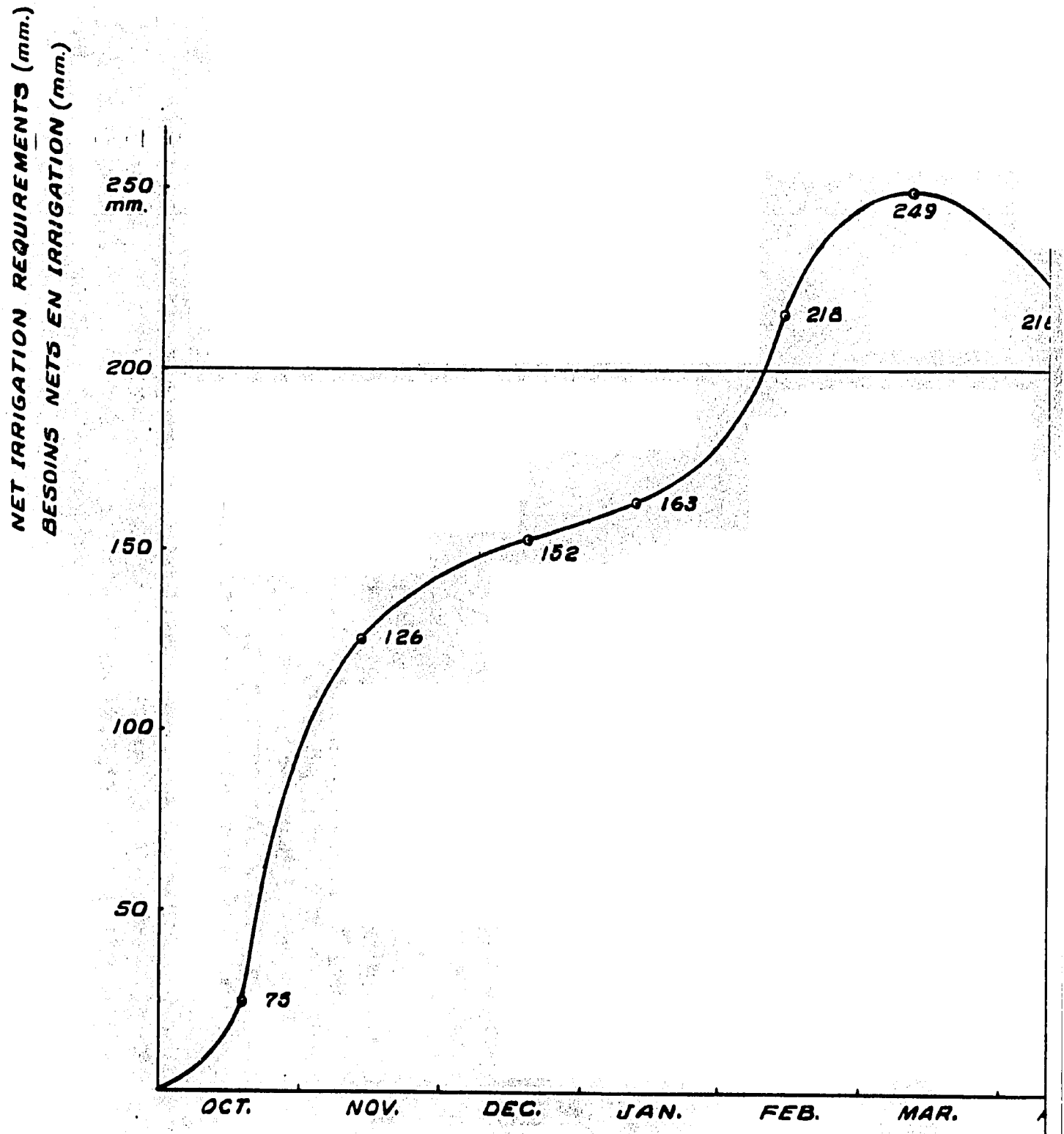

TYPICAL SECTION - COUPE TYPE

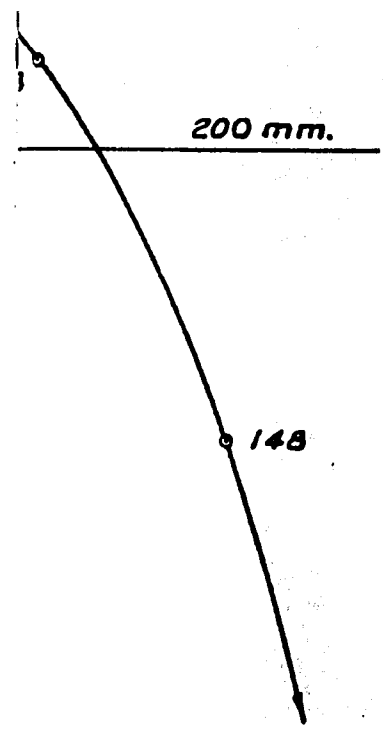
SCALE 1:250 M. ECHELLE 1:250 M.

FIG. 11.2.3

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| PROJECT: SENERIZ<br>PROJET SENERIZ | | | | CONCEPTUAL DESIGN OF PROPOSED IRRIGATION DAM<br>ETUDE CONCEPTUELLE DU PROPOSE BARRAGE D'IRRIGATION | | | | | |
| CONTRACTORS<br>ENGINEERS<br>CONSULTANTS | | | | WEITZ HETTELSATER CORP.<br>Leadership in Agriculture & Nutrition<br>A Subsidiary of International Systems & Controls Corporation | | | | | |
| Des. By: RED/JLP | Date 7-77 | Checked By: RED/RMR | Date 7-77 | Drawn By: JLPEREZ | Date 7-7-77 | Scale NOTED | Dwg. No. 05-11-2 | | Rev. 0 |

429


NET IRRIGATION REQUIREMENTS (mm.)
BESOINS NETS EN IRRIGATION (mm.)
250 mm.
200
150
100
50
75
126
152
163
218
249
OCT.
NOV.
DEC.
JAN.
FEB.
MAR.




DESIGN NET MONTHLY APPLICATION

APPLICATION MENSUELLE NETTE THEORIQUE

TOTAL ANNUAL REQUIREMENTS (NET)
BESOINS ANNUELS TOTAUX (NET) = 799 mm.

MAX. MONTHLY REQUIREMENTS (NET)
BESOINS ANNUELS MAXIMA (NET) = 249 mm.

APR. MAY. JUNE JULY AUG. SEPT.

FIGURE- II·3·1

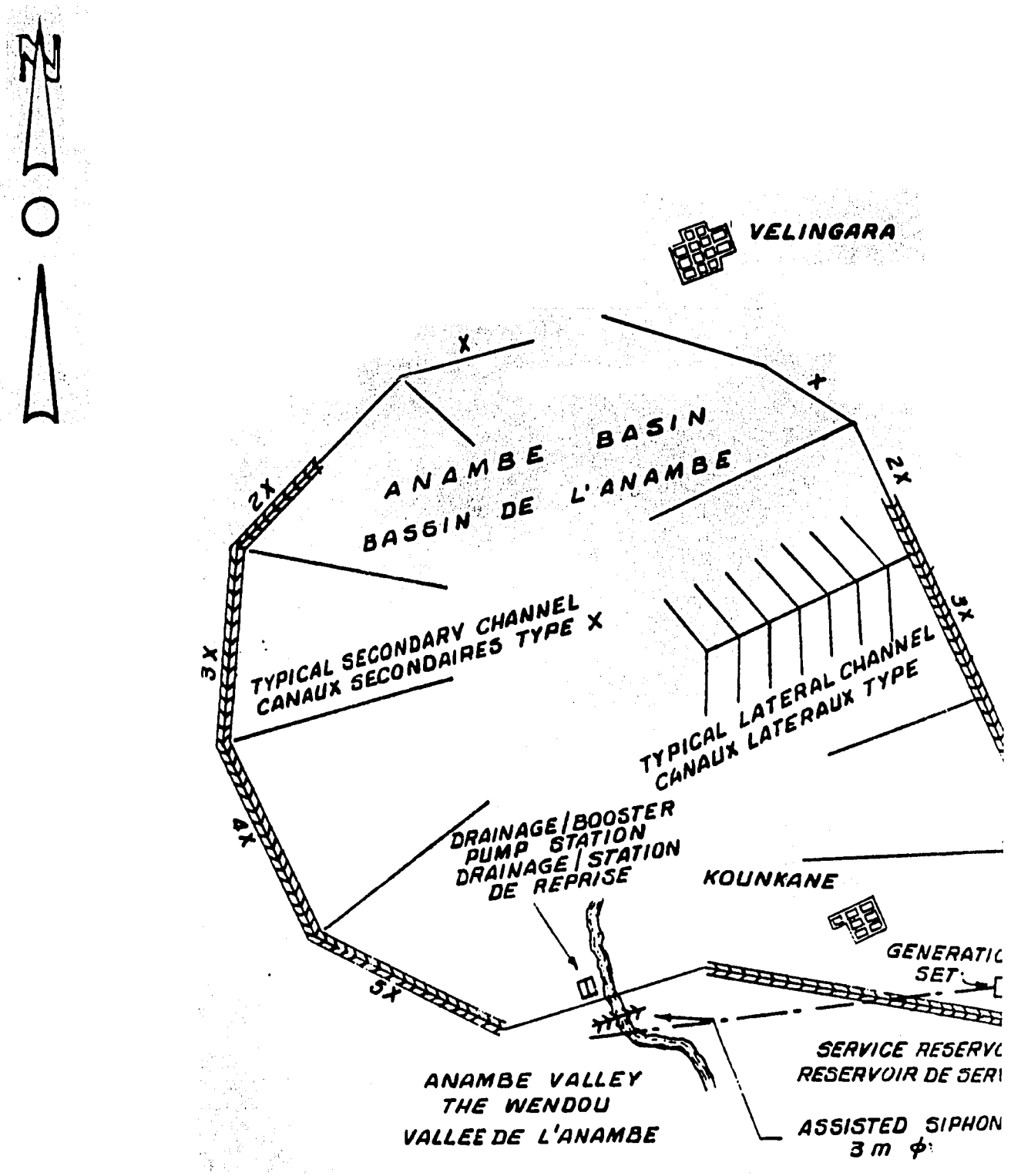
WEITZ HETTELSATER CORP-SODAGRI

IRRIGATION REQUIREMENTS
BESOINS IN IRRIGATION

DRAWING NO. 01. II. 3. 1

PREPARED BY: R.D. BUNTING

431


N
VELINGARA
X
X
2X
2X
3X
3X
4X
5X
ANAMBE BASIN
BASSIN DE L'ANAMBE
TYPICAL SECONDARY CHANNEL
CANAUX SECONDAIRES TYPE X
TYPICAL LATERAL CHANNEL
CANAUX LATERAUX TYPE
DRAINAGE/BOOSTER
PUMP STATION
DRAINAGE/STATION
DE REPRISE
KOUNKANE
GENERATIO
SET
SERVICE RESERVO
RESERVOIR DE SERV
ANAMBE VALLEY
THE WENDOU
VALLEE DE L'ANAMBE
ASSISTED SIPHON
3 m φ

## NOTES

NOT TO SCALE
SANS ECHELLE

PRIMARY CANALS
CANAUX PRIMAIRES

X, 2X, 3X, 4X, 5X. — INDICATED DESIGN OF CANAL
INDIQUE LE TYPE DE CANAL

CANAL FLOOD PROTECTION DYKE
DIGUE DE PROTECTION

POWER TRANSMISSION LINES
LIGNES ELECTRIQUES

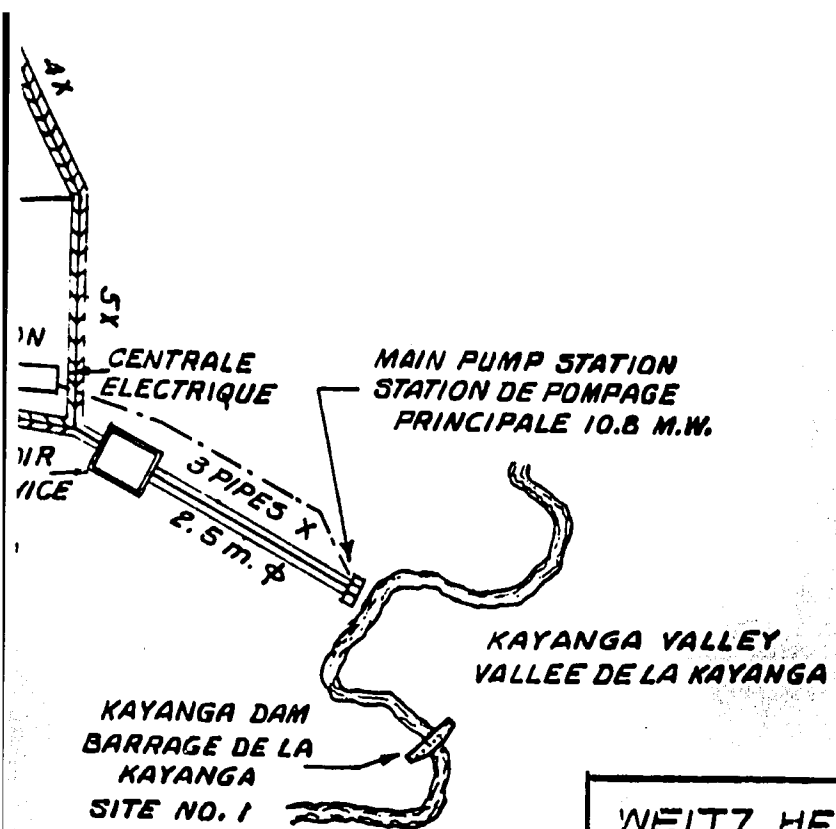



FIGURE - 11·3·2A

WEITZ HETTELSATER CORP. - SODAGRI

IRRIGATION NETWORK LAYOUT

AGENCEMENT DU RESEAU D'IRRIGATION

DRAWING NO. 01.11.3.2

PREPARED BY P.D. BUNTING

DRAWING BY E.J. CAYO DATE 6-13-1977

FOR TYPE 5'X' F

POUR LE TYPE 5'X'

FLOW
DEBIT $Q = 13,5\ m^3/s$ (476 c.f.s.)

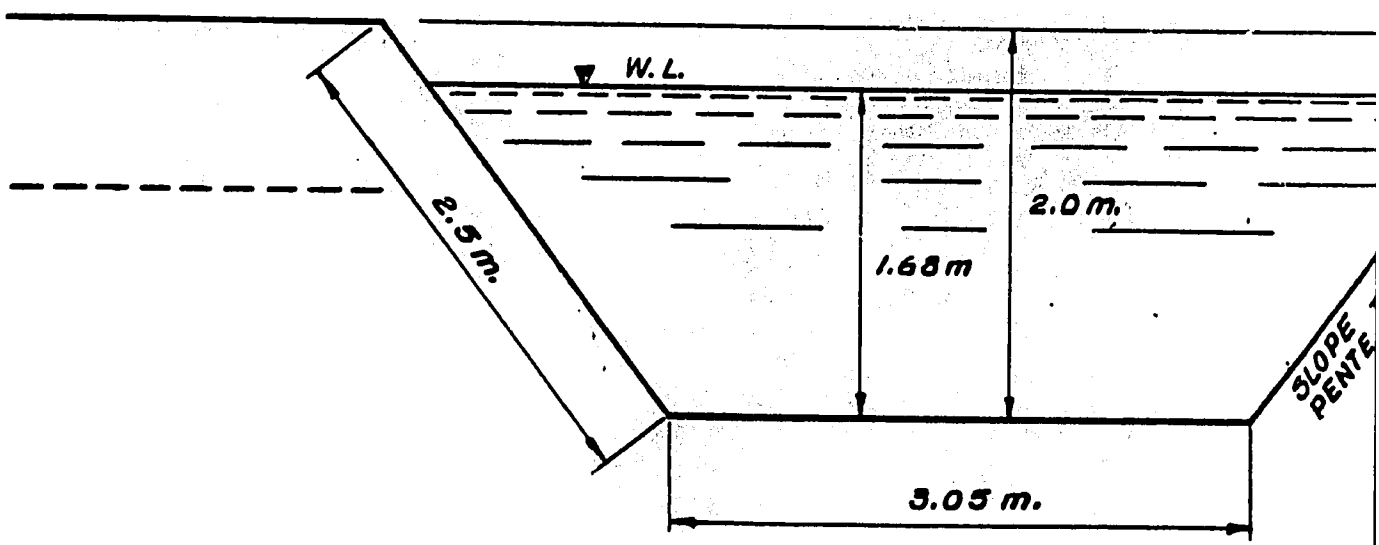
HYDRAULIC GRAD
PENTE HYDRAULIQUE $i = 0,0010$

ROUGHNESS COEFFICIENT
COEFFICIENT DE RUGOSITE $n = 0,0175$

FOR TYPE 4'X'

POUR LE TYPE 2'X'

FLOW
DEBIT $Q = 10,8\ m^3/s$ (381.0 c.f.s.)




CUT
DEBLAIS 4,7.4 m./lin. m.

CONCRETE LINING (50 OR 75 mm. THICK)
REVETEMENT EN BETON (50 OU 75 mm. D'EPAISSEUR) 8,0 m²

434

'RIMARY

PRIMAIRE

FLOW DEPTH
PROFONDEUR DE LA LAME D'EAU — d = 1,68 m (5'-6")

FLOW VELOCITY
VITESSE D'ECOULEMENT — V = 1,81 m/s. (5.95 ft/s.)

FLOW AREA
SECTION D'ECOULEMENT — A = 7,43 m² (80.0 ft²)

'RIMARY

PRIMAIRE

FLOW DEPTH
PROFONDEUR DE LA LAME D'EAU — d = 1,52 m. (5'-0")

FLOW VELOCITY
VITESSE D'ECOULEMENT — V = 1,72 m/s (5.66 ft/s)

FLOW AREA
SECTION D'ECOULEMENT — A = 6,39 m² (68 ft²)

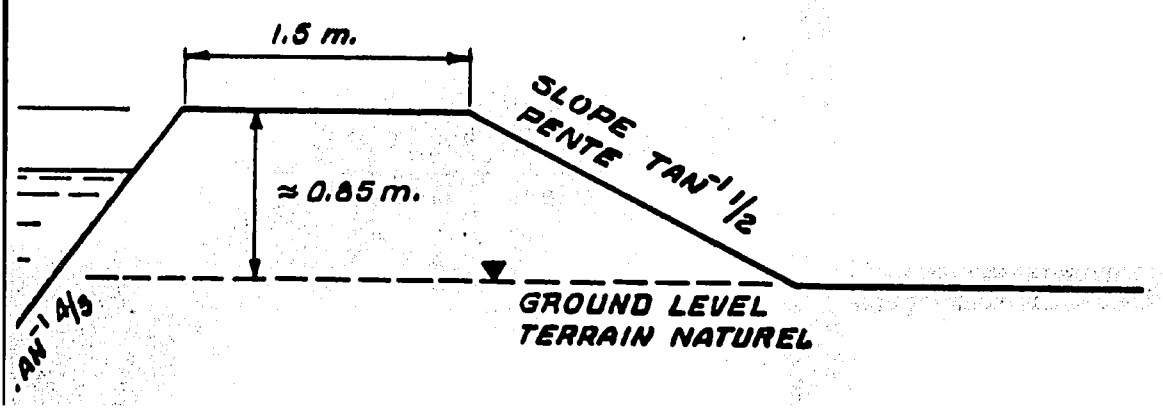



FIGURE- 11·3·2B

WEITZ HETTELSATER CORP.-SODAGRI

CANAL TYPE 5' X' ¢ 4' X'

DRAWING NO 02.11.3.2
PREPARED BY = P.D. BUNTING

/lin.m.

435

FOR TYPE 3'

POUR LE TYPE 3

FLOW / DÉBIT Q = 8,1 M³/s (285 c.f.s.)

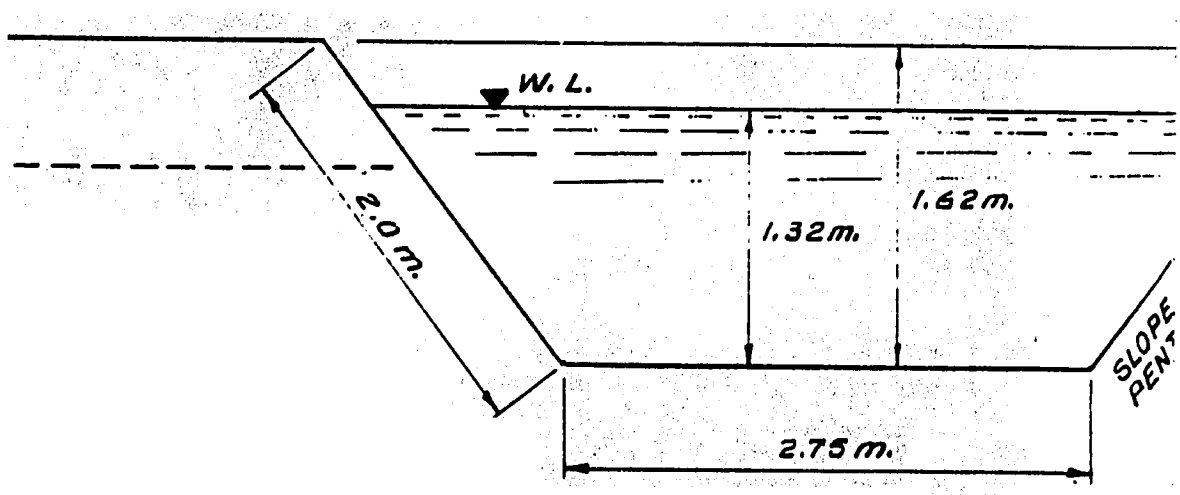
HYDRAULIC GRAD / PENTE HYDRAULIQUE i = 0,0010

ROUGHNESS COEFFICIENT / COEFFICIENT DE RUGOSITÉ n = 0,0175

FOR TYPE 2'

POUR LE TYPE 2

FLOW / DÉBIT Q = 5,4 M³/s (190,6 c.f.s.)




CUT / DÉBLAIS 3,63 m²/ lin. m.

CONCRETE LINING (50 OR 75 mm THICK)

REVETEMENT EN BETON (50 OU 75 mm D'ÉPAISSEUR)

## ' PRIMARY

## X' PRIMAIRE

FLOW DEPTH
PROFONDEUR DE LA LAME D'EAU — d = 1,32M. (4'-4")

FLOW VELOCITY
VITESSE D'ECOULEMENT — V = 1,59 m/s (5.22 ft/s.)

FLOW AREA
SECTION D'ECOULEMENT — A = 3,02 m² (34.04 ft²)

## r' PRIMARY

## 'X' PRIMAIRE

FLOW DEPTH
PROFONDEUR DE LA LAME D'EAU — d = 1,02 m. (3'-4")

FLOW VELOCITY
VITESSE D'ECOULEMENT — V = 1,4 m/s (4.59 ft/s)

FLOW AREA
SECTION D'ECOULEMENT — A = 3,6 m² (38.75 ft²)

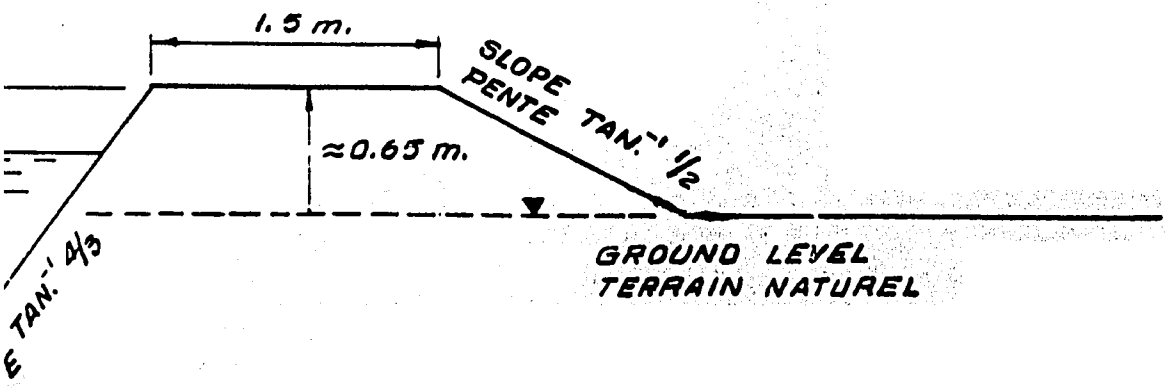



FIGURE- 11·3·2C

75 m²/lin.m.

WEITZ HETTELSATER CORP - SODAGRI

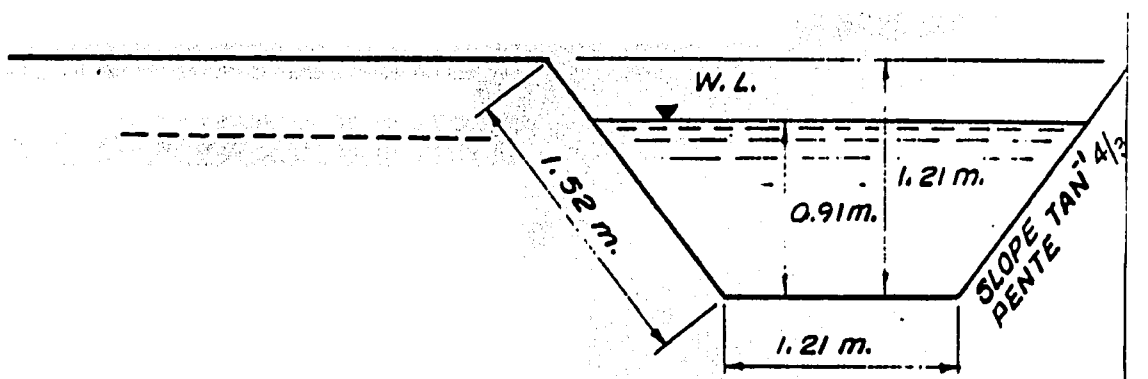
CANAL TYPE 3' X' & 2' X'

DRAWING NO. 03.11.3.2
PREPARED BY = P.D. BUNTING
DRAWN BY = F.J. CAYO DATE : 5-7-1977

FLOW
DÉBIT $Q = 2{,}7\ m^3/s$ ( 95.3 c.f.s. )

HYDRAULIC GRAD
PENTE HYDRAULIQUE $i = 0{,}0020$

ROUGHNESS COEFFICIENT
COEFFICIENT DE RUGOSITÉ, $n = 0{,}0175$

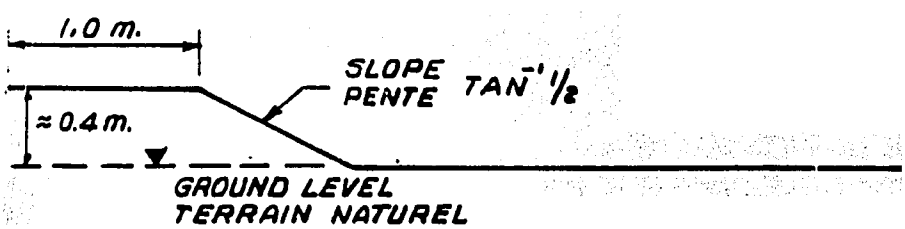



CUT
DEBLAIS $1{,}46\ m^2/lin.m.$

CONCRETE LINING (50 OR 75 mm. THICK)
REVETEMENT EN BETON (50 OU 75 mm. D'EPAISSEUR)

438

| | |
|---|---|
| FLOW DEPTH<br>PROFONDEUR DE LA LAME D'EAU | d = 0,91 m. (3'-0") |
| FLOW VELOCITY<br>VITESSE D'ECOULEMENT | V = 1,6 m/s (5.26 ft/s.) |
| FLOW AREA<br>SECTION D'ECOULEMENT | A = 1,74 m² (18.75 ft²) |




4.26 m²/lin.m.

FIGURE - 11.3.2D

WEITZ HETTELSATER CORP - SODAGRI

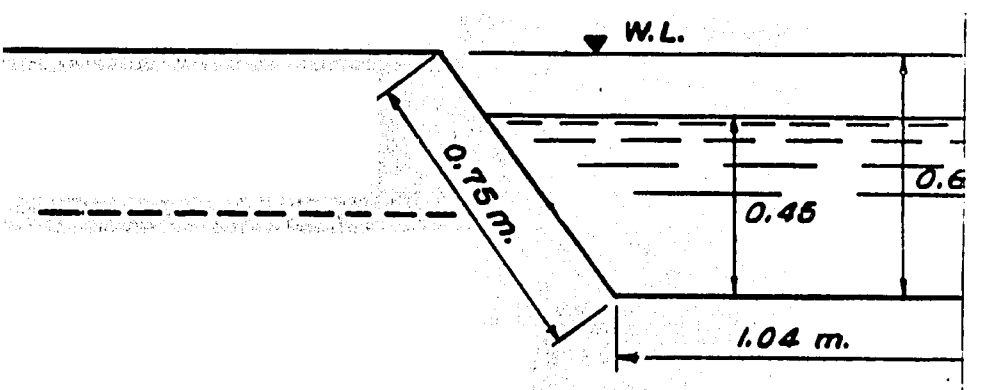
CANAL TYPE "X" SECONDARY
CANAL SECONDAIRE TYPE "X"

DRAWING NO. 04.11.3.2
PREPARED BY = P.D. BUNTING
DRAWN BY = E.J. CAYO DATE: 5-8-1977

FLOW
DEBIT $Q = 0{,}38\ m^3/s$ (11.9 c.f.s.)

HYDRAULIC GRAD
PENTE HYDRAULIQUE $i = 0{,}0005$

ROUGHNESS COEFFICIENT
COEFFICIENT DE RUGOSITE $n = 0{,}0175$




CUT : ASSUME
DEBLAIS : SUPPOSE
FILL : MAX. OF
REMBLAIS : MAX. D

CONCRETE LINING (50 OR 75 m
REVETEMENT EN BETON (50 OU 75 m

| | |
|---|---|
| FLOW DEPTH<br>PROFONDEUR DE LA LAME D'EAU | d = 0,46 m. (1'-5") |
| FLOW VELOCITY<br>VITESSE D'ECOULEMENT | V = 0,56 m/s (1.84 ft/s) |
| FLOW AREA<br>SECTION D'ECOULEMENT | A = 0,52 m² (6.72 ft²) |

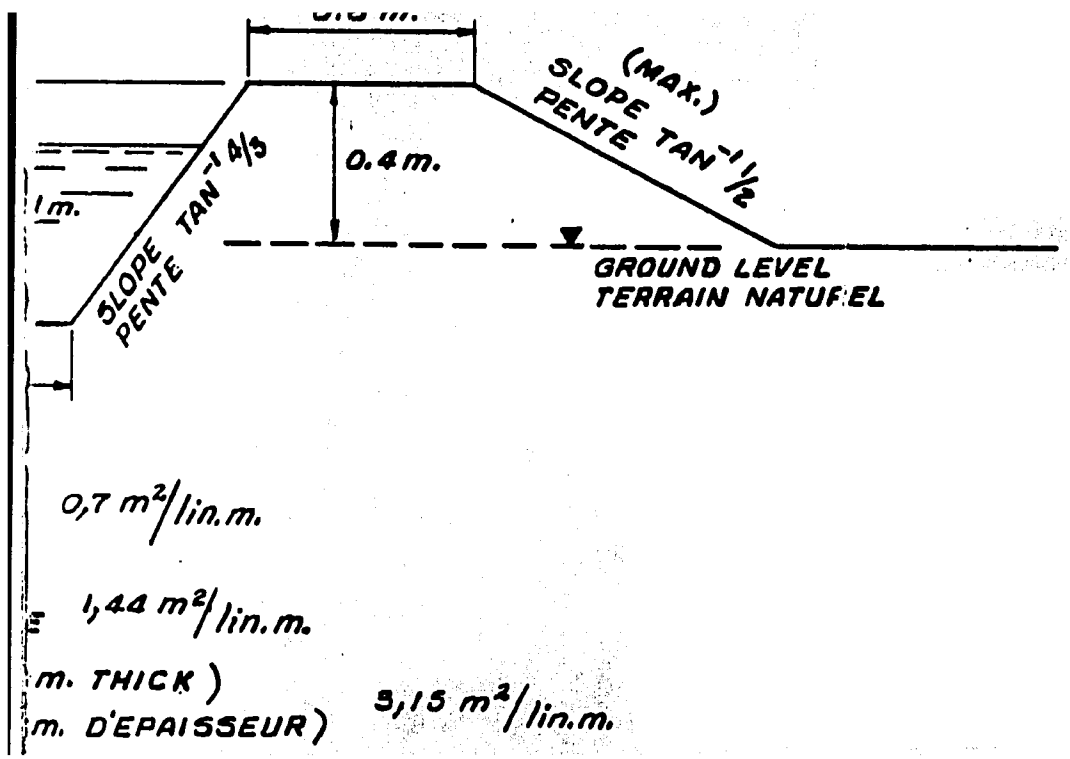



FIGURE - 11·3·2E

WEITZ HETTELSATER CORP - SODAGRI

CANAL TYPE "X/8" LATERAL

CANAL LATERAL TYPE "X/8"

DRAWING NO. 05.11.3.2

PREPARED BY = P.D. BUNTING
DRAWN BY = E.J. CAYO DATE : 5-11-1977

Full laboratory tests on the soils must be undertaken, on samples from selected borrow areas and abutments. These tests should include in situ density, shear strength, gradation determination of liquid and plastic limits, and relative density and Procter compaction tests.

Earthfill quantities : For a preliminary design estimate of construction quantities, upstream and downstream slopes of 3:1 have been used. This is considered conservative, but in the absence of precise soils characteristics, its use is justified.

Stripping quantities to a depth of 1.5 meters over the base of the dam have been allowed for in estimations of fill quantities.

For a maximum dam height of 15 meters and total crest length of just over two kilometers, the fill volumes are :

| | |
|---|---|
| Western section | 990,000 $m^3$ |
| Center section | 364,000 $m^3$ |
| Eastern section | 38,000 $m^3$ |
| Stripping | 123,000 $m^3$ |
| Total | 1.51 million $m^3$ |

Final design quantities should be a little lower than this, because of increases in the embankment slopes, but considering that the fill used may be of poor quality whose shear strength is low and which thus tends to slough easily, especially under rapid draw-down conditions, the reduction would not be great.

Gravel drainage filters to reduce pore water pressure in the dam fill and to allow controlled seepage should be installed.

Slope protection : Waves : As already mentioned, winds are generally from the west during the wet season when the reservoir

.../...

will be full. Even should freak winds accompanying rainstorms occur, they would be unlikely to exceed 160 km/h.

The site itself is just downstream of a sharp bend in the valley, which restricts the action of waves which may have developed several kilometers upstream. Such waves, using a fetch of 20 kilometers or more, could exceed two meters, but would be directed towards the western bank of the reservoir, not the dam wall.

The worst wave which might be considered to develop at maximum normal storage conditions would be produced on a short fetch.

| | | |
|---|---|---|
| Example : | Fetch | Less than 5 kilometers |
| | Wind speed | 160 km/h |
| | Wave height | 1.2 meters |
| | Uprush factor | 1.5 |
| | Design wave | 1.8 meters |

Under extraordinary flood conditions, with maximum reservoir water level under surcharge conditions, the minimum freeboard would be reduced to one meter below the crest elevation. This is considered satisfactory :

| | |
|---|---|
| Fetch | 5 kilometers |
| Wind speed | 80 km/h |
| Wave height | 1.0 meter |

Uprush : overtopping due to uprush considered acceptable.

<u>Rip-rap on the upstream face</u> : Laterite boulders are not the ideal material for rip-rap for many reasons :

1. Low density, resulting in thicker beds and greater volumes of rock.
2. Slight tendency to abrade, due to rather friable nature

of the rock.

3. Slight tendency to break down in water.

4. Rounded nature of the boulders, causing poor stability on steeper slopes.

However, on many sites lateritic boulders have been used successfully and certainly have provided the most economic solution. Should a source of harder stone be found in the project area, a careful cost comparison of the use of the two materials should be made.

On the dam of 40 meters crest height, the total upstream face area is 61,500 $m^2$.

Were laterite used, a thickness of 90 cm would be necessary. thus, the total volume of laterite would be 55,000 $m^3$.

This volume could be reduced by 20% were a denser, more durable, more angular rock available.

Downstream slope protection : Although the planting of grass on downstream slopes is a normal and inexpensive practice, in the case of this dry, arid climate, punctuated by heavy rainfall, 30 cm deep cobbles are recommended for a complete coverage. Difficulties resulting from drying cracks and then the possible ingress of water into the dam fill on the downstream face influence this recommendation.

Storms and spillway protection : Past meteorological data indicate that in the Vélingara Department, a maximum 24-hour rainfall of 237 mm occurred.

Extrapolation to the potential 100-year maximum tends to 300 mm. Application of this to the Kayanga, using a runoff coefficient of 40% under these exceptional conditions and assuming that 60% of the runoff occurs on the second day of the flood, indicates

that a total runoff of 115 million $m^3$ would be experienced.

Allowing for the surcharge storage capacity of 52 million $m^3$, the spillway capacity required would be for 60 million $m^3$ in 24 hours, i.e., 690 $m^3$/sec.

Other methods of calculating extreme floods include :

A. The Creager Formula : originally developed in the U.S.A., after the study of many floods, this formula has been applied to rivers of West Africa, but with lower C values than those originally adopted.

The expression for the maximum peak flood is :

$$Q = 1.303\ C \left(\frac{A}{2.59}\right)^{0.93A^{-0.048}}$$ , where

Q = Flow in $m^3$/sec

C- use 12.

A = Watershed, in $km^2$

Thus, the maximum flood would be 1,440 $m^3$/sec, but this is a point value.

B. Some designers have suggested the use of a broad rule of thumb : the anticipated maximum flood is equal to twice the maximum observed flood. Using the Kayanga runoff of October 7th, 1967, of 133.50 $m^3$/sec., the anticipated maximum flood, by this rule, would be 267 $m^3$/sec.

However, such an estimate is considered low because of the lack of long-term flood records. In the light of available information, a spillway capacity of 690 $m^3$/sec. is considered necessary.

More detailed investigation of the site and hydrological

regime of the valley will dictate final spillway design, but two possibilities should be mentioned :

A. A side overflow broad-crested weir and chute spillway, possibly located on the western side of the dam embankment. This would be in concrete.

B. A simple overflow channel dug out of the ridge two and one-half kilometers to the east of the dam center. This would discharge into the small valley joining the main Kayanga valley over one km downstream of the dam site.

Other engineering considerations : Earthquakes : Following enquiries at the Geology Department of the University of Dakar, it was reported that seismic activity is slight for the area, and should not be considered as a design criterium. A fault running from Linguère in the north down to Kolda is known to exist, but no damage is known to have occurred from movement of this fault.

Foundations : The exact nature of ground conditions beneath the dam is unknown, but believed to be several meters of grey clayey silt. It is undoubtedly unconsolidated because of its very recent fluvial origin. As a dam foundation, it is likely to allow little seepage, but because of its compressibility, settlement under the weight of the dam embankment will take place. Both the east and west lateritic abutments pose different problems; settlement might be minimal, but seepage more important. In future investigations, particular attention should be paid to the eastern abutment as it appears to be heavily weathered.

Sedimentation : Due to the total lack of information, no estimate of reservoir sedimentation has been made. During the future wet season, water samples from the Kayanga River should be taken periodically, upstream of the confluence with the Anambé. Using this and other field observations, estimates of the total bed-load and suspended load will be made, and life expectancy of the reservoir determined.

## 11.3. IRRIGATION SYSTEMS.

### 11.3.1. Irrigation Requirements and Potential.

The total available water in the storage reservoir is envisaged as 240 million $m^3$.

Rice grown using the contour strip method is not as wasteful of water as small scale traditional paddy rice production, as seepage from higher perimeters benefits lower fields, but nevertheless total irrigation efficiencies of 50% would be expected. On this basis, a total annual net irrigation requirement of 1,6 m is assumed, and considering the available stored water, a maximum potential area for dry season rice cultivation of 15,000 hectares is obtained.

Canal Capacity : The planned reservoir will make available 240 million $m^3$ of stored water in an average year. If one makes the assumption that the irrigation season will last five months, that water requirements will be distributed 10, 25, 35, 24, and 5 percent during the months of December through April, and that irrigation will be carried on 12 hours per day, the irrigation system must have a maximum capacity of 38.8 $m^3/s$. This capacity is necessary to meet the February demand. Increasing the irrigation period in February to 17 hours permits reduction of required maximum capacity to 27.5 $m^3/s$, thus giving a constant demand for January, February, and March. Irrigation requirements are presented in graphic form in Figure 11.3.1.

### 11.3.2. Irrigation System Design.

Bearing in mind the high price of imported oil, a major consideration in the operating cost of power production or pumping, and the expense of other imported hardware, an attempt was made in the overall system design to achieve a functional, economic, yet not overly sophisticated irrigation scheme.

Figure 11.3.2.A. shows the schematic layout of this

irrigation network. Wherever possible, open canals have been recommended, but two sets of large-bore cast in situ reinforced concrete pipelines are essential, one leading from the main pumping station to the service reservoir and the other operating as an assisted syphon to cross the north end of the Anambé Valley.

The pumping units used at this assisted syphon should be designed to operate as drainage pumps for the principal drainage way of the Anambé basin during the wet season, and in the dry season to operate as a booster for the irrigation flow to the western side of the basin.

### 11.3.3. Sizing of the Irrigation Network.

The maximum theoretical net irrigation requirement is 249 mm/month during March. However, by this time some of the rice will no longer require water, assuming a 100-day rice planted in mid-November. A design net irrigation requirement was established to be applied at 50% overall efficiency, and with a normal operating period of 20 hours per day during the peak demand season; the gross application is thus : 400 mm/month on a 20 hour day. Design maximum irrigation flow is Q' = 27 $m^3$/sec., equivalent to 953 cfs or 427,680 g.p.m.

Major Pipelines : Main pump station to service reservoir.

Although expensive, as the scheme is presently envisaged, these cast-in-situ, reinforced pipes are the only practical solution for obtaining a head to the primary irrigation canals. Standard design procedures indicate :

to carry 27 $m^3$/ sec., use three pipelines, each 9 $m^3$/sec. capacity. Required diameter for velocities - 2 - 2.5 m/sec., = 2.5 $\phi$.

Distance of service reservoir from main pump station = 4 kilometers.

Thus, total pipeline required = 12 kilometers.

The pipelines should be fabricated with a steel shutter for preference, or any other method which would give $C_1$ = 140 (Mazen Williams Roughness coefficient).

Service Reservoir : Such a structure is considered adviseable as a flow regulator to both the outgoing and incoming lines and also as a limited storage in the event of emergency breakdown at the main pumping station.

At maximum daily flow rates, such a reservoir would have a capacity of 1,944,000 $m^3$ (24 hour supply). However, considering that in the event of power failure, the western branch of the irrigation network would also be inoperative, then the required storage would be 972,000 $m^3$.

A tentative size of 623 meters$^2$ by 2.5 m deep is suggested, shallow dig material being used to construct a peripheral dyke, 2.49 kilometers long and of cross sectional area 16 $m^2$, requiring 40,000 $m^3$ of fill. The bottom of this reservoir, 388,000 $m^2$, is to be treated to prevent unnecessary leakage.

Irrigation Canals : The general layout of irrigation canals is shown in Figure 11.3.2.A. Cross sections of typical canals making up the system are shown in Figures 11.3.2.B. through 11.3.2.D.

The sections of suggested canals are included not as final designs, but as a representation of the conceptual design of the project which may be used for initial budgetary purposes.

All flow rates were proportioned to the maximum design flow rate of Q = 27 $m^3$/sec., such that 'X', the secondary flow rate, was 2.7 $m^3$/sec., and the lateral flow was 'X'/8, i.e. 0.38

$m^3$/sec. Slopes were chosen on the basis of available topographic information - typically 0.0010 for primaries, 0.0020 for secondaries, and 0.0005 for laterals. These values are not representative in all cases, but suffice for this stage of the design of the project.

All irrigation canals should be faced with 50 to 75 mm of unreinforced Portland Cement concrete, or similar material to achieve a value of 0.0175 (Manning's coefficient). Field ditches are not included in this preliminary design.

Total canals runs are as follows :

| | |
|---|---|
| Primary | 46 kilometers |
| Secondary | 41.5 kilometers |
| Tertiary | 166 kilometers |

Also to cross the north end of the Anambé River, an assisted syphon will be necessary. Preliminary calculations indicate the use of a reinforced cast-in-situ pipe, three meters in diameter and three kilometers long.

11.3.4. Pumping Requirements.

The main pumping station, located on the western bank of Kayanga Dam Site No. 1, is described as follows :

| | |
|---|---|
| Lift : max. static lift | 20 meters |
| Column and pump station losses | 5 meters (7 psi estimate) |
| Discharge pipes | 8 meters |
| Total design head | 33 meters (108 ft., 47 psi). |

Three interconnected pumping groups are required, allowing for repairs on any of the groups or delivery lines. Each pumping group is to be designed for the following needs :

| | |
|---|---|
| Rate of flow | Q = 9 $m^3$/sec. |
| Total design head or T.D.H. | 33 meters |

.../... 450

Efficiency = 0.8
Power requirement = 4860 hp or 3.6 M.W./group.
Thus, station power requirements are 3 x 3.6 = 10.8 M.W.

The pumping unit at the drainage/booster station must satisfy two criteria :

For drainage : Q = 31.3 $m^3$/sec.
Head estimate = 5 meters
Efficiency or E = 70%
Hp = 2933.

For boosting irrigation supply head :
Q = 13.5 $m^3$/sec.
Head estimate = 15 meters
Efficiency or E = 70%
Hp = 3780 (2.8 M.W.)

On first inspection, it would appear that a pumping group, most probably low head centrifugal pumps, could be designed to meet both needs.

Total power requirements are thus 13.6 M.W.

11.3.5. Construction Quantities.

Quantities required for construction of the irrigation system are shown in Table 11.3.5. Principal items are listed below.

| Item | Quantity |
|---|---|
| For canals : | |
| Cut (dirt) | 754,140 $m^3$ |
| Place and compact (dirt) | 628,433 $m^3$ |
| Place concrete | 58,374 $m^3$ |
| Lining of canals | 1,047,690 $m^3$ of 50 or 75 mm slab. |

| | |
|---|---|
| **For service reservoir** | |
| Borrow, place, and compact | 40,000 $m^3$ |
| Place thin roller lining | 388,129 $m^3$ |
| **Reinforced concrete pipelines :** | |
| 3 meters in diameter | 3,000 lin. m. |
| 2.5 meters in diameter | 12,000 lin. m. |
| **Pumping stations :** | |
| Main pumping station at 10.8 M.W. | 1 station complete |
| Drainage/booster station at 2.8 M.W. | 1 station complete |
| **Power transmission :** | |
| Line (30 KVA) | 19 kilometers |
| Transformers | 1 set for 10.8 M.W. |
| | 1 set for 2.8 M.W. |

## 11.4. AGRO-INDUSTRIAL COMPLEX:

### 11.4.0. Introduction.

The development of rice production is the top priority for Project SENERIZ, but other crops such as sorghum, millet, and maize will also be produced.

An industrial complex which will provide a capability for receiving, weighing, precleaning, drying and storing paddy rice and other cereals is an essential part of the project. A rice mill, to produce good quality milled rice as a primary product, is also indispensable as a part of the industrial complex. Since paddy rice is the most delicate and difficult product to process, the basic industrial complex should be designed and sized to process this agricultural product, but the complex should also have the capability for processing

TABLE 11.3.5. Quantites Required for Construction of Irrigation System.

| Canal type | Quantity km east side | Quantity km west side | Total km | | Minimum cut $m^3$ | Concrete slab thickness | Concrete area of lining $m^2$ | Concrete slab to place $m^2$ |
|---|---|---|---|---|---|---|---|---|
| 5'X'. | 6.5 | 15.5 | 22 | PRIMARY | 104,280 | .075 cm | 176,000 | 13,200 |
| 4'X'. | 3 | 5 | 8 | | 37,920 | .075 cm | 64,000 | 4,800 |
| 3'X'. | 3 | 5 | 8 | | 29,040 | .050 cm | 54,000 | 2,700 |
| 2'X' | 4.5 | 3.5 | 8 | | 29,040 | .050 cm | 54,000 | 2,700 |
| 'X' | 20.5 | 21 | 41.5 (secondary) | | 60,590 | .050 cm | 176,790 | 8,839 |
| Laterals 'X'/8 | 82 | 84 | 166 (tertiary) | | 116,200 | .050 cm | 522,900 | 26,145 |
| Total quantites | | | | | 377,070 | | 1,047,630 | 58,374 |

N.B. The total quantity for minimum cut = 377,070 $m^3$. Actual cut is estimated to be twice measurement or 754,140 $m^3$. The latter figure is to be used for budget.

TABLE 11.3.6. Characteristics of Possible "Irrigated-Agricultural" Land.

| Crop | Soil Group | Useful ha. | Soil as studied by SODAGRI 1977 | Soil as studied by GERCA 1962 | Typical slopes | Any other comments |
|---|---|---|---|---|---|---|
| Rice | 4 | 18,000 x .6<br>10,800 | Heavier than anticipated. Has some rice potential; | Sandy-silt | 0.25% | As viewed rather light, but cultivated rice was seen on the soil. |
| | 6 | 5,500 | Silty-clay | Silty-clay | 0.06%-0.10% | Slightly sandy first 6 inches, after clay-silt. Drainage scheme necessary to prevent flooding. |
| | 7 | 2,000 | Heavy clay | Clay | less than .05% | Permanent swampy area; Hummocks. |
| Sorghum or other low moisture resistant crop | 5 | 12,000 (total available) | Sandy, rather permeable | Sand-sandy loam | 0.12%-0.27% | Top 30 cm loamy fine sand, below 30 cm, grey-brown sandy-clay loam. |

the other agricultural products mentioned above. Overly complicated systems are not included, but in many instances excess capacity has been provided to allow for equipment breakdowns and management problems.

Following studies and assessments of the Anambé basin region, and based in part on the personal knowledge and experience of members of the study team in other countries with similar climatic conditions, SODAGRI has attempted to design, size, and choose the most appropriate and practical type of machinery and equipment for the industrial complex of the project.

Harvesting of agricultural products may be considered the culmination of the agricultural activities for any particular crop. Harvesting must be coordinated with subsequent processing activities because of critical characteristic requirements that must be observed, some of which are as follows :

1. Grain harvested must not remain in its original form either in the field or covered for a prolonged period of time.
2. It must not be violently dried; that is, the drying must be done in smooth multiple steps for obtaining optimum results in quality of the final product.
3. Grain must be cleaned, and all trash that is brought from the field must be eliminated before drying and storing.
4. It must be properly stored and periodically observed while in storage in order to prevent spoilage.
5. It must be milled in an efficient manner to minimize breakage of the grain, thus producing higher quality in the finished product.
6. When the dried product is going to be used for seed, the product should be properly dried, cleaned, classified and graded and its germination must be determined and approved.

.../...

Incalculable losses occur in many countries of the world during the harvesting, drying, storing and handling of paddy rice and other agricultural products. Improper harvesting procedures, lack of adequate machinery and equipment for processing, storing, and milling the products, lack of knowledge and training of personnel are the causes of these valuable losses. Projet SENERIZ sets as its objectives the avoidance of such losses, by providing proper procedures, machinery and facilities, and training of personnel.

The industrial complex recommended should be composed of the following units or departments :

1. A drying and storage plant for weighing, receiving, pre-cleaning before drying, cleaning after drying, and storing.
2. A diesel-electric power generating plant, which will be the center of all power requirements for the combined agro-industrial complex.
3. A rice mill, capable of processing the dry paddy rice into a finished marketable product.
4. A laboratory to test the incoming paddy rice and other agricultural products, the finished product and other types of analyses that will be of assistance not only to the processors, but also to the field technical team.
5. A seed processing and treating plant. This plant will be capable of selecting the highest quality seed of the different agricultural products and subjecting them to treatments that will retain their quality until they are ready to be used.
6. A feed mill. This plant will be capable to process and proportionally mix balanced ration from the several products and by-products, thus producing proper feed for cattle, swine, and poultry.

.../...

All above-mentioned plants are herewith tentatively sized and explained in order to take care of the incoming crops within a period of time dictated by the duration of the harvests. A reasonable factor of safety has been taken into consideration for possible bumper crops within the economic parameters. Also, space has been provided for future expansion programs.

The general administrative offices and the central warehouse will be placed within the industrial complex with the purpose of obtaining a more effective supervision and overall control.

Required Plant Capacity : When the land development program has been fully carried out and the program of teaching and assistance to farmers is in full swing, cereals production in the Anambé basin should be at a high level. The combination of programs described in Chapter 10 should result in the following amounts of production :

| | |
|---|---|
| Rice | 104 173 tons |
| Sorghum | 30 756 tons |
| Millet | 6 551 tons |
| Maize | 26 172 tons |
| Total | 167 652 tons |

These quantities of cereals dictate the size and other characteristics of the various elements of the industrial complex, with particular effect on the capacity of the cereals center and the rice mill. The size of the seed plant is a function of area of crops grown, since that area determines the amount of seed needed. The size of the feed plant is determined by two interrelated factors : the amount of by-product from cereals processing that is available for livestock feeding, and the numbers of livestock to be fed.

11.4.1. General Description of the Drying and Storing Plant.



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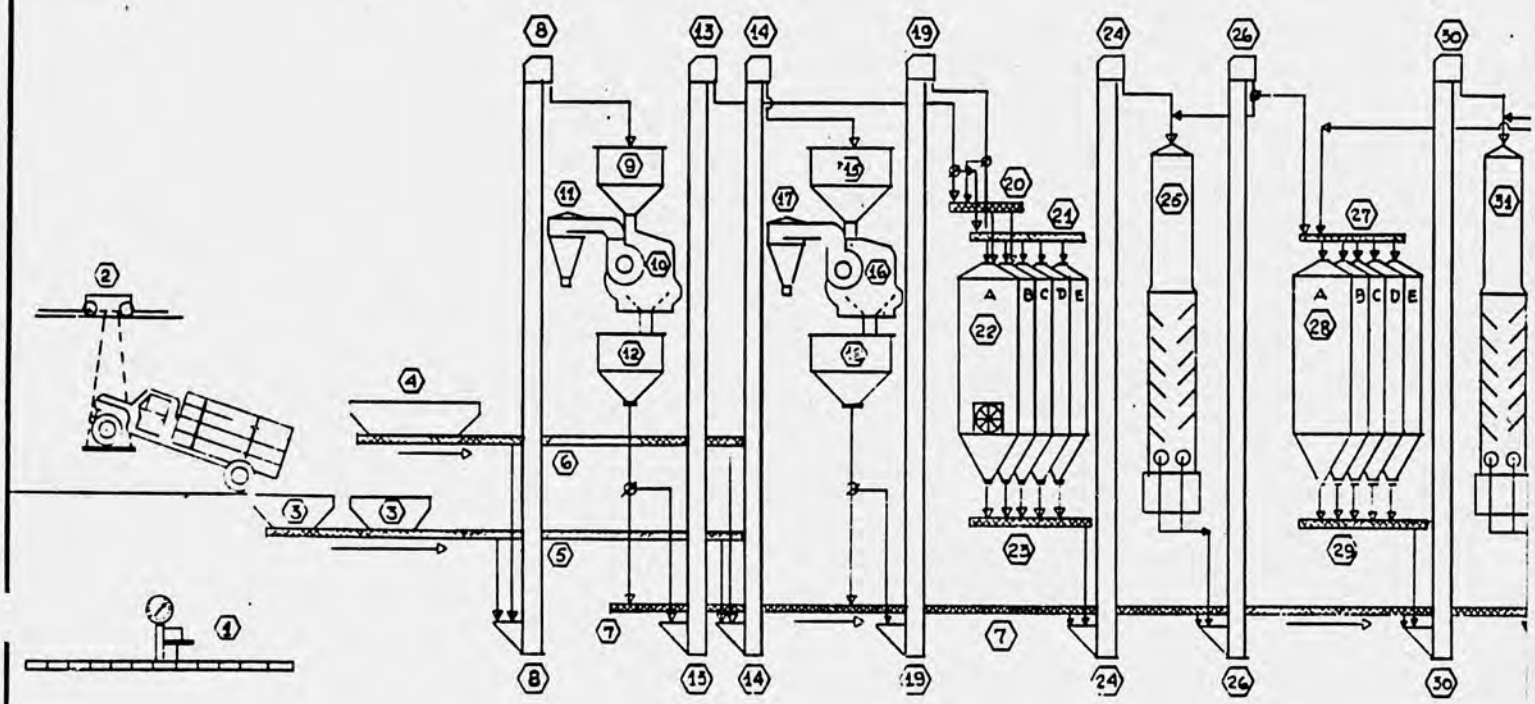
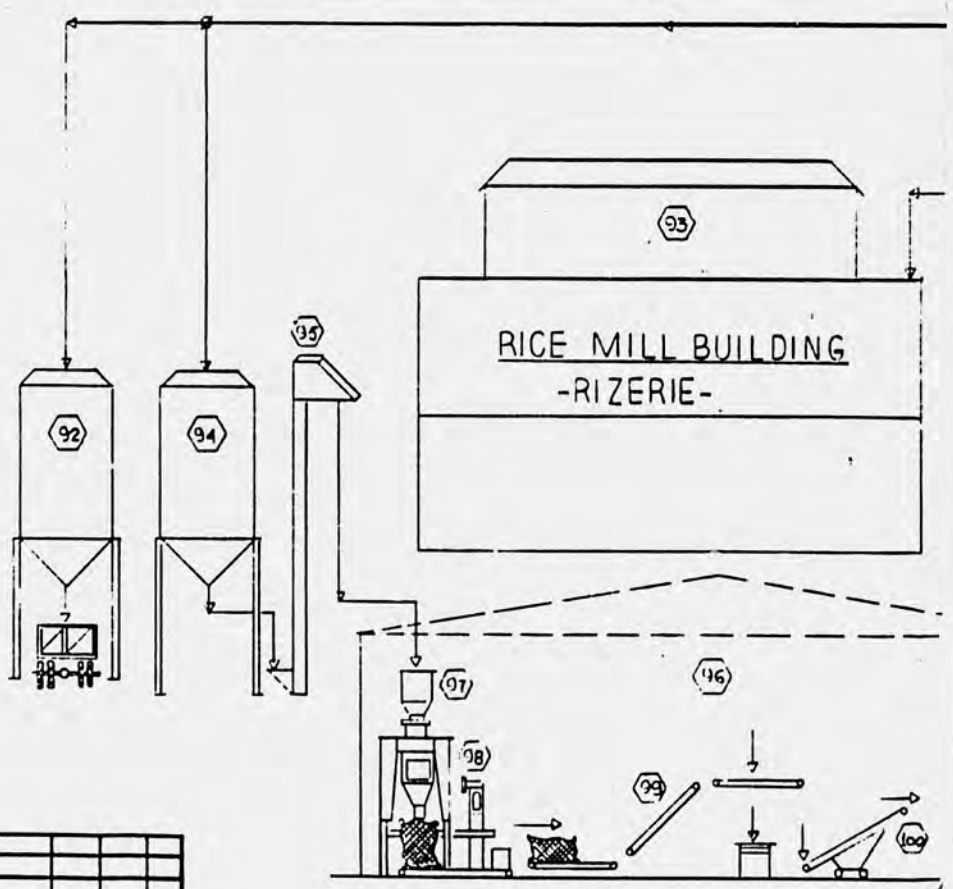
INSTALLATION DE NETTOYAGE SECHAGE ET STOCK

COMPLEXE AGRO-INDUSTRIEL D'ANAMBE BASSIN D'SEN

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| NO | DESCRIPTION | DRAWN BY | APPD BY | DATE | NO | DESCRIPTION | DRAWN BY | APPD BY | DATE |
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REVISIONS

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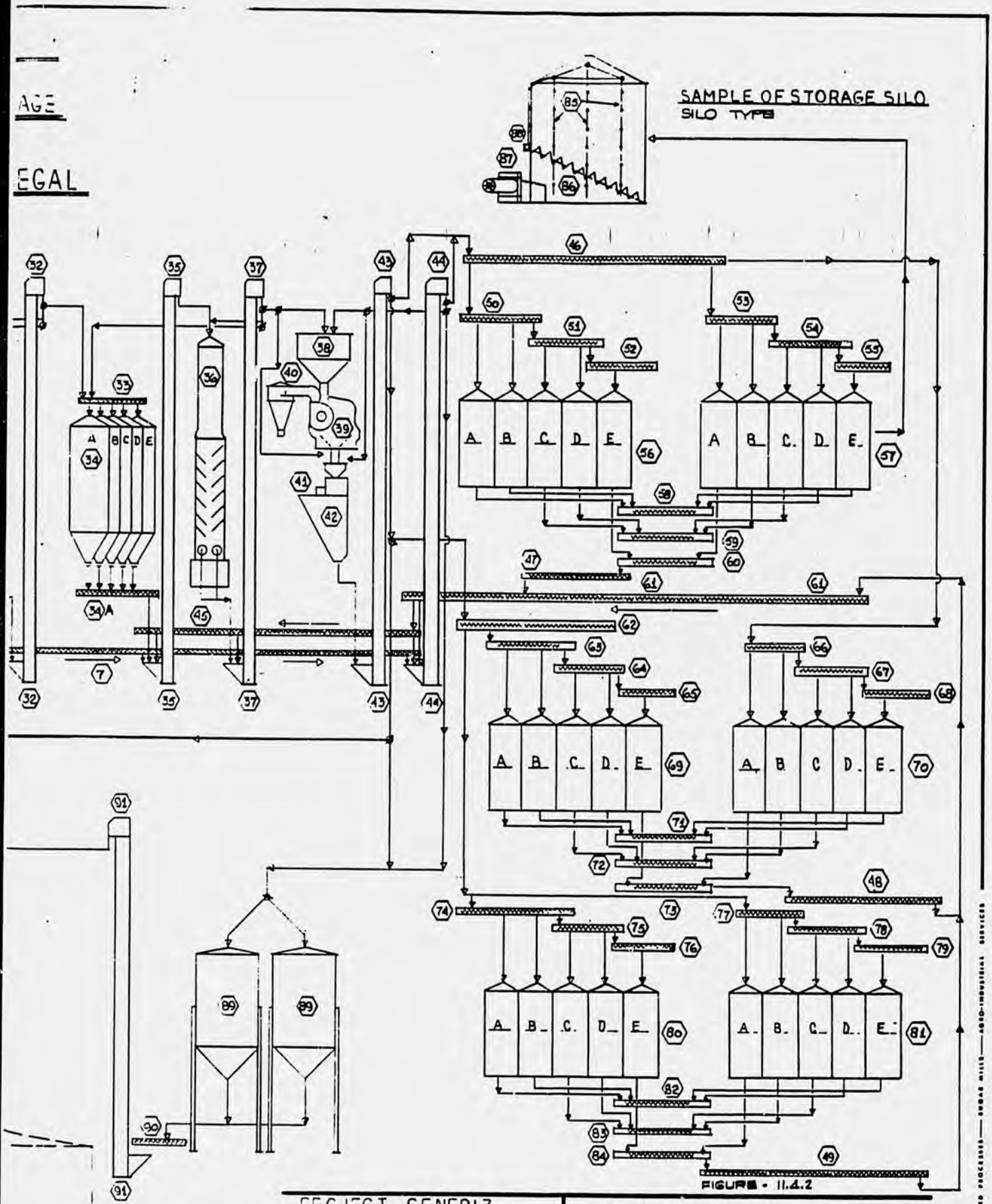


FIGURE - II.4.2

PROJECT SENERIZ
DEVELOPMENT OF THE ANAMBE BASIN

FLOW DIAGRAM
SCHEMA D'ECOULEMENT

SODAGRI

CONTRACTORS
ENGINEERS
CONSULTANTS

WEITZ HETTELSATER CORP.

Leadership in Agriculture & Nutrition

A Subsidiary of International Systems & Controls Corporation

| Des. By: | Date | Checked By: | Date | Drawn By: | Date | Scale | Dwg. No. | Rev. |
|---|---|---|---|---|---|---|---|---|
| F. Sarmiento | 2/26/77 | E.M. | 2/26/77 | F. Sarmiento | 2/26/77 | None | S-077-1 | 0 |

GRAIN PROCESSING — FOOD FIELD PROCESSORS — SUGAR MILLS — AGRO-INDUSTRIAL SERVICES

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INSTALLATION

# LEGEND

| ITEM | DESCRIPTION OF EQUIPMENT | MODEL-TYPE-SIZE | QTY |
|---|---|---|---|
| 1 | TRUCK SCALE | | 1 |
| 2 | TRUCK LIFT | | 1 |
| 3 | RECEIVING HOPPER | | 2 |
| 4 | RECEIVING HOPPER | | 1 |
| 5 | DRAG-FLIGHT CONVEYOR | | 1 |
| 6 | DRAG-FLIGHT CONVEYOR | | 1 |
| 7 | DRAG-FLIGHT CONVEYOR (TRANSFER) | | 1 |
| 8 | BELT BUCKET ELEVATOR | | 1 |
| 9 | STEEL HOPPER TANK | | 1 |
| 10 | PRE-CLEANER | | 1 |
| 11 | CYCLONE & EXHAUST FAN | | 1 |
| 12 | STEEL HOPPER TANK | | 1 |
| 13 | BELT BUCKET ELEVATOR | | 1 |
| 14 | BELT BUCKET ELEVATOR | | 1 |
| 15 | STEEL HOPPER TANK. | | 1 |
| 16 | PRE-CLEANER | | 1 |
| 17 | CYCLONE & EXHAUST FAN | | 1 |
| 18 | STEEL HOPPER TANK | | 1 |
| 19 | BELT BUCKET ELEVATOR | | 1 |
| 20 | DRAG-FLIGHT CONVEYOR | | 1 |
| 21 | DRAG-FLIGHT CONVEYOR | | 1 |
| 22 | RECEIVING HOPPER BOTTOM SILOS | | 5 |
| 23 | DRAG-FLIGHT CONVEYOR | | 1 |
| 24 | BELT BUCKET ELEVATOR (DRY LEG) | | 1 |
| 25 | COLUMNAR DRYER Nº 1 | | 1 |
| 26 | BELT BUCKET ELEVATOR (WET LEG) | | 1 |
| 27 | DRAG-FLIGHT CONVEYOR | | 1 |
| 28 | WORKING (TEMPERING) SILOS | | 5 |
| 29 | DRAG-FLIGHT CONVEYOR | | 1 |
| 30 | BELT BUCKET ELEVATOR (DRY LEG) | | 1 |
| 31 | COLUMNAR DRYER - Nº 2 | | 1 |
| 32 | BELT BUCKET ELEVATOR (WET LEG) | | 1 |
| 33 | DRAG FLIGHT CONVEYOR | | 1 |
| 34 | WORKING (TEMPERING) SILOS | | 5 |
| 35 | BELT BUCKET ELEVATOR (DRY LEG) | | 1 |
| 36 | COLUMNAR DRYER - Nº 3 | | 1 |
| 37 | BELT BUCKET ELEVATOR (WET LEG) | | 1 |
| 38 | STEEL HOPPER TANK | | 1 |
| 39 | PRE-CLEANER (END) | | 1 |
| 40 | CYCLONE & EXHAUST FAN | | 1 |
| 41 | AUTOMATIC HOPPER SCALE | | 1 |
| 42 | STEEL HOPPER TANK | | 1 |
| 43 | BELT BUCKET ELEVATOR | | 1 |
| 44 | BELT BUCKET ELEVATOR | | 1 |
| 45 | DRAG-FLIGHT CONVEYOR (TRANSFER) | | 1 |
| 46 | DRAG-FLIGHT CONVEYOR (TRANSFER) | | 1 |
| 47 | DRAG-FLIGHT CONVEYOR (TRANSFER) | | 1 |
| 48 | DRAG-FLIGHT CONVEYOR (TRANSFER) | | 1 |
| 49 | DRAG-FLIGHT CONVEYOR (TRANSFER) | | 1 |
| 50 | DRAG FLIGHT CONVEYOR | | 1 |
| 51 | DRAG-FLIGHT CONVEYOR | | 1 |
| 52 | DRAG-FLIGHT CONVEYOR | | 1 |
| 53 | DRAG FLIGHT CONVEYOR | | 1 |
| 54 | DRAG-FLIGHT CONVEYOR | | 1 |
| 55 | DRAG-FLIGHT CONVEYOR | | 1 |
| 56 | STORAGE SILOS - 1st ROW | | 5 |
| 57 | STORAGE SILOS - 2nd ROW | | 5 |
| 58 | DRAG-FLIGHT CONVEYOR | | 1 |
| 59 | DRAG FLIGHT CONVEYOR | | 1 |
| 60 | DRAG-FLIGHT CONVEYOR | | 1 |
| 61 | DRAG FLIGHT CONVEYOR (TRANSFER) | | 1 |
| 62 | DRAG FLIGHT CONVEYOR | | 1 |
| 63 | DRAG-FLIGHT CONVEYOR | | 1 |
| 64 | DRAG-FLIGHT CONVEYOR | | 1 |
| 65 | DRAG-FLIGHT CONVEYOR | | 1 |
| 66 | DRAG FLIGHT CONVEYOR | | 1 |
| 67 | DRAG-FLIGHT CONVEYOR | | 1 |
| 68 | DRAG-FLIGHT CONVEYOR | | 1 |
| 69 | STORAGE SILOS 3rd ROW | | 5 |

| ITEM | DESCRIPTION OF EQUIPMENT | MODEL-TYPE-SIZE | QTY |
|---|---|---|---|
| 70 | STORAGE SILOS - 4th ROW | | |
| 71 | DRAG-FLIGHT CONVEYOR | | 1 |
| 72 | DRAG-FLIGHT CONVEYOR | | 1 |
| 73 | DRAG-FLIGHT CONVEYOR | | 1 |
| 74 | DRAG-FLIGHT CONVEYOR | | 1 |
| 75 | DRAG-FLIGHT CONVEYOR | | 1 |
| 76 | DRAG-FLIGHT CONVEYOR | | 1 |
| 77 | DRAG FLIGHT CONVEYOR | | 1 |
| 78 | DRAG-FLIGHT CONVEYOR | | 1 |
| 79 | DRAG-FLIGHT CONVEYOR | | 1 |
| 80 | STORAGE SILOS 5th ROW | | 5 |
| 81 | STORAGE SILOS - 6th ROW | | 5 |
| 82 | DRAG-FLIGHT CONVEYOR | | 1 |
| 83 | DRAG-FLIGHT CONVEYOR | | 1 |
| 84 | DRAG-FLIGHT CONVEYOR | | 1 |
| 85 | TEMPERATURE DETECTION SYSTEM | | 30 |
| 86 | BIN SWEEPER & UNLOADING CONVEYOR | | 30 |
| 87 | AERATION FAN | | 30 |
| 88 | CENTRALIZED TEMPERATURE READING STA | | 2 |
| 89 | RICE MILL DAY TANKS | | 2 |
| 90 | HELICOID (SCREW) CONVEYOR | | 1 |
| 91 | BELT BUCKET ELEVATOR | | 1 |
| 92 | STEEL HOPPER BOTTOM SILO (SHIPPING) | | 1 |
| 93 | RICE MILL BUILDING | | 1 |
| 94 | STEEL HOPPER BOTTOM SILO (BAGGING) | | 1 |
| 95 | BELT BUCKET ELEVATOR (BAGGING) | | 1 |
| 96 | WAREHOUSE (BAGGING & STORAGE) | | 1 |
| 97 | AUTOMATIC BAGGING SCALE | | 1 |
| 98 | SEWING MACHINE & CONVEYOR | | 1 |
| 99 | PORTABLE BAG CONVEYOR | | 1 |
| 100 | PORTABLE STACKING CONVEYOR | | 2 |
| 101 | | | |
| 102 | | | |
| 103 | | | |
| 104 | | | |
| 105 | | | |
| 106 | | | |
| 107 | | | |
| 108 | | | |
| 109 | | | |
| 110 | | | |
| 111 | | | |
| 112 | | | |
| 113 | | | |

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| NO | DESCRIPTION | MADE BY | APPD BY | DATE | NO | DESCRIPTION | MADE BY | APPD BY | DATE |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

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# LEGENDE

| NUM | DESCRIPTION DES EQUIPEMENTS | SPECIFICATION | QTE |
|---|---|---|---|
| 1 | PONT A BASCULE | | 1 |
| 2 | ELEVATEUR DE CAMION | | 1 |
| 3 | TREMIE RECEPTION GRAIN | | 2 |
| 4 | TREMIE RECEPTION GRAIN | | 1 |
| 5 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 6 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 7 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 8 | ELEVATEUR A GODETS | | 1 |
| 9 | TREMIE EN ACIER | | 1 |
| 10 | PRE-NETTOYAGE | | 1 |
| 11 | CYCLONE ET VENTILATEUR ASPIRANT | | 1 |
| 12 | TREMIE EN ACIER | | 1 |
| 13 | ELEVATEUR A GODETS | | 1 |
| 14 | ELEVATEUR A GODETS | | 1 |
| 15 | TREMIE EN ACIER | | 1 |
| 16 | PRE-NETTOYAGE | | 1 |
| 17 | CYCLONE ET VENTILATEUR ASPIRANT | | 1 |
| 18 | TREMIE EN ACIER | | 1 |
| 19 | ELEVATEUR A GODETS | | 1 |
| 20 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 21 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 22 | TREMIE RECEPTION GRAIN | | 5 |
| 23 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 24 | ELEVATEUR A GODETS | | 1 |
| 25 | SECHOIR A COLONNES | | 1 |
| 26 | ELEVATEUR A GODETS | | 1 |
| 27 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 28 | SILOS D'ATTENTE PREMIERE PASSAGE | | 5 |
| 29 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 30 | ELEVATEUR A GODETS | | 1 |
| 31 | SECHOIR A COLONNES | | 1 |
| 32 | ELEVATEUR A GODETS | | 1 |
| 33 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 34 | SILOS D'ATTENTE TROISIEME PASSAGE | | 5 |
| 35 | ELEVATEUR A GODETS | | 1 |
| | SECHOIR A COLONNES | | 1 |
| 37 | ELEVATEUR A GODETS | | 1 |
| 38 | TREMIE EN ACIER | | 1 |
| 39 | PRE-NETTOYAGE | | 1 |
| 40 | CYCLONE ET VENTILATEUR ASPIRANT | | 1 |
| 41 | BALANCE AUTOMATIQUE A TREMIE | | 1 |
| 42 | TREMIE EN ACIER | | 1 |
| 43 | ELEVATEUR A GODETS | | 1 |
| 44 | ELEVATEUR A GODETS | | 1 |
| 45 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 46 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 47 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 48 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 49 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 50 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 51 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 52 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 53 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 54 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 55 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 56 | CELLULES DE STOCKAGE | | 5 |
| 57 | CELLULES DE STOCKAGE | | 5 |
| 58 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 59 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 60 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 61 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 62 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 63 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 64 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 65 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 66 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 67 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 68 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 69 | CELLULES DE STOCKAGE | | 5 |

| NUM | DESCRIPTION DES EQUIPEMENTS | SPECIFICATION | QTE |
|---|---|---|---|
| 70 | CELLULES DE STOCKAGE | | 5 |
| 71 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 72 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 73 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 74 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 75 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 76 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 77 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 78 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 79 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 80 | CELLULES DE STOCKAGE | | 5 |
| 81 | CELLULES DE STOCKAGE | | 5 |
| 82 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 83 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 84 | TRANSPORTEUR A ENTRAINEMENT | | 1 |
| 85 | CONTROLE DE TEMPERATURE | | 30 |
| 86 | NETTOYEUR DE SILOS ET TRANSPORTEUR | | 30 |
| 87 | VENTILATEUR D'ASPIRATION | | 20 |
| 88 | STATION DE LECTURE DE TEMPERATURES | | 2 |
| 89 | SILOS DE LA RIZERIE | | 2 |
| 90 | TRANSPORTEUR A VIS | | 1 |
| 91 | ELEVATEUR A GODETS | | 1 |
| 92 | TREMIE EN ACIER | | 1 |
| 93 | RIZERIE | | 1 |
| 94 | TREMIE EN ACIER | | 1 |
| 95 | ELEVATEUR A GODETS | | 1 |
| 96 | MAGASIN | | 1 |
| 97 | BALANCE AUTOMATIQUE D'ENSACHAGE | | 1 |
| 98 | MACHINE A COUDRE ET TRANSPORTEUR | | 1 |
| 99 | TRANSPORTEUR MOBILE DE SACS | | 3 |
| 100 | TRANSPORTEUR MOBILE DE STOCKAGE | | 2 |
| 101 | | | |
| 102 | | | |
| 103 | | | |
| 104 | | | |
| 105 | | | |
| 106 | | | |
| 107 | | | |
| 108 | | | |
| 109 | | | |
| 110 | | | |
| 111 | | | |
| 112 | | | |
| 113 | | | |

FIGURE-11.4.24

PROJECT SENERIZ

DEVELOPMENT ANAMBE BASIN

LEGEND-FLOW DIAGRAM

LEGENDE-SCHEMA D'ECOULEMENT

SODAGRI CONTRACTORS ENGINEERS CONSULTANTS

WEITZ HETTELSATER CORP.

Leadership in Agriculture & Nutrition

A Subsidiary of International Systems & Controls Corporation

| Des By: | Date | Checked By: | Date | Drawn By: | Date | Scale | Dwg. No. | Rev. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | S-077-1A | |

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4-7-11

The industrial complex for receiving, pre-cleaning, drying, and storing paddy rice and other grains such as maize, sorghum, and millet shall have the capability and flexibility for processing and storing several products at the same time, with the least amount of mixing them during the process.

Generally, in multi-crop projects, the harvesting of the different agricultural products is prescheduled in order to avoid handling several products at the same time in the industrial plant. Nevertheless, a certain amount of overlapping of crops always occurs. This overlapping can be handled without difficulty by a double receiving system to be incorporated in this plant. By means of this double receiving system, two or more different products or varieties of the same product could be received and pre-cleaned at the same time.

Products shall be received either in bulk or in bags. A truck-scale (weightbridge) with an automatic ticket printer to register the incoming and outgoing products shall be located near the main entrance of the complex or near the main office.

When products are received in bags, these bags shall be unloaded, classified and graded before dumping them in the proper receiving hopper.

Five (5) receiving bins are located after the pre-cleaners and before the columnar dryers. Products of different characteristics shall be stored temporarily in these silos with aeration fans, before passing them through the dryers.

The drying plant shall contain three (3) columnar dryers, rather than one or two of larger capacity. The reasons for using three units are the following :

1. Flexibility for drying two products at the same time.

2. Avoidance of serious delays, in case any drying unit gets temporarily out of order.

Tempering or working silos, sized according to drying potential, are located near the three drying units. These silos are located in two rows of about five silos each, ten silos in total. They are hopper bottom silos, and are used to temper the grain in between passes. This tempering or equalisation of moisture in the grain is explained later in more details.

Several bucket elevators and drag-flight conveyors are used for handling the product throughout the plant. This handling equipment used for elevating and transporting the product while being processed shall also be used for storing the product in the different storage tanks, and for unloading the product from the storage tanks to the rice mill for shipping out in bulk or in bags.

The storage tanks shall be placed in rows in an approximately square configuration, to minimize the length of conveyors needed.

The capacity of each tank, for the first phase of the project, shall be approximately 1,700 tons (paddy rice basis), which makes a total of 52,000 tons of storage.

More tanks may be added in the future as needed, maintaining the flexibility of the plant.

Each storage tank shall contain an aeration and temperature detection system.

These systems shall enable the operators of the plant to monitor the conditions of the stored product and to aerate the product when necessary to preserve its quality.

The product could be returned from the storage silos to

main plant if required.

The drying and storage plant has been designed in such a way as to permit not only the performance of several operations at the same time, but actually two entire sequences of operations at the same time. The following are the standard sequences of operations in a plant of this type :

A Reception, pre-cleaning; drying; and storing.

B Reception, pre-cleaning, drying, and transporting to the rice mill.

C Reception, pre-cleaning; drying and transporting to bagging tank to bag the product.

D. Reception, pre-cleaning and by-passing the columnar dryers when the product is received dried to be stored.

E Transferring the product from one working silo to another.

F Transferring the product from any storage silo to another, to the rice mill, or to the bagging tank.

G Transferring the product from any storage silo to the main plant.

H Transferring the product from any storage tank to the automatic hopper scale and then to another storage tank. This is done during inventory.

The following combinations of operations can be performed simultaneously :

| | |
|---|---|
| A and F | C and F |
| A and G | C and G |
| A and H | C and H |
| B and F | D and F |
| B and G | D and G |
| B and H | D and H |
| E and F | E and G |
| E and H | |

While the plant is not receiving any product during the night-hours, several other operations could be performed.

Usually drying is done during the whole day in order to have the processing plant empty for the following day.

All products received during the day (usually 12-hours receiving time), shall be cleaned, dried, and stored in approximately 24 hours.

11.4.2. Drying and Storage Plant in Detail.

The following is a description of the installation and equipment of the cereals center and how it will operate. Reference numbers refer to encircled numbers in Figure 11.4.2. (Drawing 5-007-1), the flow diagram for the drying and storage plant.

Receiving and Weighing : Paddy rice, and other agricultural grain products, are received at the industrial complex from the fields in bulk by wagon, trucks and carts. Deliveries of products may also be made in bags from the smaller lots.

A truck scale (weightbridge), Reference No. 1, with a capacity of 50 tons. Platform shall be approximately 15.24 meters in length by 3.05 meters in width and shall have a deck of reinforced concrete construction. Weighing indicator shall be a cabinet dial. Scale shall be furnished with a printer, equipped with electric time and date stamp. Unit of weight shall be kilograms (metric system).

The truck scale shall be located at an entrance near the main office, where all the incoming and outgoing trucks shall be weighed and registered.

When receiving products from the field to be dried and stored, samples of the products shall be taken. These samples shall be classified and the moisture content shall be determined before dumping the load into the proper steel receiving hopper.

At the weighing-receiving office, a space shall be assigned for installing laboratory instruments such as electronic moisture testers, sample divider, laboratory cleaner, balances, pans, and other pertinent laboratory devices for testing the product at this stage.

Three steel receiving hoppers (Reference Nos. 3 and 4) shall be located under roof at the receiving area. This receiving area shall be a one-sided open structure, to serve as cover to the receiving area. The lengthwise open side shall be sufficient to permit the unloading of three trucks at the same time when the product is received by bags and shall have sufficient area to accomodate the load of three trucks.

Unloading and receiving procedures shall be the following :

- Unloading or bags from truck.
- Checking of variety and moisture content.
- Weighing of bags in portable platform scale. (This is done if not weighed in truck scale, or if different varieties are in the same truck).
- Temporary piling of bags, four or five bags high. Piling at the receiving area shall be performed according to varieties and moisture content. Three to four different varieties are to be expected.
- Opening and emptying of bags by varieties and by lots of approximately equal moisture, into the receiving hopper.

The unloading or receiving shed shall be designed in such a way as to permit receiving procedures during inclement weather. In designing the receiving shed, future bulk unloading shall be envisioned.

The overhead truck lift (Ref. No. 2) shall have a cradle capacity of approximately 5.5 tons. It shall be complete with cradle assembly, reversing switch, electric cord, and steel track. It shall be operated by an electric motor.



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Each steel receiving hopper shall have an approximate capacity of 17.26 cubic meters, which is equivalent to approximately 10 tons of paddy rice. It shall be so constructed that trucks can be driven over its grid. Internally, there shall be 50 degrees slope minimum at the valley angles. It shall be built of 11 gauge steel. Gates shall have remote manual operators located at ground level adjacent to the truck hoppers, and shall include position indicators.

Two of the steel receiving hoppers shall unload into one chain drag type conveyor (Ref. No. 5), and the other steel receiving hopper shall unload into another chain drag type conveyor (Ref. No. 6).

Both receiving chain drag conveyors shall have crescent type flights, and shall have a capacity of 100 tons per hour of paddy rice. All drag conveyors shall be furnished with the motor and drive components required as designed by the manufacturer. Motor shall have sufficient power to start conveyor from a standstill position fully loaded.

Receiving drag conveyor (Ref. No. 5) shall also discharge into transfer drag conveyor (Ref. No. 7).

Belt bucket elevator, (Ref. No. 8), called herein "receiving elevator" shall be self-supporting, with a capacity of 100 tons per hour of paddy rice. It shall have a two-way discharge valve with hand-chain to be operated from ground level. Maximum belt speed shall be 152 m. per minute. In addition to the basic components, the following shall be furnished : service ladder, machinery inspection platform, extra boot hoppers as required, back-stop. Bucket elevator shall be furnished with motor and drive components required as designed by the manufacturer. Motor to have sufficient power to start elevator from a standstill position fully loaded. Spouting shall be 25.4 cms in diameter.

Belt bucket elevator (Ref. No. 14) also called receiving

elevator shall be similar to bucket elevator Ref. No. 8, with a capacity of 100 tons per hour of paddy rice, but shall have a two-way valve.

From receiving bucket elevator (Ref. No. 8), the product shall be able to be elevated and discharged to the garner bin (Ref. No. 9) above the pre-cleaner (Ref. No. 10).

The pre-cleaned product shall fall by gravity to the receiving tank (Ref. No. 12), and from here either to the bucket elevator (Ref. No. 13) or to the transfer conveyor (Ref. No. 7).

From the receiving bucket elevator (Ref. No. 14), the product shall be able to be elevated and discharged to the garner bin (Ref. No. 15), above the pre-cleaner (Ref. No. 16).

The pre-cleaned product shall fall by gravity to the receiving tank (No. 18) and from here either to the bucket elevator (No. 19) or to the tranfer conveyor (No. 7).

The drag conveyors (Ref. Nos. 20 and 21) shall be similar in capacity to the conveyors Nos. 5 and 6 mentioned above, but shall have one inlet, four intermediate outlets, manually operated slide rack and pinion discharge gates, and one end outlet.

There shall be five receiving silos, Ref. Nos. 22A, B, C, D, and E. Each receiving silo shall have a minimum capacity of 125 tons of paddy rice and 50 degrees slope minimum in the hopper bottom, and corrugated galvanized roof and walls. The bin shall include an outside ladder with extension to manhole on the cone deck, and a conveyor and catwalk support. Galvanizing shall be 190 grams per square meter per side, hot dipped. The silo shall include rack and pinion discharge valves.

Each receiving bin shall be equipped with an aeration system.

Fans shall be of axial type with high limit humidistat control, and shall be direct driven. Air requirements shall be 0.56 cubic meters per minute per ton of paddy rice.

The chain drag conveyor (Ref. No. 23) shall be similar to the chain drag conveyors Nos. 5 and 6, but with a capacity of 90 tons of paddy rice per hour, with five inlets and one end outlet.

The belt bucket elevator (Ref. No. 24) shall be similar to the belt bucket elevator No. 8, but with a capacity of 90 tons of paddy rice per hour. It shall have a two-way discharge valve. Spouting shall be 25.4 cms in diameter.

Precleaning : Two precleaners (Ref. Nos. 10 and 16). The pre-cleaning of wet and dirty products, especially paddy rice, is usually a delicate process, mainly because of the characteristics of the product at the wet stage and because of the required capacity.

The pre-cleaners shall separate light trash, dust, and chaff by scalping the wet and dirty product by means of two squirrel cage scalping reels and aspiration. A rotary mesh cleaner and aspiration could be used instead of the squirrel cage scalping reels.

After passing through the pre-cleaner, the wet rough rice shall contain no appreciable amount of foreign material with any dimension greater than 13 mm (1/2 inch). The pre-cleaned, wet rough rice may contain fine material not removed by the initial aspiration. No bottom screen or wire cloth shall be used to waste fine material during the pre-cleaning of the wet paddy rice.

The pre-cleaner shall be supplied with a minimum of two squirrel-cage reels, and shall be constructed in such a way that any rough rice carried out with the roughage from the first reels will be essentially all regained by passage through the second reel.

The pre-cleaner shall be supplied with extra appropriate

squirrel-cage reels for other grains such as maize, millet, and sorghum.

The capacity required for the pre-cleaning process shall be 100 tons per hour. Two machines shall be required, each having a capacity of 50 tons per hour of wet paddy rice with a moisture content of approximately 22% and approximately 5% of foreign material (by weight).

The pre-cleaners shall include the proper exhaust fan, to use its own air system and cyclone (dust collector) Ref. Nos. 11 and 17, as required. Equivalent equipment shall be accepted.

From the pre-cleaners, the pre-cleaned product shall be discharged by gravity or by means of a drag conveyor to the steel hopper tanks Ref. Nos. 12 and 18, and from the steel hopper tanks to the belt bucket elevators Ref. Nos. 13 and 19.

Roughage and other foreign materials separated by the pre-cleaners shall be discharged to an outside bin or steel hopper tank to be removed by truck or other vehicle.

The belt bucket elevator Ref. No. 24 is referred to here as the "wet leg", and shall be similar to the bucket elevator No. 8, with a capacity of 100 tons of paddy rice per hour. It shall have one discharge transition with a 45 degrees slope. The maximum speed shall be 152 meters per minute. Spouting shall be 25.4 cms in diameter.

The continuous flow columnar dryers (Ref. Nos. 25, 31, and 36) are practically the heart and the most important item in the drying and storing plant. The highest turnout and the utmost quality of milled rice can be obtained only if the rice is properly dried. When paddy rice is dried very rapidly, the kernels will crack and later break during the milling process. Rapid drying causes heat damage to the rice kernels.

Drying with the continuous columnar dryers consists basically



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in passing the product through a column of heated air at a pre-determined temperature and at a pre-determined retention time. After the product leaves the dryer and is elevated by a belt bucket elevator ("dry leg"), it is placed in one of the tempering or working bins (silos).

The purpose of tempering is to permit the equalization of the moisture within the kernel. When the rice leaves the dryer, the areas near the kernel's surface are drier than the center of the kernel. Tempering permits unlocking of the inner moisture in the kernel in what is described as a "sweating" action. Failure to use the tempering technique results in a very large percentage of broken kernels in the milling process, which is unacceptable because it decreases the commercial value of the milled rice. The tempering period may vary from four to six hours, depending on operating conditions and accumulation of paddy in the plant. After the paddy has tempered, it is ready for the second pass through the dryer. The second pass is effected in the same manner as the first pass. The cycle is again repeated depending on the original moisture, and until the final desired moisture is reached. The dry rice should have 13% - 14% moisture content, wet basis. The last tempering period usually takes place at the storage silos.

After the last pass through the dryer, the product is cleaned in another cleaner. This second cleaning operation is more effective than the previous pre-cleaning because the rice is now dried and more dense. The foreign materials which are present in the rice are very light in weight and easily aspirated.

After leaving the cleaner, the product is weighed in bulk in a process scale which provides for inventory control of dried product receipts. The product is then stored in the storing silos, loaded out for shipment or loaded out to the mill tank for subsequent milling.

In backtracking the drying process a bit, it can thus be see

.../...

that the product is first elevated by the first belt bucket elevator of the "wet leg", the belt bucket elevator No. 24, and discharged into the top inlet of the first columnar dryer (Ref. No. 25) in order to receive its first drying pass.

To give the required drying capacity, and also to accomodate parameters such as the initial moisture content, the required number of passes, the tempering periods, etc, we have recommended the use of three small dryers instead of one or two of greater capacity.

This is a measure recommended when an industrial installation of this magnitude and capacity is to be installed in remote places. It provides a security factor in case one of the drying units suffers a temporary rupture. Also, it offers more flexibility in every respect, especially when different products are to be received, dried, and stored.

The continuous columnar dryers shall be equipped with galvanized weatherproof baffles and specified as follows :--- total moisture reducing capacity in three passes shall be from 22% to 13%; maximum temperature for air is 65.6°C (150°F), and maximum temperature for grain is 40.6°C (105°F), for paddy rice. The dryer shall be able to heat the air up to 104°C (220°F) for drying maize, sorghum, and millet. The "put-through" or feed rate of the dryer shall not be less than 90 tons per hour of paddy rice. The dryer must be capable of 15-20 minutes retention time. Towers shall be furnished complete; with supply garner bin; access ladder, service platform and powered "line-bottom" discharge with variable speed drive. Fan house shall be furnished complete with mandoors and lighting.

The control room shall also be furnished with mandoors and lighting. Oil burners and controls shall be furnished to operate using commercial standard fuel oil numbers 1 and 2. The blower shall be a heavy-duty industrial type. Controls shall be furnished

complete including a factory pre-wired control panel, with push-button stop-start station and indicating lights; and a low-grain-level indicator. In addition, a grain level indicator and an exhaust temperature switch shall be provided.

Each grain dryer shall be furnished with the motor and drive component required as designed by the dryer manufacturer. Bearings shall be anti-friction. Automatic moisture control shall be supplied with each dryer and shall be disconnected from the unloading conveyor. Automatic control shall monitor moisture content of the product only.

By using three drying units, each unit having a capacity of approximately 70 tons per hour per pass for paddy rice, at about 20 minutes retention time, the drying capacity of the plant shall not be less than 70 tons per hour for three passes. This means that without considering the tempering time, the drying plant shall be able to dry not less than 1,400 tons per day of paddy rice even when three passes are required. If the original moisture is less than 22% and only one or two passes are required, the capacity would be doubled or tripled.

When drying other grains, such as maize, sorghum, and millet, which are not as delicate to dry as paddy rice and for which the drying temperatures could be as high as 93°C (200°F), the capacity of the three drying units shall be as high as 130 tons per hour or about 2,600 tons per day.

<u>Tempering or Working Silos</u> : There are ten tempering silos (Ref. Nos. 28 and 34). The importance of using the tempering silos when using the continuous columnar dryers for the equalization of the moisture within the kernel, especially when drying paddy rice, has been explained. Other grains also need a certain amount of tempering before they are completely dried and conditioned for storage.

For the required capacity of the drying and storage plant, considering that several products and different varieties of the same product shall be handled, two rows of five bins or silos are required. Each bin shall have a minimum capacity of 150 tons each of paddy rice, and each bin shall have an aeration system. The first row of tempering bins is Ref. No. 28 on the flow diagram; the second row of tempering bins is Ref. No. 34, and their specifications are as follows : 150 ton paddy rice capacity bins, hopper bottom with slope of 45 degrees, corrugated galvanized roof and hopper. The bins include an outside ladder with extension to manhole on cone deck, conveyor and catwalk support. Galvanizing shall be not less than 190 grams per square meter per side, hot dipped. The bins also include rack and pinion discharge valves.

Each bin shall be equipped with one aeration system. Fans shall be of the axial type, with high limit humidistat control, and shall be direct driven. Air requirements shall be 0.55 cubic meter per ton of paddy rice.

Chain Drag Conveyors for Tempering Bins : The two rows of tempering or working bins shall have their required top feeding chain drag conveyors, Ref. No. 27 for the first row and Ref. No. 33 for the second row.

The two rows of tempering bins shall also have their required bottom unloading conveyors, Ref. No. 29 for the first row, and Ref. No. 34 for the second row.

The above-mentioned chain drag conveyors shall have a minimum capacity of 90 tons of paddy rice per hour, and shall be similar to chain drag conveyor Ref. No. 6 described above.

Both top feeding conveyors and both bottom unloading conveyors shall have their required inlet and outlet discharge rack and pinion valves.

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Belt Bucket Elevators for Drying Units : Each dryer shall have its required "wet leg" for feeding the dryer and "dry leg" for unloading the dryer.

For the first dryer (Ref. No. 25) the "wet leg" belt bucket elevator is Ref. No. 24; the "dry leg" elevator is Ref. No. 26.

For the second dryer (Ref. No. 31), the "wet leg" belt bucket elevator is Ref. No. 30; the "dry leg" elevator is Ref. No. 32.

For the third dryer (Ref. No. 36), the "wet leg" belt bucket elevator is Ref. No. 35; the "dry leg" elevator is Ref. No. 37.

All three "dry legs" and all three "wet legs", a total of six elevators used for drying, shall be similar to the belt bucket elevators 8 and 14 already described, but with a minimum capacity of 90 tons per hour of paddy rice.

Second Head House for Cleaning and Weighing : As it has been previously mentioned, the product shall be cleaned for a second time after the last pass through the dryer and before it is stored. It was also mentioned that the product shall be weighed in a bulk process scale which provides for inventory control of dried product receipts.

The second head house shall contain cleaning machines and the bulk process scale. A belt bucket elevator (Ref. No. 43) shall be located after the dry leg of the last dryer and before the second head house. This bucket elevator shall be similar to the one described above (Ref. No. 8), but with a capacity of 90 tons per hour of paddy rice.

In the second head house, the following machinery and equipment shall be supplied :

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- A steel hopper tank or garner bin above the cleaner (Ref. No. 38).
- A cleaner similar to the pre-cleaner already described, but with a capacity of 100 tons per hour of dry paddy rice. (Ref. No. 39).

In this case, the product and foreign materials are in a dry stage and the capacity of the cleaner shall be more than when cleaning wet product. The cleaner shall be supplied with exhaust fan and dust collector (cyclone) Ref. No. 40.

A steel hopper tank or garner bin for the bulk process scale shall be furnished as well. The bulk process scale (Ref. No. 41) is an automatic bulk scale, and shall have a capacity of approximately 306 kilograms per discharge of paddy rice. It shall be supplied with a partial weight recorder, choke-proof inlet, automatic compensation and mechanical interlock to prevent simultaneous opening of inlet gate and weigh hopper door. Weighing shall be done in kilograms. Another steel hopper tank or garner bin (Ref No. 42) shall be located below the bulk scale to receive the weighed product. The necessary spouting and valves shall also be supplied.

Storage Bins, Complementary Drag Conveyors, and Elevators

After the paddy rice and other grains have been properly pre-cleaned and dried, they have to be stored for a certain length of time. While the products are in storage, thay have to be periodically observed. Each storage silo shall be equipped for correct monitoring and control of the rice, by the use of temperature cables and aeration.

The storage silos shall be provided with large volume air fans and motors which circulate ambient air through a perforated floor up through the grain and exhaust through vents in the tank roof. The temperature of the product inside the silos is checked at predetermined time intervals by means of thermo-couples fixed to cables that are suspended from the tank roof. A readout instru-

ment is used to read the temperatures which are then entered into a log book.

A reclaim system shall be provided to move the stored rice back to the drying part of the plant, to the rice mill, or to ship out truckloads of the product.

Each silo shall be provided with a bin sweep and discharge auger which flows into reclaim conveyors. The stored product is shipped out via conveyors, into trucks or may be transferred to the rice mill day tank. The reclaim system may also be operated in conjunction with a belt bucket elevator to permit changing or "turning" of the product from one silo to another or trimming of tanks to fill them to full capacity.

The total storage capacity in the storage silos of this plant shall be approximately 52,000 tons of paddy rice. For this total storage capacity and in order to have flexibility because of the several products to be stored, the most practical and economical distribution shall be to have thirty (30) silos of approximately 1,700 tons each, arranged in six (6) parallel rows of five (5) silos each (Ref. Nos. 56, 57, 69, 70, 80, & 81). Each storage silo shall be approximately 14.63 meters (48 feet) in diameter and 19.91 meters (65.33 feet) in overall height.

The storage silos shall have corrugated galvanized steel roof sheets and walls. They shall include sub-floor aeration ducts with 13% of opening area and round perforations, four roof ventilators, outside and inside wall ladders, roof ladder, heavy-gauge inspection manhole, center and intermediate sumps with slide and unloading tube.

Each storage silo shall be supplied with the following complementary equipment :

- Aeration fan (Ref. No. 85), centrifugal type. Volume requirement for aeration shall be 0.17 cubic meter per

minute per ton of paddy rice. The transition between the fan and the bin shall also be furnished.

- Inspection detection system (Ref. No. 85), consisting of nylon coated cables with thermo-couples at about 1.7 meters spacing. A centralized system linked to the main selector switch on the control panel for all 36 storage bins shall also be included.
- Heavy duty sweep screw conveyor (Ref. No. 86), with back-board motor mount and rubber clearance wheel. The unit is to be for a capacity of 90 tons per hour of paddy rice. Motor and drive components required as designed by the manufacturer shall also be supplied.
- Horizontal unloading auger or screw conveyor and tube cap (Ref. No. 86). Special well with control gate handle, gear boxes, clutch and clutch control handle, special bin flange, and bin wall bracket for bin sweep. Portable horizontal power heads shall be furnished, to be completed for head and flight. Each drive unit shall be provided with electrical cable and complete with "Twist-lock" plug.

Complementary Drag Conveyors and Bucket Elevator :

About three drag conveyors of approximately 40.23 meters long each shall be required at the top of each row of storage bins.

For row No. 56, the corresponding conveyors are Ref. Nos. 50, 51, and 52. For row No. 57, the corresponding conveyors are Ref. Nos. 53, 54, and 55. For row No. 69, the corresponding conveyors are Ref. Nos. 63, 64, and 65. For row No. 70, the corresponding conveyors are Ref. Nos. 66, 67, and 68. For row No. 80, the corresponding conveyors are Ref. Nos. 74, 75, and 76. For row No. 81, the corresponding conveyors are Ref. Nos. 77, 78, and 79.

These drag conveyors shall be for conveying the product

into the different storage silos in each row of tanks. In between each parallel row of storage silos there shall be three drag conveyors, approximately 40.23 meters long each. These conveyors shall be for unloading the product from each storage silo.

The bin sweepers (Ref. No. 86) already mentioned above, in connection with the horizontal unloading auger or screw conveyor, shall unload the product from the storage silos and convey it to the main unloading conveyors. The main unloading conveyors shall be the following :

- between row No. 56 and row No. 57, the corresponding conveyors are Ref. Nos. 58, 59, and 60.
- between row No. 69 and row No. 70, the corresponding conveyors are Ref. Nos. 71, 72, and 73.
- between row No. 80 and row No. 81, the corresponding conveyors are Ref. Nos. 82, 83, and 84.

The unloading conveyors between row No. 69 and row No. 70 (conveyors Ref. Nos. 71, 72, and 73) shall unload into the two belt bucket elevators Ref. Nos. 37 and 44, and also into the transfer conveyor Ref. No. 45.

There shall be the following transfer drag conveyors for inter-connecting the loading and unloading drag conveyor of the storage tanks :

Loading : The transfer conveyors Ref. Nos. 46 and 62 will transfer product to the first three top conveyors in rows Nos. 56, 57, 69, and 70. Transfer conveyors Ref. Nos. 74 and 77 will transfer product to the other three top conveyors in rows Nos. 80 and 81.

Unloading : Transfer conveyor Ref. No. 47 will transfer product from bottom conveyor between rows Nos. 56 and

No. 57 to conveyor No. 61. The transfer conveyor No. 48 will transfer product from bottom conveyors between rows Nos. 69 and 70 to conveyor No. 61. The transfer conveyor No. 49 will transfer product from bottom conveyors between rows Nos. 80 and 81 to conveyor No. 61.

The transfer conveyor (Ref. No. 7) mentioned previously at the receiving part of the plant, shall be used for by-passing dryers when the product is received already dry, and shall service the plant from receiving the product after passing through pre-cleaners to the last bucket elevators (Ref. Nos. 37 and 44).

Belt Bucket Elevator for Storage, Shipping and Transferring to Rice Mill : This bucket elevator (Ref. No. 43), in conjunction with the bucket elevator (Ref. No. 44) which feeds the second head house, shall be able to transfer product from the plant to the storage bins, transfer product from the plant to the shipping tank, transfer product from the plant to the mill day tank, transfer product from the storage bins to the shipping tank, and transfer product from the storage bins to the second head house and to the mill day tank.

Transfer Conveyor from Storage Department to Mill Day Tank : This transfer conveyor (Ref. No. 61) shall receive stored product from the storage bins and transport the product to the mill day tank for further processing.

Warehouse for Bagging Precleaned and Dried Product : A warehouse shall be provided for bagging the precleaned and dried product to be shipped out. This warehouse shall be approximately 40 meters by 25 meters, and shall include the following equipment :

- A galvanized steel corrugated bin (Ref. No. 94).
- A weighing and bagging scale (Ref. No. 97).
- A sewing machine and bag conveyor (Ref. No. 98).
- Portable bag conveyors (Ref. No. 99).
- Portable stacking conveyor (Ref. No. 100).

Supplementary equipment such as portable platform scales, hand-carts for bags, etc.

Fumigation system : It is particularly important that grain being carried over for a certain length of time be closely checked for the presence of insects and rodents.

Grain should be fumigated periodically. Routine fumigation of grain as an insurance measure is a reasonable practice, but it should not be relied on at the expense of an inspection program.

Phostoxin has proven to be an excellent grain fumigant and has excellent penetrating and killing characteristics. It is easily applied to grain as it is moved in mechanized silo storage, can be used effectively in fumigating static stored bulk grain and sacked grain under gas-tight tarpaulins or in gas-tight enclosures. It is generally less hazardous to use than other fumigants, both from the standpoint of personnel safety and maintenance of grain quality.

It does not adversely affect the germination of seeds. A fumigation system shall be recommended for the entire industrial complex.

Intercommunication System : An intercommunication system shall be highly recommended for handling this large industrial complex. This system shall be very useful especially during the training period. The intercommunication system shall be adequate for the whole industrial complex, including other departments such as the rice mill, the seed plant, the warehouses, etc.

Fire Extinguishing System : A fire extinguishing system is recommended and shall be included. All fire extinguishing devices shall be of the rechargeable dry chemical powder type and shall be for use in areas where all types of fire hasards exist, such as paper, wood, flammable liquids, rubber and electrical apparatus.

Electrical Equipment : It would be difficult to describe in this type of report the electrical requirements for this industrial complex. At this stage it can be stated that the estimated electrical consumption for the drying and storage plant including lights, when fully loaded, should be approximately 425 KW (570 HP).

It is recommended that the electric-generating system shall be distributed into three diesel engine-driven power plants, to provide facilities to manually synchronize the generating units. An auxiliary unit for lighting and other utility services shall be installed.

Miscellaneous Equipment :

1. Steel spouting for all bucket elevators, 12 gauge steel. All required welded connection flanges, with nuts and bolts, shall be supplied.
2. All required asphalt cement and caulking compound for proper sealing of hopper and flat bottom bins.
3. All required bolts and nuts, steel bracketing, etc. for the assembly of bucket elevators.
4. Level indicator units for upper and lower sections of flat-bottom bins.
5. All required bolts, nuts, gaskets, etc. for assembly of conveyors.
6. Adaptor cone, plate and accessories for assembly of aeration systems to bins and flat bottom silos.
7. All sizes of nuts and bolts required for assembly of body sheet rings, roofs, hopper bottom sheets, ladders, etc., in receiving, working, and storage bins. Includes flashing for connections of perforated floor to walls, and fittings for center well and unloading tube.
8. Nuts and bolts, transition plates, etc. for the complete assembly of columnar dryers.
9. Complete steel structure with galvanized steel roof and walls for cleaners and bulk scales including all cor-

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responding steel hoppers.

10. Steel structural supports for all dust collectors or cyclones including all necessary ducting, elbows, and connections to cleaners.

11. Steel transition between loading conveyors and receiving working bins as well as transition between the bins and the reclaim conveyor units.

12. Steel transition between loading conveyors and storage or flat bottom bins.

13. Complete steel catwalk with hand-railing including steel supports for all loading conveyors on top of working and storage bins.

14. Steel transition between conveyors and bucket elevators, as well as between conveyors.

15. Discharge steel transitions for cleaners, bulk scales, hoppers, etc.

16. Discharge steel transitions for the three columnar dryers.

17. Guy wires, turn buckets and steel frames for bucket elevators.

18. Grating to cover inlet pit and main bucket elevator pit.

19. Six sump pumps for drainage.

20. Electrical equipment and materials for the whole plant.

### 11.4.3. Rice Milling Plant.

Based on the planned rate of development of cropland in the SENERIZ project, the uses of that cropland, and the rields expected from the crops and technology proposed, the following production of rice is projected for the six years of the project :

| Year of project | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Summer crop, T | 900 | 3630 | 8280 | 16130 | 35280 | 47380 |
| Winter crop, T | 500 | 1890 | 3480 | 6100 | 39910 | 53606 |
| Total | 1400 | 5520 | 11760 | 22230 | 75190 | 100986 |

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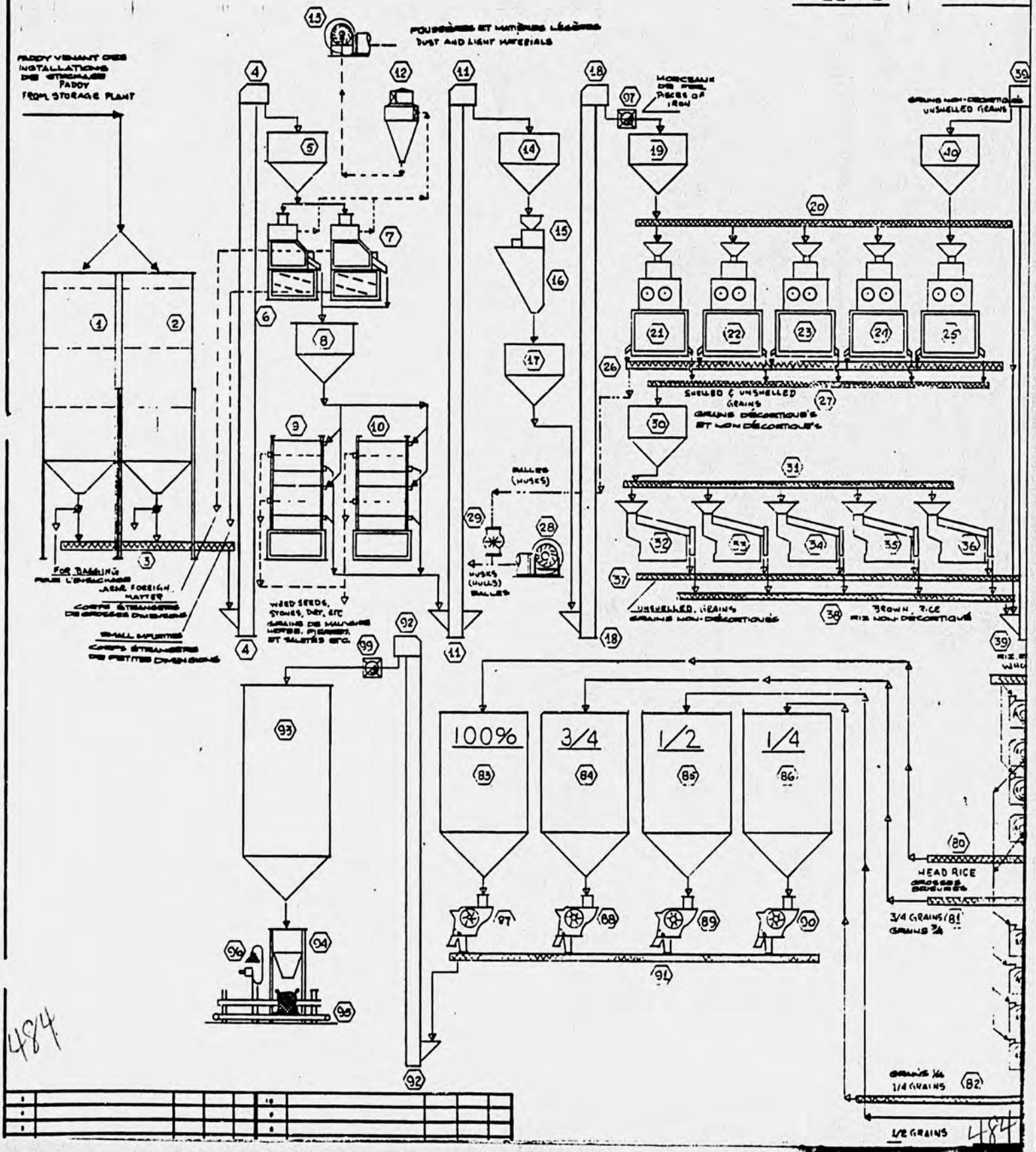
# RICE MILL (10 TON

# RIZERIE (10 MT/

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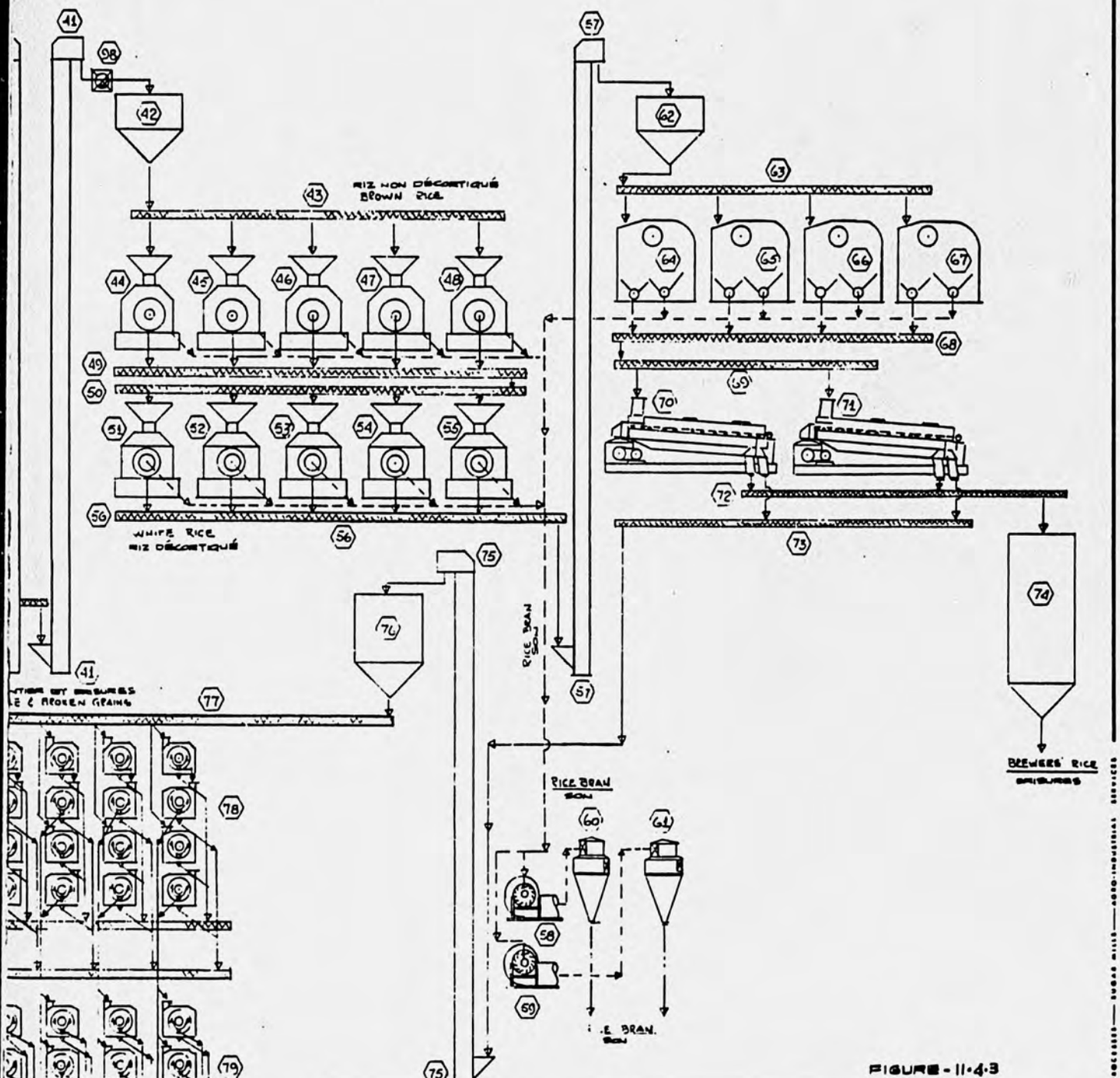


FIGURE - II·4·3

PROJECT SENERIZ

DEVELOPMENT OF THE ANAMBE BASIN

FLOW DIAGRAM

SCHEMA D'ECOULEMENT

SODAGRI

CONTRACTORS
ENGINEERS
CONSULTANTS

WEITZ HETTELSATER CORP.

Leadership in Agriculture & Nutrition

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RICE

RIZEF

# LEGEND

| ITEM | DESCRIPTION OF EQUIPMENT | MODEL-TYPE-SIZE | QTY. |
|---|---|---|---|
| 1 | MILL DAY TANK | | 1 |
| 2 | MILL DAY TANK | | 1 |
| 3 | HELICOID (SCREW) CONVEYOR | | 1 |
| 4 | BELT BUCKET ELEVATOR | | 1 |
| 5 | STEEL HOPPER BOTTOM TANK | | 1 |
| 6 | CLEANER | | 1 |
| 7 | CLEANER | | 1 |
| 8 | STEEL HOPPER BOTTOM TANK | | 1 |
| 9 | PRECISION GRADER CYLINDERS | | 6 |
| 10 | PRECISION GRADER CYLINDERS | | 6 |
| 11 | BELT BUCKET ELEVATOR | | 1 |
| 12 | CYCLONE (DUST COLLECTOR) | | 1 |
| 13 | EXHAUST FAN | | 1 |
| 14 | STEEL HOPPER BOTTOM TANK | | 1 |
| 15 | AUTOMATIC HOPPER SCALE | | 1 |
| 16 | SCALE HOPPER | | 1 |
| 17 | STEEL HOPPER BOTTOM TANK | | 1 |
| 18 | BELT BUCKET ELEVATOR | | 1 |
| 19 | STEEL HOPPER BOTTOM TANK | | 1 |
| 20 | HELICOID (SCREW) CONVEYOR | | 1 |
| 21 | RUBBER-ROLL SHELLER | | 1 |
| 22 | RUBBER-ROLL SHELLER | | 1 |
| 23 | RUBBER-ROLL SHELLER | | 1 |
| 24 | RUBBER-ROLL SHELLER | | 1 |
| 25 | RUBBER-ROLL SHELLER (RETURNS) | | 1 |
| 26 | HELICOID (SCREW) CONVEYOR - (HUSKS) | | 1 |
| 27 | HELICOID (SCREW) CONVEYOR | | 1 |
| 28 | EXHAUST (BOOSTER) FAN (HUSKS) | | 1 |
| 29 | ROTARY VALVE (HUSKS) | | 1 |
| 30 | STEEL HOPPER BOTTOM TANK | | 1 |
| 31 | HELICOID (SCREW) CONVEYOR | | 1 |
| 32 | PADDY SEPARATOR | | 1 |
| 33 | PADDY SEPARATOR | | 1 |
| 34 | PADDY SEPARATOR | | 1 |
| 35 | PADDY SEPARATOR | | 1 |
| 36 | PADDY SEPARATOR | | 1 |
| 37 | SCREW CONVEYOR (UNSHELLED GRAINS) | | 1 |
| 38 | SCREW CONVEYOR (BROWN RICE) | | 1 |
| 39 | BELT BUCKET ELEVATOR | | 1 |
| 40 | STEEL HOPPER BOTTOM TANK | | 1 |
| 41 | BELT BUCKET ELEVATOR | | 1 |
| 42 | STEEL HOPPER BOTTOM TANK | | 1 |
| 43 | HELICOID (SCREW) CONVEYOR | | 1 |
| 44 | HORIZONTAL ABRASIVE WHITENER | | 1 |
| 45 | HORIZONTAL ABRASIVE WHITENER | | 1 |
| 46 | HORIZONTAL ABRASIVE WHITENER | | 1 |
| 47 | HORIZONTAL ABRASIVE WHITENER | | 1 |
| 48 | HORIZONTAL ABRASIVE WHITENER | | 1 |
| 49 | BELT CONVEYOR | | 1 |
| 50 | BELT CONVEYOR | | 1 |
| 51 | STEEL CYLINDER WHITENER | | 1 |
| 52 | STEEL CYLINDER WHITENER | | 1 |
| 53 | STEEL CYLINDER WHITENER | | 1 |
| 54 | STEEL CYLINDER WHITENER | | 1 |
| 55 | STEEL CYLINDER WHITENER | | 1 |
| 56 | BELT CONVEYOR | | 1 |
| 57 | BELT BUCKET ELEVATOR | | 1 |
| 58 | EXHAUST FAN (BRAN) | | 1 |
| 59 | EXHAUST FAN (BRAN) | | 1 |
| 60 | CYCLONE (BRAN) | | 1 |
| 61 | CYCLONE (BRAN) | | 1 |
| 62 | STEEL HOPPER BOTTOM TANK | | 1 |
| 63 | BELT CONVEYOR | | 1 |
| 64 | DUO-ASPIRATOR (BRAN) | | 1 |
| 65 | DUO-ASPIRATOR (BRAN) | | 1 |
| 66 | DUO-ASPIRATOR (BRAN) | | 1 |
| 67 | DUO-ASPIRATOR (BRAN) | | 1 |
| 68 | BELT CONVEYOR | | 1 |
| 69 | BELT CONVEYOR | | 1 |

| ITEM | DESCRIPTION OF EQUIPMENT | MODEL-TYPE-SIZE | QTY |
|---|---|---|---|
| 70 | GYRO-SIFTER (BREWERS RICE) | | 1 |
| 71 | GYRO-SIFTER (BREWERS RICE) | | 1 |
| 72 | BELT CONVEYOR | | 1 |
| 73 | BELT CONVEYOR | | 1 |
| 74 | STEEL HOPPER BOTTOM TANK - (BREWERS) | | 1 |
| 75 | BELT BUCKET ELEVATOR | | 1 |
| 76 | STEEL HOPPER BOTTOM TANK | | 1 |
| 77 | HELICOID (SCREW) CONVEYOR | | 1 |
| 78 | INDENTED CYLINDER GRADERS | | 16 |
| 79 | INDENTED CYLINDER GRADERS | | 16 |
| 80 | BELT CONVEYOR (WHOLE GRAINS) | | 1 |
| 81 | BELT CONVEYOR (3/4 GRAINS) | | 1 |
| 82 | BELT CONVEYOR (1/4 GRAINS). | | 1 |
| 83 | STEEL HOPPER BOTTOM TANK (WHOLE) | | 1 |
| 84 | STEEL HOPPER BOTTOM TANK (3/4 G) | | 1 |
| 85 | STEEL HOPPER BOTTOM TANK (1/2 G) | | 1 |
| 86 | STEEL HOPPER BOTTOM TANK (1/4 G). | | 1 |
| 87 | VOLUMETRIC FEEDER | | 1 |
| 88 | VOLUMETRIC FEEDER | | 1 |
| 89 | VOLUMETRIC FEEDER | | 1 |
| 90 | VOLUMETRIC FEEDER | | 1 |
| 91 | HELICOID BLENDING CONVEYOR | | 1 |
| 92 | BELT BUCKET ELEVATOR | | 1 |
| 93 | STEEL HOPPER BOTTOM TANK (BAGGING) | | 1 |
| 94 | AUTOMATIC BAGGING SCALE | | 1 |
| 95 | BELT CONVEYOR (BAG) | | 1 |
| 96 | SEWING MACHINE | | 1 |
| 97 | SPOUT MAGNET | | 1 |
| 98 | SPOUT MAGNET | | 1 |
| 99 | SPOUT MAGNET | | 1 |
| 100 | | | |
| 101 | | | |
| 102 | | | |
| 103 | | | |
| 104 | | | |
| 105 | | | |
| 106 | | | |
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# LEGENDE

| NUM. | DESCRIPTION DES EQUIPEMENTS | SPECIFICATION | QTE. | NUM. | DESCRIPTION DES EQUIPEMENTS | SPECIFICATION | QTE. |
|---|---|---|---|---|---|---|---|
| 1 | SILOS DE LA RIZERIE | | 1 | 70 | PLANSICHTER (BRISURE) | | 1 |
| 2 | SILOS DE LA RIZERIE | | 1 | 71 | PLANSICHTER (BRISURE) | | 1 |
| 3 | TRANSPORTEUR A VIS | | 1 | 72 | TRANSPORTEUR A BANDE | | 1 |
| 4 | ELEVATEUR A GODETS | | 1 | 73 | TRANSPORTEUR A BANDE | | 1 |
| 5 | TREMIE EN ACIER | | 1 | 74 | TREMIE EN ACIER (BRISURE) | | 1 |
| 6 | NETTOYEUR | | 1 | 75 | ELEVATEUR A GODETS | | 1 |
| 7 | NETTOYEUR | | 1 | 76 | TREMIE EN ACIER | | 1 |
| 8 | TREMIE EN ACIER | | 1 | 77 | TRANSPORTEUR A VIS | | 1 |
| 9 | CYLINDRE CALIBREUR | | 6 | 78 | CYLINDRE TRIEUR A ALVEOLES | | 16 |
| 10 | CYLINDRE CALIBREUR | | 6 | 79 | CYLINDRE TRIEUR A ALVEOLES | | 16 |
| 11 | ELEVATEUR A GODETS | | 1 | 80 | TRANSPORTEUR A BANDE (GRAIN ENTIER) | | 1 |
| 12 | CYCLONE (COLLECTEUR DE POUSSIERES) | | 1 | 81 | TRANSPORTEUR A BANDE (GRAIN 96) | | 1 |
| 13 | VENTILATEUR A REFOULEMENT | | 1 | 82 | TRANSPORTEUR A BANDE (GRAIN 96) | | 1 |
| 14 | TREMIE EN ACIER | | 1 | 83 | TREMIE EN ACIER (ENTIER) | | 1 |
| 15 | BALANCE AUTOMATIQUE A TREMIE | | 1 | 84 | TREMIE EN ACIER (GRAIN 96) | | 1 |
| 16 | BALANCE A TREMIE | | 1 | 85 | TREMIE EN ACIER (DEMI-GRAIN) | | 1 |
| 17 | TREMIE EN ACIER | | 1 | 86 | TREMIE EN ACIER (GRAIN 96) | | 1 |
| 18 | ELEVATEUR A GODETS | | 1 | 87 | ALIMENTEUR VOLUMETRIQUE | | 1 |
| 19 | TREMIE EN ACIER | | 1 | 88 | ALIMENTEUR VOLUMETRIQUE | | 1 |
| 20 | TRANSPORTEUR A VIS | | 1 | 89 | ALIMENTEUR VOLUMETRIQUE | | 1 |
| 21 | DECORTIQUEUR A ROULEAUX DE CAOUTCHOUC | | 1 | 90 | ALIMENTEUR VOLUMETRIQUE | | 1 |
| 22 | DECORTIQUEUR A ROULEAUX DE CAOUTCHOUC | | 1 | 91 | TRANSPORTEUR MELANGEUR A VIS | | 1 |
| 23 | DECORTIQUEUR A ROULEAUX DE CAOUTCHOUC | | 1 | 92 | ELEVATEUR A GODETS | | 1 |
| 24 | DECORTIQUEUR A ROULEAUX DE CAOUTCHOUC | | 1 | 93 | TREMIE EN ACIER (SEMI-CHARGE) | | 1 |
| 25 | DECORTIQUEUR A ROULEAUX DE CAOUTCHOUC | | 1 | 94 | BALANCE AUTOMATIQUE D'ENSACHAGE | | 1 |
| 26 | TRANSPORTEUR A VIS (BALLES) | | 1 | 95 | TRANSPORTEUR A BANDE (SAC) | | 1 |
| 27 | TRANSPORTEUR A VIS | | 1 | 96 | MACHINE A COUDRE | | 1 |
| 28 | VENTILATEUR A REFOULEMENT (BALLES) | | 1 | 97 | TUYAU MAGNETIQUE | | 1 |
| 29 | VANNE ROTATIVE (BALLES) | | 1 | 98 | TUYAU MAGNETIQUE | | 1 |
| 30 | TREMIE EN ACIER | | 1 | 99 | TUYAU MAGNETIQUE | | 1 |
| 31 | TRANSPORTEUR A VIS | | 1 | 100 | | | |
| 32 | SEPARATEUR A PALLOY | | 1 | 101 | | | |
| 33 | SEPARATEUR A PALLOY | | 1 | 102 | | | |
| 34 | SEPARATEUR A PALLOY | | 1 | 103 | | | |
| 35 | SEPARATEUR A PALLOY | | 1 | 104 | | | |
| 36 | SEPARATEUR A PALLOY | | 1 | 105 | | | |
| 37 | TRANSPORTEUR A VIS (RIZ NON DECORTIQUE) | | 1 | 106 | | | |
| 38 | TRANSPORTEUR A VIS (RIZ NON DECORTIQUE) | | 1 | 107 | | | |
| 39 | ELEVATEUR A GODETS | | 1 | 108 | | | |
| 40 | TREMIE EN ACIER | | 1 | 109 | | | |
| 41 | ELEVATEUR A GODETS | | 1 | 110 | | | |
| 42 | TREMIE EN ACIER | | 1 | 111 | | | |
| 43 | TRANSPORTEUR A VIS | | 1 | 112 | | | |
| 44 | CYLINDRE ABRASIF A BLANCHIR | | 1 | 113 | | | |
| 45 | CYLINDRE ABRASIF A BLANCHIR | | 1 | | | | |
| 46 | CYLINDRE ABRASIF A BLANCHIR | | 1 | | | | |
| 47 | CYLINDRE ABRASIF A BLANCHIR | | 1 | | | | |
| 48 | CYLINDRE ABRASIF A BLANCHIR | | 1 | | | | |
| 49 | TRANSPORTEUR A BANDE | | 1 | | | | |
| 50 | TRANSPORTEUR A BANDE | | 1 | | | | |
| 51 | CYLINDRE EN ACIER A BLANCHIR | | 1 | | | | |
| 52 | CYLINDRE EN ACIER A BLANCHIR | | 1 | | | | |
| 53 | CYLINDRE EN ACIER A BLANCHIR | | 1 | | | | |
| 54 | CYLINDRE EN ACIER A BLANCHIR | | 1 | | | | |
| 55 | CYLINDRE EN ACIER A BLANCHIR | | 1 | | | | |
| 56 | TRANSPORTEUR A BANDE | | 1 | | | | |
| 57 | ELEVATEUR A GODETS | | 1 | | | | |
| 58 | VENTILATEUR A REFOULEMENT (SON) | | 1 | | | | |
| 59 | VENTILATEUR A REFOULEMENT (SON) | | 1 | | | | |
| 60 | CYCLONE (SON) | | 1 | | | | |
| 61 | CYCLONE (SON) | | 1 | | | | |
| 62 | TREMIE EN ACIER | | 1 | | | | |
| 63 | TRANSPORTEUR A BANDE | | 1 | | | | |
| 64 | ASPIRATEUR (SON) | | 1 | | | | |
| 65 | ASPIRATEUR (SON) | | 1 | | | | |
| 66 | ASPIRATEUR (SON) | | 1 | | | | |
| 67 | ASPIRATEUR (SON) | | 1 | | | | |
| 68 | TRANSPORTEUR A BANDE | | 1 | | | | |
| 69 | TRANSPORTEUR A BANDE | | 1 | | | | |

FIGURE- II-4-5A

PROJECT SENERIZ

DEVELOPMENT ANAMBE BASIN

LEGEND-FLOW DIAGRAM

LEGENDE-SCHEMA D'ECOULEMENT

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The foregoing production targets guide the choice of size of rice milling plant that is desirable. Not all of the production from the agro-industrial complex will be milled, as some must be saved for seed. In the other hand, the grain center expects to purchase from local producers their marketable surplus of cereals, including rice. Finally, it is recognized that the large scale milling of rice by the project will require that arrangements be made with CNCAD. For planning purposes, it is assumed that suitable arrangements will be made.

The rice produced will be of several different varieties that should be handled and milled separately.

A rice milling plant for Project [redacted] is planned with a capacity of 10 tons of paddy rice per hour. An alternative considered was to have two rice milling units, each of 5 tons per hour capacity; however, some factors such as construction costs and personnel training were determining factors in the decision to have one large unit instead of two small units. It is possible to design the large unit in such a way that only part of machinery and equipment will be working; thus, the large unit will be able to work at half capacity for small lots of paddy rice.

Rice milling capacity of 10 tons per hour yields the following theoretical capacities, if the mill operates 8,16 or 24 hours per day :

| | Hours of Operation per Day | | |
|---|---|---|---|
| | 8 Hours | 16 Hours | 24 Hours |
| One Day | 80 tons | 160 tons | 240 tons |
| One Month (20 Days) | 1,600 " | 3,200 " | 4,800 " |
| Six Months (120 Days) | 9,600 " | 19,200 " | 28,800 " |
| One Year (240 Days) | 19,200 " | 38,200 " | 57,600 " |

.../...

The rice mill planned does not have capacity to process all of the rice that the project is expected to produce in year 6. It is anticipated that other rice production projects in the Casamance will come into production before the production of SEMRIZ exceeds its milling capacity, and that in this context additional rice milling capacity will be developed. Such additional mills could be incorporated in the Anambe Basin Complex, or could be situated else-where, perhaps closer to centers of population.

Description of the rice milling process: In this description of the Rice Milling Process, it should be understood that the raw material entering the mill is relatively clean, dry (approximately 14% moisture) paddy rice. For the benefit of the end product of the milling process, it is of great importance to classify the paddy rice into homogeneous varieties, and to keep each variety separate from other varieties. The paddy rice entering the mill is the finished product of the drying plant of the Grain Center, and the various varieties will be kept separate without mixing during receiving, drying and storage in the Grain Center.

In case that different lots of paddy rice are bought from other farmers, these lots shall be properly classified before milling. Moisture content of purchased lots shall be tested in the laboratory, and weight discounts as well as excessive amount of foreign materials shall be deducted from the price paid for the purchased product.

The basic stages of the complete rice milling operation are the following :

a. Cleaning
b. Shelling
c. Separation
d. Whitening (Polishing)
e. Grading
f. Blending
g. Weighing and Bagging

Certain intermediate operations, such as separation of weed seeds, dirt-lumps, small stones and pieces of metals shall also be performed during one or more of the foregoing basic stages of the rice milling plant.

.../...

In the following section, the component units of the rice mill are described and their functions discussed. References are made to the Flow Diagram, Figure 11.4.3.

Mill day tanks (Ref. No. 1,2) : Mill day tanks with hopper bottom, with a capacity of approximately 240 metric tons each, shall be located near the milling plant. Their capacity shall be sufficient for one day of milling. The paddy rice from the storage bins shall be weighed at the automatic hopper scale of the drying and Storage Plant, and conveyed to the mill day tanks.

Cleaning (Ref. No. 6, 7 ) : This first stage of cleaning the paddy rice is always made, even though the paddy has been pre-cleaned during the drying stage, because particles of foreign matter such as earth, dust, immature grains, etc. have remained and the success of a good milling depends on a perfect cleaning of the grain before it is processed.

A. It is always very important to have a good sample of the paddy to be milled. Usually a laboratory analysis of the paddy to be milled is made, in order to know the percentages of foreign seeds; pebbles and other foreign mater.

B. The Cleaning equipment includes the standard cleaners (Ref. No. 6, 7). These units are equipped with two screens, an upper screen made of perforated metal and a lower screen of woven alloy wire. The screens are agitated by bouncing rubber balls. Aspiration is at inlet and outlet, and aspirated material is delivered to dust collectors (cyclones).

C. Because of the great amount of foreign seeds, stones, lumps of dirt, etc., that may be present, special cleaning equipment will be provided for use when needed. Sets of perforated Cylinders (Ref. No. 9) and Indented Disc Separators (Ref. No. 10) will be installed. There shall be provisions to by-pass the cylinders and discs, in case the paddy delivered does not have sufficient weed-seed or other foreign matter

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content to justify the use of special cleaning equipment.

Automatic Hopper Scale (Ref. No. 15,16) An automatic hopper scale shall be installed in sequence after the cleaning equipment. Weighing shall be in kilograms. This scale shall a partial weight recorder, choke-proof inlet, automatic compensation and mechanical interlock to prevent simultaneous opening of inlet gate and weigh hopper door, and shall include ticket printer device and counter.

Magnet : After the automatic hopper scale and before the paddy rice goes to the shelling machines, a spout magnet (Ref. No. 97) shall be installed. The flow of paddy shall be passed through the field of a non-electric, permanent magnet, which is sufficiently strong to capture all iron or steel nuts, bolts, tools, scrap metal, etc. that may cause damage to the rice milling equipement.

One magnet shall be located at each of the following locations :

A. In the paddy rice stream immediately before Paddy Sheller. (Ref. No. 97)
B. In the milled rice stream immediately before the first Polisher.
C. In the milled rice stream immediately before the bagging operation. (Ref. No. 99)

Shelling : Immediately after cleaning, the paddy goes to the Paddy Shellers (Ref. Nos. 21, 22, 23, 24, 25) to have the husk removed.

The old method of shelling was done by means of shellers with horizontal abrasive stones, one of them fixed, while the other stone moved at fixed speed and sufficient space between them so that when the grains were subjected to the abrasive surfaces, the shell would separate.

.../...

The stone sheller has the disadvantage of breaking both ends of the grains, especially when the machine has to be adjusted for the shelling of the short grains. Also, the stone sheller does not have an integrated husk separator.

A more modern solution is the rubber roll sheller, which has the advantage of reducing the percentage of grains broken during the shelling process. This has been considered a major break-through in the rice milling process. Shellers with rubber rolls, which rotate at two different speeds, shell the grains from the sides, needing only a light pressure.

The modern rubber roll shellers are made in compact units composed of the sheller itself and a closed circuit husk separator working as one unit. The following advantages of the rubber roll sheller have been observed :

A. It shells the grain by lateral pressure without requiring a previous grading of the grain.
B. The husk separator may be delivered as an integral part of the machine.
C. The rubber roll sheller has a larger capacity than the corresponding standard size of the stone sheller.
D. It breaks fewer grains than the stone sheller.
E. It does not require technical know-how for the maintenance of abrasive surface.
F. All wearing parts are easy to install and replace.

Paddy Separation: When the shelling and separation of the husk is done, approximately 5 to 20 percent of the paddy, the proportion depending on the type of shelling equipment and the condition of the paddy rice, will come out unshelled. The rest is "shelled" brown rice. The separation of these two kinds of rice is performed in the Paddy Separators (Ref. Nos. 32,33,34, 35, 36), which have to be adequate for the capacity of the shellers.

.../...

There are different types of paddy separators, but the priciple of separation is identical in all types. A gravity or densimetric type separator with 60 separating cells and variable speed is recommended, as this is one of the most advanced and accurate paddy separator.

The special oscillation, the specific gravity of the rice, and the compartments make it possible to separate the brown rice from the paddy rice. The final separation takes the brown rice to the whiteners (polishers), while the unshelled rice returns to the paddy sheller.

Whitening (Polishing): The brown rice, separated from the paddy rice as described in the section above, now goes to the whiteners (Ref. No. 44, 45,46,47, 48). These machines remove the outer layers of the grain, also called rice bran, whitening it and delivering a completely clean white rice.

There exist two systems for the process of whitening the rice : the traditional way uses vertical cones of abrasive material; a new system uses whiteners (polishers) with horizontal steel cylinders or abrasive cylinders. In both cases, the principle of whitening is that the friction removes the superficial coats of the grain. In the abrasive cones, the friction is produced between the stone and the grain. In the case of horizontal steel cylinders, the friction is obtained by rubbing the rice grains against them-selves inside the polishing chamber.

Experience has shown many advantages with the uses of the horizontal whiteners with steel cylinders; some of these are:

A. Easier to operate.
B. It removes the rice shell, in case some unshelled grains have been passed by the paddy separators.
C. Less breakage of grains.
D. Better whitening gives the rice its natural color.
E. Easier to clean in case the rice is milled with more moisture than usual.

.../...

F. Maintenance is easier and more economical.
G. More capacity with less space.

The new type of horizontal abrasive cylinder shall in this case replace the old traditional vertical cone, thus decreasing grain breakage in the whitening process. The horizontal abrasive cylinder has four ventilation channels with a blower fan which maintains a low temperature in the whitening chamber. High temperature is one cause of broken grains.

It is not advisable to try to polish the rice in only one pass in the polisher; to do so would cause more pressure on the grains, resulting in excessive heating and breaking of the grains. Horizontal Steel Cylinder Whiteners (Ref. Nos. 51, 52, 53, 54, 55) shall be used for the second pass. Two polishing passes should be used as a minimum, and in the case of rice which is delicate to polish, three passes are recommended. In this way, the whitening is done gradually, allowing time for the grain to cool between one step and the next, which results in a better finished product with a smaller percentage of split grai

The rice bran, by-product of rice which is obtained during the whitening process, is aspirated and exhausted to bran collectors (cyclones) (Ref. Nos. 60, 61) where it is bagged to be used for livestock feed.

Grading : The next step after the whitening is grading, which is done in two operations :

Horizontal flat sieves (Ref. Nos. 70,71).
Indented cylinders (Ref. Nos. 78, 79).

The rice is first put through the cycle of the Flat Sieve, which consists of two perforated metal sheets, the upper one of sufficient perforation to allow passage of the split grains and the lower one of

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smaller perforation which allows the passage of small split rice or "brewer's rice". The whole grains will slide on top of the upper perforated sheet and will go on to a grain tank.

The grains that have gone through the upper perforated sheet will pass through the Idented Cylinders, of which there may be two or three, as the case may require. This cycle will make separations of second heads (brokens) of large and small size, and simultaneously will recover the whole grains which may have slipped through the flat sieves.

Blending : As the rice market requires different rice grades, based on percentage of broken grains, there is included a Rice Blending System (Ref. Nos. 87, 88, 89, 90) within the general structure of the mill. This blending system can produce a final product that includes only perfect grains, or only broken grains, or any desired blend. The market requirement and the desires of the customer will determine the blend or blends produced.

Weighing, Bagging, and Sewing Bags : A complete system of weighing, bagging and sewing shall be provided. The Bagging Scale (Ref. No. 94) shall be gravity fed, automatically loaded, for rapidly and precisely filling bags with a predetermined amount of milled rice.

The Bagging Scale shall measure weights in metric system, and shall be supplied with a complete set of precise weights for its operation.

The Bagging Scale shall be equipped with a mechanically actuated counter which records and indicates the number of weighings by means of a dust tight, easily read indicator. The counter shall be automatically indexed each time the hopper is loaded. The indicator shall be composed of a six digit continuous register which resets itself to zero after 99,999 counts, plus a three digit counter which can be manually reset to zero without affecting the six digit continuous register.

.../...

The bag spout of the bagging scale shall be constructed to accommodate paper, burlap or other fiber bags in sizes from 45 to 100 kgs. The bag spout shall not incorporate any hocks or clamps which penetrate through the bag to hold the bags being filled.

The rice processing plant shall be equipped with a Bag Closing Machine, which consists of a sewing machine head with a sewing pedestal (Ref. No. 96) and a belt conveyor capable of handling bags in sizes from 45 to 100 kgs. (Ref. No. 95). The bag sewing machine shall be capable of sewing at least 4 bags per minute on a production scale. The sewing head shall be capable of making a double thread, double locked stitch closure on paper, cotton, burlap, jute, plastic or any other materials normally used in making bags.

Important Notes : The previous items on the milling process give only a general idea of the system, in order to reveal the function and characteristics of each piece of equipment, capacities, and how each of the elements of the milling equipment operates individually and as whole unit.

This would be a very long report if the characteristics of each piece of machinery and equipment were described in full detail. Detailed specifications should be included in a proposal and/or contract type of report.

The complete rice milling plant, including all necessary machinery and equipment, shall have the capacity of efficiently milling 10 tons of paddy rice per hour.

A complete laboratory shall be included with the rice mill. The complete laboratory shall be suitable for making complete laboratory analysis of paddy rice, milled rice and seed rice.

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With the complete Rice Laboratory, the milling yields, germination of seeds, and similar type of analysis shall be predetermined. Performance of the rice milling plant shall be able to be adjusted according to the laboratory analysis of any particular and independent lot of paddy rice.

Rice Mill Performance and Milling Yields : The performance of a rice mill is not something abstract, but it depends on the paddy rice that is being processed. It would be very difficult to confirm in advance the performance of any rice mill, or the yielding behavior of the product for any particular lot of paddy. Such parameters as the intrinsic varietal characteristics of different rice varieties, conditions of the particular lot of paddy, previous treatment of the paddy during and after harvest, and physico-chemical properties of different varieties under particular treatment, are a few of the important factor which determine the yielding behavior of the product during the milling process.

Besides the characteristics of the paddy, mentioned in the above paragraph, there are also important factors such as the knowledge and experience of the Head Miller, training of personnel, proper handling and maintenance of machinery and equipment, which play an important role in the milling process, and could influence the results obtained with respect to milling yields and quality of the end product.

Yields of Product and By-Product in the Rice Milling Process:

Using the world's best and most modern machinery and equipment for rice milling, the yields obtained in milling a particular lot of paddy rice will vary, depending on varieties and conditions of the product entering the rice mill, within the ranges shown in the following table :

Table 11.4.3. Normal Yields of Products and By-Products in the Rice Milling Process.

| | Amount kgs | Aver. Yield % | Balance Remaining |
|---|---|---|---|
| Dirty Incoming Paddy | 100.01 102.6 | | 100.1 - 102.6 kg |
| Foreign Materials: (Chaff, straw, weed-seeds, dust, stones ets.) | 1.0-2.0 | 1.5% | 98.1-101.6 kgs. |
| Clean Paddy | 100 | 100.0(Base) | 100 |
| Hulls (husks) | 21.0-24.5 | 23.2% | 76.80 |
| Rice Bran | 6.9-10.0 | 8.5% | 68.30 |
| Brewer's Rice | 1.3-3.2 | 2.3% | 66.0 |
| Large Brokens | 5.1-12.6 | 8.9% | 57.10 |
| Small Brokens | 4.7-22.1 | 13.4% | 43.70 |
| Whole Grains | 25.6-61.8 | 43.70% | -0- |

Rice Milling Yield Calculations : From the above table and from comparison of market rice characteristics in Senegal and elsewhere, assumptions can be made about rice milling yields in Senegal. Beginning with paddy rice in good condition, fairly clean, without a large percentage of foreign materials, and with well trained personnel handling the mill, the following milling yield on 1,000 kgs. (one metric ton) of dry paddy should be obtained:

.../...

| | Weight | Percentage |
|---|---|---|
| Paddy Rice | 1,000 kgs. | 100% |
| Hulls (husks) | 220 kgs. | 22.0% |
| Rice Bran | 80 kgs. | 8.0% |
| Brewer's rice and screenings | 50 kgs. | 5.0% |
| Small Brokens | 130 kgs. | 13.0% |
| Whole Grains and large brokens | 520 kgs. | 52.0% |

The basic assumption is a milling yield of 52-70, which means 52 percent whole grains and 70 percent all rice on the basis of mill dry paddy. The 18 percent difference is assumed to be made up of brokens (13 percent) and brewer's-small brokens (5 percent). In addition, it is assumed that the remaining 30 percent is 8 percent bran and 22 percent husks.

The bran and a certain amount of pulverised husks that are by-products of rice milling in this project will be used as cattle feed. More detail on the amounts involved is given in Chapter 10.3.4.

It is assumed that the output of milled rice will go into the domestic market, and that most of the output will be sold in 100kg. bags, blended to contain 25 percent broken grains. The milling yield assumptions shown above will permit production of 65 kg. of commercial rice (25% broken) per 100 kg. of dry paddy. A small amount of premium quality (whole grain) rice, 3 kg. per 100 kg. of paddy, as well as 2 kg. of Brewer's rice, will also be produced. The relationship between the milling and sales categories is shown by the following diagram.

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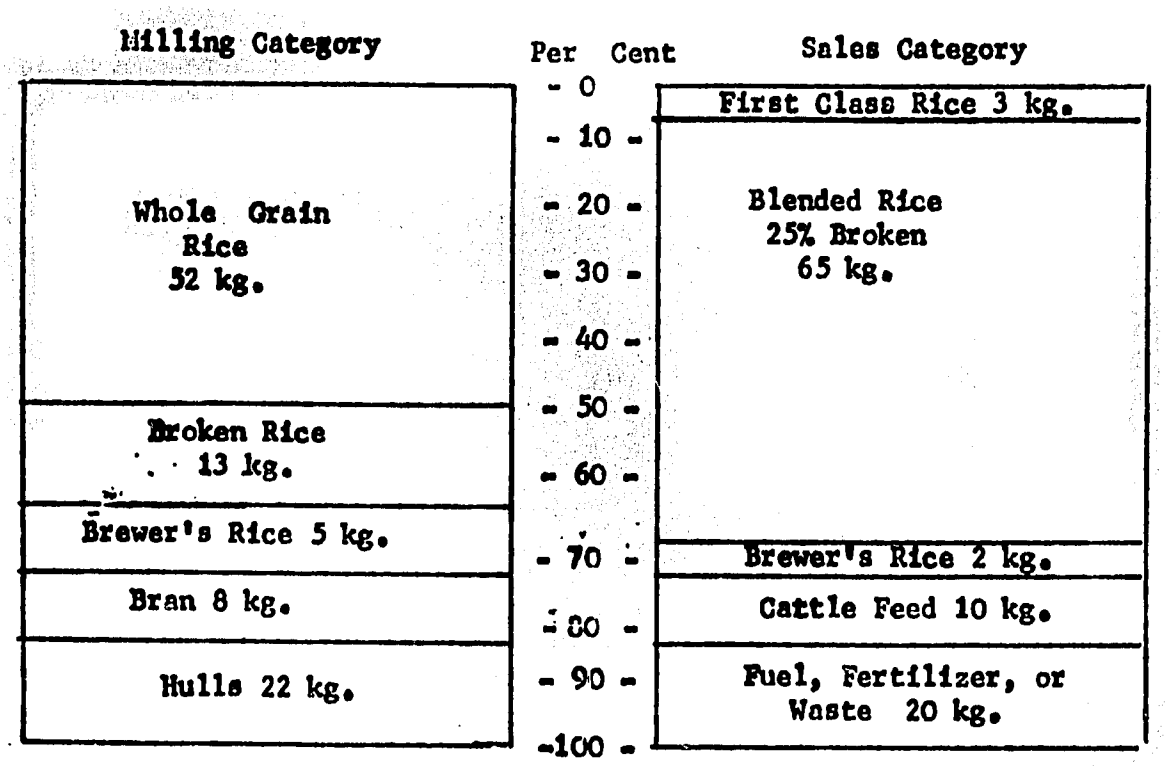
Milling and Sales Breakdown of the Products from 100 kg. of Paddy




The above pattern appears to be the most lucrative in the context of the Senegalese market, and is preferable to improving the quality by reducing the percentage of brokens and compensating by selling more brewers or brokens as such. Should the market for rice of the first class (unbroken) be greater than the 3 percent assumed, it can be produced by compensating with greater percentages sold as broken or by reducing the quality of the rice. In order to produce the pattern recommended, good quality separation followed by skillful re-blending will be required.

.../...

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Rice Milling Fee : Observation of the rice sold in Senegalese markets indicates the trade off between price and quality. A large proportion of the rice sold is of inferior quality, containing a large proportion of broken grains and contaminants. Better quality rice - well cleaned and not excessively broken - brings a higher price.

The rice mill described in this report, when properly operated, will produce a lower proportion of broken grains and far fewer contaminants than observed in rice on sale in Dakar, Velingara and other places in Senegal. The product of the rice mill of project SENERIZ being of higher than normal quality, and being worth more when purchased by the consumer, it is proper that the extra quality should be rewarded. Therefore, in the economic analysis of Project SENERIZ, it is assumed that O.N.C.A.D. will pay a milling fee of 20 CFA per kilo of paddy rice, at 10 CFA more than the standard milling fee. This differential is easily justified by the higher quality of the product and the higher retail selling price.

References 1 through 99 in the foregoing section refer to the Rice Mill "Flow Diagram", Drawing No. S-C07-2, Figure 11.4.3.

## 11.4.4. Seed Plant

Introduction : The importance of using pure or certified seed, properly cleaned, graded and treated, for obtaining good crops has been explained and emphasized by world-famous experts in many books and articles in many languages. Several Universities and Agricultural Experiment Stations all over the world have special courses and departments for teaching the technology of Seed Processing and Handling.

Because of this background, the importance of providing pure and properly conditioned seed in adequate quantities is not at issue. We accept that it is essential, and focus on meeting the need.

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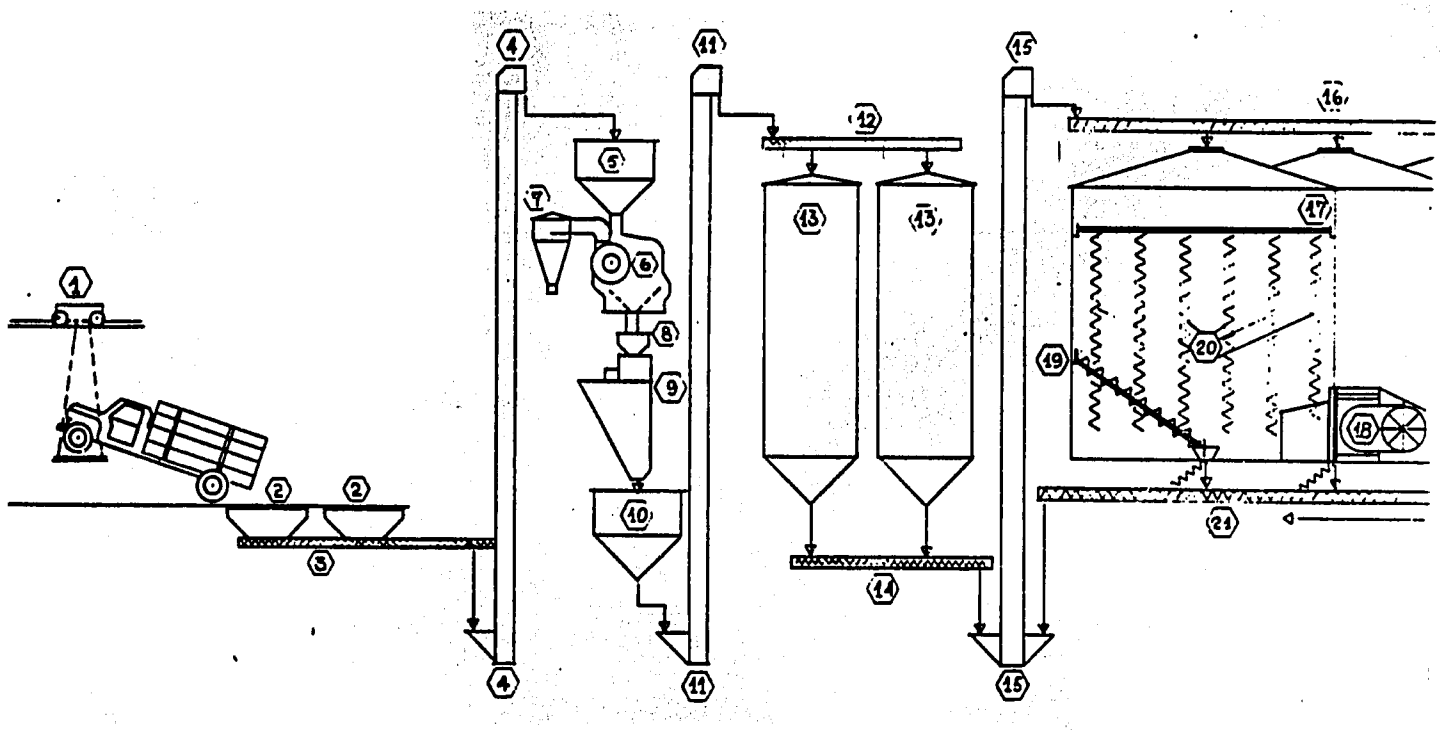


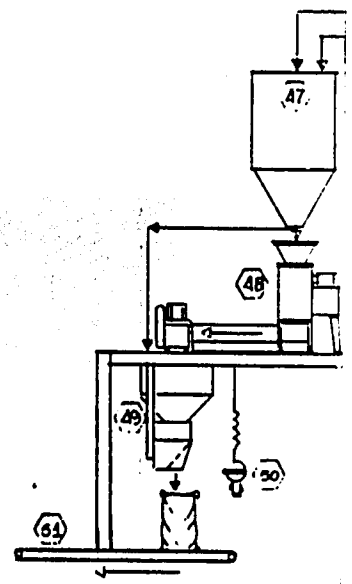


| NO | DESCRIPTION | DRAWN BY | APPD BY | DATE | NO | DESCRIPTION | DRAWN BY | APPD BY | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 5 | | | | | 10 | | | | |
| 4 | | | | | 9 | | | | |
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ANAMBE BASIN, SENEGAL

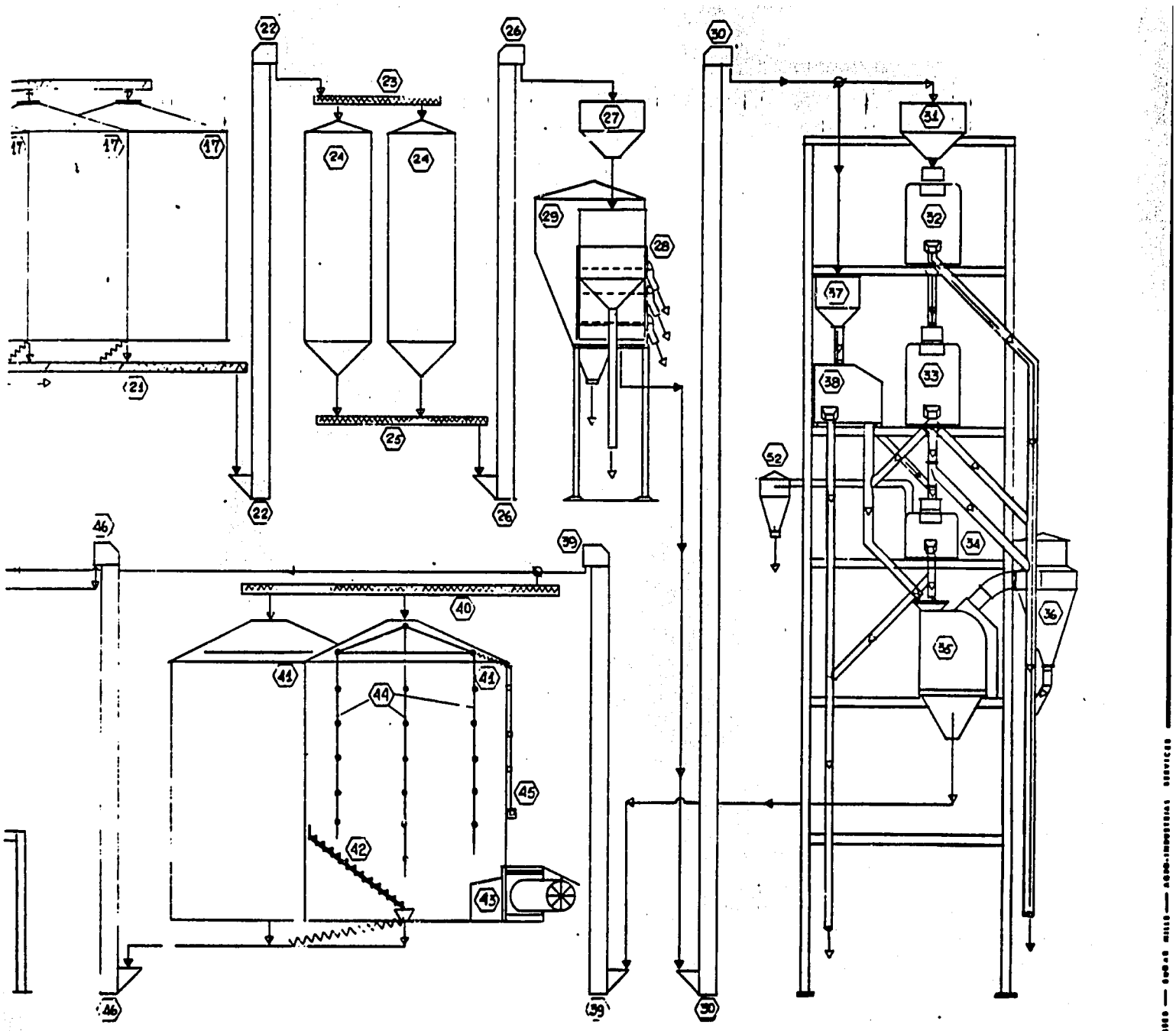


FIGURE - II-44

PROJECT SENERIZ

DEVELOPMENT OF THE ANAMBE BASIN

FLOW DIAGRAM-SEED PLANT

SCHEMA-INSTALLATION DE SEMENCE

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| Des. By: | Date | Checked By: | Date | Drawn By: | Date | Scale | Dwg. No. | Rev. |
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SEED PLANT

INSTALLATION DE

# LEGEND

| ITEM | DESCRIPTION OF EQUIPMENT | MODEL-TYPE-SIZE | QTY | ITEM | DESCRIPTION OF EQUIPMENT | MODEL-TYPE-SIZE | QTY | NU |
|---|---|---|---|---|---|---|---|---|
| 1 | TRUCK LIFT | | 1 | 70 | | | | |
| 2 | RECEIVING STEEL HOPPER. | | 2 | 71 | | | | |
| 3 | DRAG-FLIGHT CONVEYOR | | 1 | 72 | | | | |
| 4 | BELT BUCKET ELEVATOR | | 1 | 73 | | | | |
| 5 | STEEL HOPPER TANK | | 1 | 74 | | | | |
| 6 | PRE-CLEANER (SCALPERATOR) | | 1 | 75 | | | | |
| 7 | CYCLONE (DUST COLLECTOR) | | 1 | 76 | | | | |
| 8 | STEEL HOPPER TANK (SCALE) | | 1 | 77 | | | | |
| 9 | AUTOMATIC HOPPER SCALE | | 1 | 78 | | | | |
| 10 | STEEL HOPPER TANK | | 1 | 79 | | | | 1 |
| 11 | BELT BUCKET ELEVATOR | | 1 | 80 | | | | 1 |
| 12 | DRAG-FLIGHT CONVEYOR | | 1 | 81 | | | | 1 |
| 13 | RECEIVING HOPPER (SILO BOTTOM) | | 2 | 82 | | | | 1 |
| 14 | DRAG-FLIGHT CONVEYOR | | 1 | 83 | | | | 1 |
| 15 | BELT BUCKET ELEVATOR | | 1 | 84 | | | | 1 |
| 16 | DRAG-FLIGHT CONVEYOR | | 1 | 85 | | | | 1 |
| 17 | DRYING SILOS | | 4 | 86 | | | | 1 |
| 18 | DRYING FAN & BURNER | | 4 | 87 | | | | 1 |
| 19 | BIN SWEEPER & UNLOADER | | 4 | 88 | | | | 1 |
| 20 | STIRRING SYSTEM | | 4 | 89 | | | | 2 |
| 21 | DRAG-FLIGHT CONVEYOR (REVERS) | | 1 | 90 | | | | 2 |
| 22 | BELT BUCKET ELEVATOR | | 1 | 91 | | | | 2 |
| 23 | DRAG-FLIGHT CONVEYOR | | 1 | 92 | | | | 2 |
| 24 | WORKING SILOS (HOPPER BOTTOM) | | 2 | 93 | | | | 2 |
| 25 | DRAG-FLIGHT CONVEYOR | | 1 | 94 | | | | 2 |
| 26 | BELT BUCKET ELEVATOR | | 1 | 95 | | | | 2 |
| 27 | STEEL HOPPER TANK | | 1 | 96 | | | | 2 |
| 28 | CLEANER (SIEVES & ASPIRATION) | | 1 | 97 | | | | 2 |
| 29 | CYCLONE (DUST COLLECTOR) | | 1 | 98 | | | | 2 |
| 30 | BELT BUCKET ELEVATOR | | 1 | 99 | | | | 3 |
| 31 | STEEL HOPPER TANK | | 1 | 100 | | | | 3 |
| 32 | INDENTED CYLINDERS (UNI-FLOW) | | 6 | 101 | | | | 3 |
| 33 | PERFORATED CYLINDERS (PRECISION G) | | 6 | 102 | | | | 3 |
| 34 | STONERATOR | | 1 | 103 | | | | 3 |
| 35 | DUO-ASPIRATOR | | 1 | 104 | | | | 3 |
| 36 | CYCLONE (DUST COLLECTOR) | | 1 | 105 | | | | 3 |
| 37 | STEEL HOPPER TANK | | 1 | 106 | | | | 3 |
| 38 | INDENTED DISC SEPARATOR | | 2 | 107 | | | | 3 |
| 39 | BELT BUCKET ELEVATOR | | 1 | 108 | | | | 3 |
| 40 | DRAG-FLIGHT CONVEYOR | | 1 | 109 | | | | 4 |
| 41 | STORAGE SILOS (FLAT BOTTOM) | | 2 | 110 | | | | 4 |
| 42 | BIN SWEEPER & UNLOADER | | 2 | 111 | | | | 4 |
| 43 | AERATION FANS | | 2 | 112 | | | | 4 |
| 44 | TEMPERATURE DETECTION SYSTEM | | 2 | 113 | | | | 4 |
| 45 | TEMPERATURES READING STATION | | 2 | | | | | 4 |
| 46 | BELT BUCKET ELEVATOR | | 1 | | | | | 4 |
| 47 | STEEL HOPPER TANK | | 1 | | | | | 4 |
| 48 | SEED TREATER | | 1 | | | | | 4 |
| 49 | AUTOMATIC BAGGING SCALE | | 1 | | | | | 4 |
| 50 | SEWING MACHINE | | 1 | | | | | 5 |
| 51 | BAG CONVEYOR | | 1 | | | | | 5 |
| 52 | CYCLONE (DUST COLLECTOR) | | 1 | | | | | 5 |
| 53 | | | | | | | | 5 |
| 54 | | | | | | | | 5 |
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| 64 | | | | | | | | 6 |
| 65 | | | | | | | | 6 |
| 66 | | | | | | | | 6 |
| 67 | | | | | | | | 6 |
| 68 | | | | | | | | 6 |
| 69 | | | | | | | | 6 |

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SEMENCE

## LEGENDE

| M | DESCRIPTION DES EQUIPEMENTS | SPECIFICATION | QTE. | NUM. | DESCRIPTION DES EQUIPEMENTS | SPECIFICATION | TL |
|---|---|---|---|---|---|---|---|
| 1 | ELEVATEUR DE CAMION | | 1 | 70 | | | |
| 2 | TREMIE RECEPTION GRAIN | | 2 | 71 | | | |
| 3 | TRANSPORTEUR A ENTRAINEMENT | | 1 | 72 | | | |
| 4 | ELEVATEUR A GODETS | | 1 | 73 | | | |
| 5 | TREMIE EN ACIER | | 1 | 74 | | | |
| 6 | PRE-NETTOYEUR (NETTOYEUR) | | 1 | 75 | | | |
| 7 | CYCLONE (COLLECTEUR DE POUSSIERES) | | 1 | 76 | | | |
| 8 | TREMIE EN ACIER (BALANCE) | | 1 | 77 | | | |
| 9 | BALANCE AUTOMATIQUE A TREMIE | | 1 | 78 | | | |
| 0 | TREMIE EN ACIER | | 1 | 79 | | | |
| 1 | ELEVATEUR A GODETS | | 1 | 80 | | | |
| 2 | TRANSPORTEUR A ENTRAINEMENT | | 1 | 81 | | | |
| 3 | TREMIE RECEPTION - TYPE SILO | | 2 | 82 | | | |
| 4 | TRANSPORTEUR A ENTRAINEMENT | | 1 | 83 | | | |
| 5 | ELEVATEUR A GODETS | | 1 | 84 | | | |
| 6 | TRANSPORTEUR A ENTRAINEMENT | | 1 | 85 | | | |
| 7 | SILOS DE SECHAGE | | 4 | 86 | | | |
| 8 | VENTILATEUR DE SECHAGE ET BRULEUR | | 4 | 87 | | | |
| 9 | NETTOYEUR DE SILOS ET TRANSPORTEUR | | 4 | 88 | | | |
| 0 | AGITATEUR | | 4 | 89 | | | |
| 1 | TRANSPORTEUR A ENTRAINEMENT (REVERSIBLE) | | 1 | 90 | | | |
| 2 | ELEVATEUR A GODETS | | 1 | 91 | | | |
| 3 | TRANSPORTEUR A ENTRAINEMENT | | 1 | 92 | | | |
| 4 | SILO D'ATTENTE - TYPE TREMIE | | 2 | 93 | | | |
| 5 | TRANSPORTEUR A ENTRAINEMENT | | 1 | 94 | | | |
| 6 | ELEVATEUR A GODETS | | 1 | 95 | | | |
| 7 | TREMIE EN ACIER | | 1 | 96 | | | |
| 8 | NETTOYEUR (CRIBLES ET ASPIRATION) | | 1 | 97 | | | |
| 9 | CYCLONE (COLLECTEUR DE POUSSIERES) | | 1 | 98 | | | |
| 0 | ELEVATEUR A GODETS | | 1 | 99 | | | |
| 1 | TREMIE EN ACIER | | 1 | 100 | | | |
| 2 | CYLINDRES A ALVEOLES | | 6 | 101 | | | |
| 3 | CYLINDRES FERRURES (CALIBREUR) | | 6 | 102 | | | |
| 4 | SEPARATEUR A FIBRES | | 1 | 103 | | | |
| 5 | ASPIRATEUR | | 1 | 104 | | | |
| 6 | CYCLONE (COLLECTEUR DE POUSSIERES) | | 1 | 105 | | | |
| 7 | TREMIE EN ACIER | | 1 | 106 | | | |
| 8 | TRIEUR A DISQUES ALVEOLES | | 2 | 107 | | | |
| 9 | ELEVATEUR A GODETS | | 1 | 108 | | | |
| 0 | TRANSPORTEUR A ENTRAINEMENT | | 1 | 109 | | | |
| 1 | CELLULES DE STOCKAGE (FOND PLAT) | | 2 | 110 | | | |
| 2 | NETTOYEUR DE SILOS ET TRANSPORTEUR | | 2 | 111 | | | |
| 3 | VENTILATEURS D'AERATION | | 2 | 112 | | | |
| 4 | CONTROLE DE TEMPERATURES | | 2 | 113 | | | |
| 5 | STATION DE LECTURE DES TEMPERATURES | | 2 | | | | |
| 6 | ELEVATEUR A GODETS | | 1 | | | | |
| 7 | TREMIE EN ACIER | | 1 | | | | |
| 8 | TRAITEMENT DES SEMENCES | | 1 | | | | |
| 9 | BALANCE AUTOMATIQUE D'ENSACHAGE | | 1 | | | | |
| 0 | MACHINE A COUDRE | | 1 | | | | |
| 1 | TRANSPORTEUR DE SACS | | 1 | | | | |
| 2 | CYCLONE (COLLECTEUR DE POUSSIERES) | | 1 | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
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FIGURE - II·4·4A

PROJECT SENERIZ

DEVELOPMENT OF THE ANAMBE BASIN

SODAGRI

CONTRACTORS
ENGINEERS
CONSULTANTS

LEGEND-SEED PLANT

LEGENDE-INSTALLATION DE SEMENCE

WEITZ HETTELSATER CORP.

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The seed plant proposed here is designed to meet the seed processing needs of Projet SENERIZ. As with other components of the project, final design specifications could modify the capacity, depending on the need.

One of the first steps in a program of improved agricultural technology is to produce and distribute to farmers in the different agricultural sectors of the country, pure seed of the best varieties available. What varieties are best is always subject to change, pending time-consuming breeding and field testing of still better varieties. It has been frequently believed that ten or more different varieties are necessary to meet local conditions in any particular country. In reality, only a few varieties are usually needed. One, two or theree varieties should be selected that best fit the principal production areas and which are acceptable to consumers.

The Experimental Stations in Senegal are already doing a praiseworthy work producing, testing and distributing several different varieties of paddy rice and other agricultural seeds. This Governemantal service should be encouraged and expanded to serve those farmers who are financed by Government Institutions.

It has been observed that in general, in several regions in Sénégal, different varieties of cereals are badly mixed after harvest. Mixed varieties create many problems, not only in production but also in milling and marketing. Some of these problems are the following :

1) When the varieties are mixed, uneven ripening results because of uneven maturity date. Some over- ripe grains shatter before they are harvested; other grains are immature at harvest. Both shattering and immaturity result in reduced yields per hectare, and immature grains are of poor quality.

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2) Mixed varieties delay the harvesting period because the farmer must wait for the late maturing varieties to mature; this lengthens the period when rice is subject to bird and rodent damage.

3) If locally produced rice is to compete with imports in the urban markets or if Senegal contemplates the potential of exporting its good quality rice, it is imperative that a well milled uniform product be produced.

4) When the seed to be planted is mixed with foreign materials, such as straw, weed-seeds, stones, etc., a larger quantity of seed is needed per hectare, in addition to the problem of planting weed seeds in the fields.

5) When the seed is not properly cleaned and graded, and has not been tested for its germination, some of the seed-- perhaps even half or more-- will not grow and the field may have to be replanted. Sometimes replanting is difficult or impossible because of the season, and the field may be lost for the year.

6) Even if the seed is pure in terms of variety, there are contaminants that must be removed from the raw seed: weed-seeds, seeds of other crops, immature grains, stones, dirt lumps, etc., can seriously affect production if they are not removed.

Other problems exist, but the foregoing are among the most important. The importance of varietal segregation of seeds and of proper quality control confirm the need for a seed plant to be properly designed and equipped to perform its functions.

The quality of the final product is directly related to the processor's ability to remove contaminants and low quality seed, to properly size-grade for planting, to treat the seed effectively and to prevent mechanical mixtures of the seed with those of other varieties or hybrids. The productivity of the seed depends in addition on the inherent or genetic capacity to produce. The task of the seed processing unit is to make it possible for that inherent potential to be achieved.

The foregoing discussion supports the inclusion in the industrial complex of Project SENERIZ of a seed processing plant. The following section describes the proposed plant and its operation.

Description of Seed Plant Operation : The Seed Plant proposed may be divided into two sections : the receiving, drying and storage section and the seed processing, treating and bagging section.

From the description of this plant, a Flow Diagram, Drawing Nos. S-077-3 and S-077-3A, has been made. This is presented as Figure 11.4.4. References in the following paragraphs are to that figure.

Receiving Section : Seeds of paddy rice and other agricultural products, such as maize, millet and sorghum are received at the Agro-Industrial Complex from the fields or from an agricultural station. Seeds may be received either in bags or in bulk, by means of wagon, trucks or carts. All seeds should be weighed upon receipt. Bagged goods shall be unloaded and dumped by hand. An overhead lift (Ref. No. 1) shall be available for dumping some sizes of trucks.

The grain is discharged over the receiving hoppers (Ref. No.2) which are equipped with steel grating on top, in order to prevent large foreign objects from getting inside the receiving system. Samples of grain flowing into the hopper are obtained at the time of unloading, and sent to the laboratory for grading. The receiving capacity has been designed for five metric tons per hour.

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A paddy type self-cleaning conveyor (Ref. No.3) will move the grain to the receiving bucket elevator (Ref.No.4). This unit will elevate it to the beginning of the Precleaning Section.

Pre-cleaning Section : The seed travels into a steel hopper tank (Ref. No. 5) and flows into the inlet of the Pre-cleaner (Ref. No. 6). This unit will scalp and aspirate the incoming grain. The foreign material is removed in two steps: the first consists of scalping of all sticks or oversized material as the seed passes over a rotating "squirrel cage" scalping reel with wire mesh screen, or a similar machine. The proper sized product goes through the reel while rejected material passes over it to a discharge outlet.

The second step consists of aspiration of light or fine materials such as : chaff, dust, empty husks, etc. Heavier particles settle out of the air stream in an expansion chamber, while the extremely light dust material is collected by means of an auxiliary dust collection unit or cyclone (Ref. No. 7).

The Pre-cleaner may be adjusted to remove a maximum amount of foreign materials without carrying over sound kernels of seed. The pre-cleaned seed is ready now to flow into an inlet steel hopper tank (Ref. No.8) prior to entering a Weighing Section.

Weighing Section : The weighing of the pre-cleaned seed is effected in the Automatic Receiving Bulk Scale (Ref. No. 9). This unit has a choke-proof inlet plus compensation and mechanical interlock to prevent simultaneous opening of inlet gate and weigh hopper door. A counter, ticket printer device and a residual weigh beam for weighing partial drafts are also standard accessories with this weighing unit.

After all the received grain is passed through the scale and any residual draft is weighed, a ticket, in triplicate, is printed in the unit. Spaces are provided in this ticket for required information

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such as producer's name, variety of grain, moisture content, test weight, and percentage of foreign materials. Some of the above mentioned information is provided from the laboratory and based on the samples previously taken at the Receiving Section. The original of the three tickets is issued to the producer by the scale operator. The other two will remain for the plant records.

After leaving the scale, the seed is dumped into a steel dump receiving hopper (Ref. No. 10). From there, it goes to a bucket elevator (Ref. No. 11), which moves or elevates the grain to the Receiving Bins (Ref. No. 13) by means of paddle conveyor (Ref. No. 12). These two (2) Receiving Bins, or Working Silos, shall be steel hopper bottom, center draw type with 45 degree slopes, corrugated galvanized steel walls, and plain galvanized roof and hopper.

From these working bins, the seed is transported to the Drying Section by means of a paddle type conveyor (Ref. No. 14), bucket elevator (Ref. No. 15) and distributing paddle type conveyor (Ref. No.16).

Drying Section : In commercial drying of grain for seed purposes, two methods are commonly used. One method makes use of columnar dryers with working bins for tempering the grain between passes. The other method uses in-bin drying. Each of these methods has its merits, and there are many commercial plants throughout the world which use one or the other method.

For the proposed Seed Plant, bin drying is recommended. The in-bin drying method recommended includes "stirring devices" inside the drying bins. These devices have solved the major drawback of in-bin drying, that is, over-drying of the bottom layers of grain, specially when diesel burners are used which can not be started and stopped constantly as the gas burners can. Diesel burners must stay on for long periods of time, and the danger of over-drying at the bottom layer is increased, with the consequences of killing the germination quality of the seed.

Stirring devices have greatly minimized, if not eliminated, this problem. Furthermore, stirring devices speed up the process of drying. As the mass of grain is in continuous movement, compaction of the mass is avoided, thus decreasing the friction to the air flow, giving way to a decrease of static pressure, which in turn increases the air flow with a decrease in drying time.

These drying bins (Ref. No. 17) are four bins : round flat bottom type, made of corrugated metal, 7.3 meters diameter, 23 cm. air chamber, 5 meters shell height and 7 meters overall height. Capacity at shell level shall be approximately 119 tons. Corrugated perforated metal drying floor, gauge 18, with flashing and hardware and center unloading for tube well. Additional features include ring with air entrance collar and transition for fan, one-hinged hatch roof opening, inside and outside ladders, and tube-well bin unloading system and Stirring Device System as explained above (Ref. Nos. 19, 20).

Each bin shall include a Fan Unit (Ref. No. 18) with a 76 cm. diameter wheel, backward curved blades, about 22.37 kw., delivering 11658 cubic meters of air per minute at 20.32 cm. of static water pressure, with a diesel oil No. 2 burner capable of delivering up to 527,600 kj per hour. Fumes from the burning diesel oil must not go through the grain.

After the grain is dried in any of the four drying bins, the dried grain shall be transported through a reversible paddle conveyor (Ref. No. 21), to a bucket elevator (Ref. No. 22) to two working silos (Ref. No. 24) for processing in the Seed Processing, Treating and Bagging Section.

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Seed Processing, Treating and Bagging Section : The main purpose of a seed processing plant is to produce a stock of thoroughly cleaned and treated grain kernels with as much uniformity as possible in their length, thickness and weight. Therefore, in order to produce a seed of such quality, a stock of good grain must go through the following basic steps :

a. Cleaning by screens and air : To remove any foreign product which is lighter than the grain, and also the foreign products that are heavier than the grain.

b. Length grading : To remove all the products shorter than a given length. The product removed consists largely of small whole grains, broken grains, grass seeds, small stones, etc.

c. Thickness grading : To remove such products that while having the same length as the grain kernels in question, are thinner. Most of the product removed consists of thin grains, shelled paddy kernels, and immature grains.

d. Gravity grading : To remove such products that while having the same length and thickness as the grain which has been processed, are heavier or lighter.

e. Aspiration : To give a final air cleaning to the good stock of the good quality seed.

f. Treating : To apply to the seed a coat of chemicals for its protection.

The matter of good seed is so important to the success of this project, that the plant must not have any limitations that could jeopardize the quality of the product.

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Description of Classifying and Treating Section : The grain leaving the working silos (Ref. No. 24) will be conveyed through a paddle conveyor (Ref. No. 25) to bucket elevator (Ref. No. 26) to be deposited into steel hopper tank which will feed the heavy duty cleaner. (Ref. No.28) This unit will remove roughage on the top sieve equipped with reciprocal motion to convey materials to the end of the screens.

The cleaner is also equipped with slow travel retardor brushes which control the flow of scalpings and residue over the tail end of the top sieve.

A major portion of material passes through the lower screen which is used for removal of dust, sand, and other similar fine materials. The ball type sieve cleaning method assures uniform screening operation because the bouncing balls keep the screen clean. Heavier particles settle out of the air stream in an expansion chamber while the extremely light dust material is collected by means of an auxiliary dust collector unit or cyclone (Ref. No. 29).

The cleaned grain seed leaves the cleaner and is elevated by bucket elevator (Ref. No. 30) to steel hopper tank (Ref. No.31) which feeds the Indented Cylinder Separators (Ref. No. 32). This unit is equipped with not less than six indented cylinders mounted in two rows. It will remove the long, and short foreign material, including cross-broken grains of seeds, wild seeds, straws, etc. In general, it makes separations by length quickly and easily. The separation results in a product of uniform length. The length of the material being separated can be controlled by means of an adjustment screw, raising or lowering the setting of the separation.

A system of several Disc Separators could be used instead of the Indented Cylinder Separators, but the discs in the Disc Separators are more difficult to interchange than the indented cylinders.

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After the seed is classified properly in the Indented Cylinder Separators, it is discharged by gravity to feed two precision grader units (Ref. No. 33) located in parallel.

Each Grader is equipped with a mechanical feeder and will effect a separation of the grain by thickness, width and diameter. The product is fed to a machine which has cylinders with slotted perforations (6 cylinders in two rows of 3 units per machine). The immature and thin seed goes through perforations and falls into the trough below. The good seed is conveyed to the collection end of the Precision Grader, while the rejected material is gathered by a vibrating conveyor and conveyed to one end of the unit for discharge.

A revolving cleaner keeps the perforations from becoming clogged. Rubber strips gently tap out over-sized materials that have collected in the perforations. Therefore, maximum capacity and accuracy is always maintained.

After the grain leaves the Precision Graders it will flow by gravity to a Stonerator (Ref. No. 34). This machine removes stone glass, metal pieces, dirt, fertilizer and other contaminants from the seed.

In this unit the grain is fed across the full width of the deck and separation is effected by weight. The grain floats above the deck on an air stream. Heavier objects sink to the deck and are conveyed to be discharged. The product or seed flows down the deck to the discharge chute and dust is carried away to the dust collector or cyclone (Ref. No. 52).

After the Stonerator, the seed is discharged to the steel hopper which feeds the Duo-Aspirator Units (Ref. No. 35).

This machine will effect the final separation by weight, removing the light weight or undersized kernels. Its design

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permits two-stage aspiration, for greater efficiency. Air flow in the first aspiration duct is adjustable to allow the operator to determine exactly the weight of product to be sexparated. The product enters the machine from the hopper and a feed roller evenly distributes it to the air stream.

The large and heavy seeds drop by gravity from the air stream and are discharged while the lighter seeds are lifted into an expansion chamber where the heavier rejected material is settled out and the dust and chaff are vented to a dust collector (Ref. No. 36).

After leaving the Duo-Aspirator, the grain will flow into the inlet hopper of bucket elevator (Ref. No. 39) to be elevated and discharged into paddle conveyor (Ref. No. 40). This unit will transport the grain into either of the two storage bins (Ref. No. 41) for its storage and subsequent treatment.

Alternatively, after leaving the Duo Aspirator, the seed could go directly into the inlet hopper of bucket elevator (Ref. No.39); to be elevated and discharged into steel hopper tank (Ref. No. 47) which feed the Treater (Ref. No. 48).

The Seed Treating System uses an exclusive mist chamber application to provide the highest efficiency and finest results in liquid seed treating. The seed flows into a stainless steel chamber which applies chemical. Continuous flow process type metering tank, gear reduction motor and feel control handle are standard accessories. A 190-liter stainless steel liquid pre-mix tank, equipped with circular paddles, pump and operated by independent electric motors, is connected to first described container for supply of chemicals.

The seed will travel to a connecting stainless steel conveyor furnished with blending rods which gently turn and rub

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the seed to provide an even film coating. This last unit has independent drive system.

The treated seed flows to the inlet hopper of Automatic Bagging Scale (Ref. No. 49).

Storage Bins : In the section above, it was mentioned that the seed, after being cleaned and classified, could be stored in two Storage Silos (Ref. No. 41) before treatment with chemicals.

The two Storage Silos are flat-bottom round type bins, made up of corrugated metal and having the following characteristics : diameter about 11 meters; 9 meters shell height; 14.3 meters overall height; 23 cm. air chamber; 505 ton capacity (shell level); they shall have corrugated perforated 16 gauge metal drying floor, with flashing and hardware and center unloading for tube well, with foundation ring with air entrance collar and transition for fan. They shall be equipped with one hinged roof hatch opening, inside and outside ladders and roof ladder.

Additional equipment shall include tube well bin unloading kit, with bin unloading augers; axial fan for aeration, with capacity for 170 cubic meter of air per minute at 7.62 cm. static pressure; and 3 cables for temperature detection having sensing elements spaced at 1.83 m. intervals (Ref. Nos. 42,43, 44).

From the Storage Silos, the seed could be transported by the unloading system of the silos, into the steel inlet hopper of bucket elevator (Ref. No. 46) to be elevated and discharged into steel hopper tank (Ref. No. 47). which feeds the treater (Ref. No. 48) The process of treating the seed with chemicals has already been explained.

If treatment of the seed is not required, the treater could be by-passed and weighing-bagging of the seed could be effected.

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Weighing and Bagging Section : A modern weighing and bag filling and sewing machine completes the cycle of the plant. This unit (Ref. Nos. 49, 50, 51) accurately weighs, fills, and conveys the bag, neatly sews it and delivers it to a pallet or truck. The operator places a bag on the scale bag spout and pulls down the feed gate handle. When the correct weight is in the bag, feeding stops automatically. The bag is released into the conveyor and is stopped automatically by a limit switch after clearing the filling location. The operator places another bag on the filling spout to start a new weighing cycle, then turns to the bag on the conveyor, and presses a two-stage foot switch restarting the conveyor. The foot switch is pressed further to start the sewing head drive. During the sewing operation, the scale will have automatically completed weighing the material into the next bag.

Generalities : The different processing machinery of the Seed Plant shall be furnished with several sieves, indented cylinders and perforated cylinders, with indentations and perforations suitable for processing different types of agricultural products such as paddy rice, maize, sorghum and millet.

The arrangement of the conveyors, elevators and various other elements of the seed plant shall permit alternatives in routing of products through the plant. For example, as shown in the Flow Diagram (Figure 11.4.4.) after bucket elevator (Ref. No. 30) there is a by-pass by which the grain could be routed either to steel hopper tank Ref. No. 31 , or to steel hopper tank Ref. No. 37 which feeds a Disc Separator machine (Ref. No. 38). From this machine the product can flow to the Stonerator (Ref. No. 34) or directly to Duo-Aspirator (Ref. No. 35).

Undersized grains, as well as broken grains and other by-products from the seed plant, such as shelled rice (brown rice), split kernels of maize, etc. shall not be discarded but shall be bagged and taken to the rice mill or to the feed plant for further processing.

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11.4.5. Feed Mill :

Introduction : Encouragement of livestock production and regional distribution of meat and dairy products have been concerns of the Government of Senegal for some time. While Project SENERIZ is not primarily a livestock project, it is nevertheless desirable that assistance from the project to achievement of the Governments livestock goals should be exploited to the extent feasible.

Cattle raising in Senegal is primarily a nomadic or semi-nomadic occupation, using techniques derived from family tradition. Most of the cattle are moved between grazing fields and watering locations. Losses in the cattle sector from mortality and lowered productivity as a result of diseases and insects have plagued the industry.

New land areas with availability of water will have to be selected for controlled cattle raising on a regional basis. Meat and dairy production should be matched with population projections and estimated consumption. Feed and water studies should be made to determine nutritional valves and proper feeding programs. Breeding programs have already been undertaken to improve the stock under controlled conditions.

Locations of processing plants will be dependant on the availability of raw material and the distribution channels that are established.

Project SENERIZ has not studied and does not make recommendations on the scope, timing or location of all necessary facilities for the implementation of beef cattle, dairy cattle, poultry and swine production. However, in the development project of the Anambe Basin undertaken by SODAGRI, the availability of water and raw materials such as maize, maize cobs, rice by-products, sorghum, millet and other grains creates an important opportunity to augment local cattle production. In order to facilitate the program of growing calves and feeding

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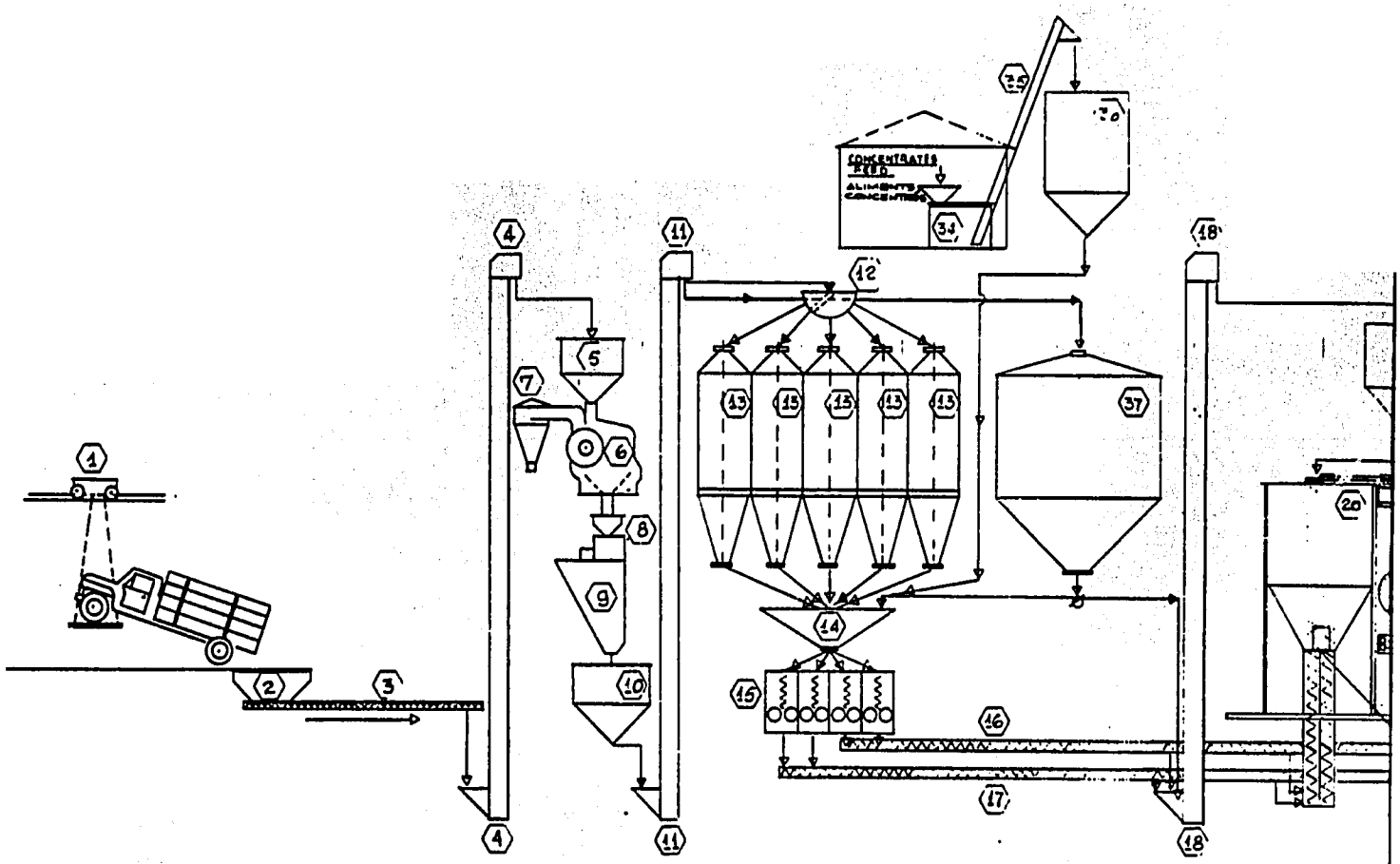


FEED MILL (5 TONNES/

USINE D'ALIMENT DE BETAIL (5 M

| NO | DESCRIPTION | DRAWN BY | APPD BY | DATE | NO | DESCRIPTION | DRAWN BY | APPD BY | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 5 | | | | | 10 | | | | |
| 4 | | | | | 9 | | | | |
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REVISIONS

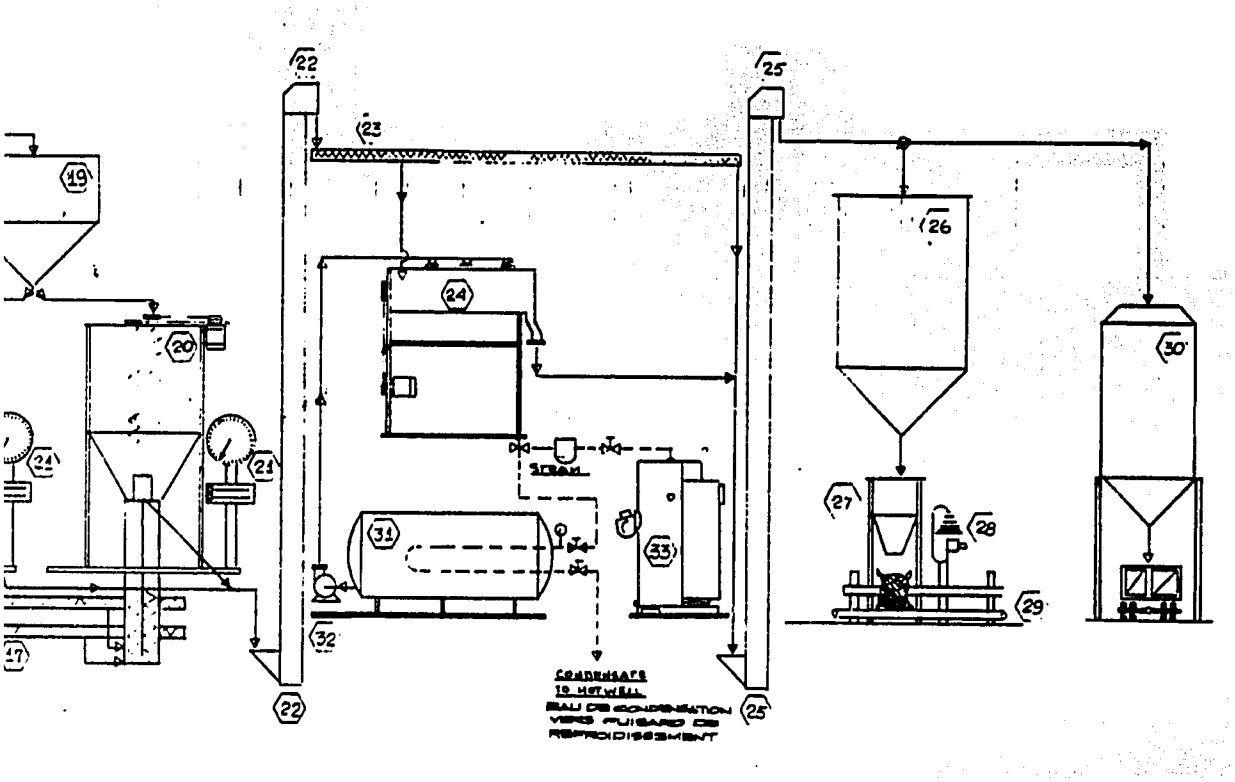


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FIGURE - 11·4·5

PROJECT SENERIZ

DEVELOPMENT OF THE ANAMBE BASIN

FEED MILL FLOW DIAGRAM

USINE D'ALIMENT DE BETAIL

SCHEMA D'ECOULEMENT

SODAGRI

CONTRACTORS
ENGINEERS
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| Des. By: | Date | Checked By: | Date | Drawn By: | Date | Scale | Dwg. No: | Rev. |
|---|---|---|---|---|---|---|---|---|
| E. SARDINA | 3/16/77 | E. M. | 3/17/77 | E. S. | 3/16/77 | — | S-077-4 | |

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# LEGEND

| ITEM | DESCRIPTION OF EQUIPMENT | MODEL-TYPE-SIZE | QTY. | ITEM | DESCRIPTION OF EQUIPMENT | MODEL-TYPE-SIZE | Q |
|---|---|---|---|---|---|---|---|
| 1 | TRUCK LIFT | | 1 | 70 | | | |
| 2 | RECEIVING STEEL HOPPER | | 1 | 71 | | | |
| 3 | DRAG-FLIGHT CONVEYOR | | 1 | 72 | | | |
| 4 | BELT BUCKET ELEVATOR | | 1 | 73 | | | |
| 5 | STEEL HOPPER BOTTOM TANK | | 1 | 74 | | | |
| 6 | PRE-CLEANER (SCALPER) | | 1 | 75 | | | |
| 7 | DUST COLLECTOR (CYCLONE) | | 1 | 76 | | | |
| 8 | SCALE HOPPER | | 1 | 77 | | | |
| 9 | AUTOMATIC HOPPER SCALE | | 1 | 78 | | | |
| 10 | STEEL HOPPER TANK | | 1 | 79 | | | |
| 11 | BELT BUCKET ELEVATOR | | 1 | 80 | | | |
| 12 | GRAIN DISTRIBUTOR | | 1 | 81 | | | |
| 13 | MILL FEEDER TANKS | | 5 | 82 | | | |
| 14 | GRAVITY HAMMER MILL FEED HOPPER | | 1 | 83 | | | |
| 15 | GRAVITY HAMMER MILL - TWO R.H. TWO L.H. | | 4 | 84 | | | |
| 16 | DRAG FLIGHT CONVEYOR | | 1 | 85 | | | |
| 17 | DRAG FLIGHT CONVEYOR | | 1 | 86 | | | |
| 18 | BELT BUCKET ELEVATOR | | 1 | 87 | | | |
| 19 | STEEL HOPPER TANK | | 1 | 88 | | | |
| 20 | VERTICAL MIXER | | 2 | 89 | | | |
| 21 | SCALE FOR VERTICAL MIXER | | 2 | 90 | | | |
| 22 | BELT BUCKET ELEVATOR | | 1 | 91 | | | |
| 23 | DRAG FLIGHT CONVEYOR | | 1 | 92 | | | |
| 24 | MOLASSES MIXER | | 1 | 93 | | | |
| 25 | BELT BUCKET ELEVATOR | | 1 | 94 | | | |
| 26 | BAGGING TANK | | 1 | 95 | | | |
| 27 | AUTOMATIC BAGGING SCALE | | 1 | 96 | | | |
| 28 | SEWING MACHINE | | 1 | 97 | | | |
| 29 | BAG BELT CONVEYOR | | 1 | 98 | | | |
| 30 | BULK SHIPPING TANK | | 1 | 99 | | | |
| 31 | MOLASSES TANK | | 1 | 100 | | | |
| 32 | MOLASSES PUMP | | 1 | 101 | | | |
| 33 | BOILER | | 1 | 102 | | | |
| 34 | CONCENTRATE MIXER | | 1 | 103 | | | |
| 35 | SCREW ELEVATOR | | 1 | 104 | | | |
| 36 | CONCENTRATE STORAGE TANK | | 1 | 105 | | | |
| 37 | STEEL HOPPER SILO (BULK TANK) | | 1 | 106 | | | |
| 38 | | | | 107 | | | |
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REVISIONS

# LEGENDE

| TY. | NUM. | DESCRIPTION DES EQUIPEMENTS | SPECIFICATION | QTE. | NUM. | DESCRIPTION DES EQUIPEMENTS | SPECIFICATION | QTE |
|---|---|---|---|---|---|---|---|---|
| | 1 | ELEVATEUR DE CAMION | | 1 | 70 | | | |
| | 2 | TREMIE RECEPTION GRAIN EN ACIER | | 1 | 71 | | | |
| | 3 | TRANSPORTEUR A ENTRAINEMENT | | 1 | 72 | | | |
| | 4 | ELEVATEUR A GODETS | | 1 | 73 | | | |
| | 5 | TREMIE EN ACIER - TYPE SILO | | 1 | 74 | | | |
| | 6 | PRE-NETTOYAGE (CALIBREUR) | | 1 | 75 | | | |
| | 7 | COLLECTEUR DE POUSSIERES | | 1 | 76 | | | |
| | 8 | BALANCE A TREMIE | | 1 | 77 | | | |
| | 9 | BALANCE AUTOMATIQUE A TREMIE | | 1 | 78 | | | |
| | 10 | TREMIE EN ACIER | | 1 | 79 | | | |
| | 11 | ELEVATEUR A GODETS | | 1 | 80 | | | |
| | 12 | DISTRIBUTEUR DE GRAIN | | 1 | 81 | | | |
| | 13 | RESERVOIR D'ALIMENTATION DE LA BROYEUSE | | 5 | 82 | | | |
| | 14 | TREMIE D'ALIMENTATION DU BROYEUR | | 1 | 83 | | | |
| | 15 | BROYEUR - TYPE GRAVITE GAUCHE DROIT | | 4 | 84 | | | |
| | 16 | TRANSPORTEUR A ENTRAINEMENT | | 1 | 85 | | | |
| | 17 | TRANSPORTEUR A ENTRAINEMENT | | 1 | 86 | | | |
| | 18 | ELEVATEUR A GODETS | | 1 | 87 | | | |
| | 19 | TREMIE EN ACIER | | 1 | 88 | | | |
| | 20 | MELANGEUR VERTICAL | | 2 | 89 | | | |
| | 21 | BALANCE POUR MELANGEUR VERTICAL | | 2 | 90 | | | |
| | 22 | ELEVATEUR A GODETS | | 1 | 91 | | | |
| | 23 | TRANSPORTEUR A ENTRAINEMENT | | 1 | 92 | | | |
| | 24 | MELANGEUR DE MELASSE | | 1 | 93 | | | |
| | 25 | ELEVATEUR A GODETS | | 1 | 94 | | | |
| | 26 | TREMIE POUR ENSACHAGE | | 1 | 95 | | | |
| | 27 | BALANCE AUTOMATIQUE D'ENSACHAGE | | 1 | 96 | | | |
| | 28 | MACHINE A COUDRE | | 1 | 97 | | | |
| | 29 | TRANSPORTEUR DE SACS | | 1 | 98 | | | |
| | 30 | TREMIE POUR CHARGEMENT EN VRAC | | 1 | 99 | | | |
| | 31 | RESERVOIR A MELASSE | | 1 | 100 | | | |
| | 32 | POMPE A MELASSE | | 1 | 101 | | | |
| | 33 | CHAUDIERE | | 1 | 102 | | | |
| | 34 | MELANGEUR DE CONCENTRES | | 1 | 103 | | | |
| | 35 | ELEVATEUR A VIS | | 1 | 104 | | | |
| | 36 | RESERVOIR A CONCENTRES | | 1 | 105 | | | |
| | 37 | TREMIE EN ACIER - TYPE SILO | | 1 | 106 | | | |
| | 38 | | | | 107 | | | |
| | 39 | | | | 108 | | | |
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FIGURE - II-4-EA

PROJECT SENERIZ

DEVELOPMENT OF THE ANAMBE BASIN

LEGEND-FEED MILL

LEGENDE-USINE D'ALIMENT DE BETAIL

SODAGRI

CONTRACTORS
ENGINEERS
CONSULTANTS

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cattle, a Feed Mill is included in the project. The cattle production activities of Project SENERIZ could serve as a first step for the implementation of a regional Project for meat and dairy production.

Generalities : Animal Feed factories could vary from a simple, small, compact unit which consists of the reception, grinding, mixing, molassing and sacking-off, to a large sophisticated, push-button system with apportioning bins or silos, pre-mixing, pellet production system, and several bins for the storage of raw and finished products.

Determining the right site, choosing the appropriate methode of production, and the proper size and output of a plant are factors to be carefully studied. In addition to the financial and commercial aspects, technical questions have to be considered regarding communications to the site, origin and delivery of raw materials, product to be manufactured and the use of the finished product.

Many alternative layouts are possible when planning a mixed feed mill, always with possibilities for future expansion at minimum expense.

The Feed Mill recommended consists basically of a feed factory to produce 5 metric tons per hour of mixed cattle feed from maize, maize cobs, sorghum, rice by-products, other grains and molasses. The plant includes facilities for the preparation and addition of mineral solutions, salt solution, and molasses to the feed. It also includes storage facilities for feed ingredients.

Process Description : In the following paragraphs, reference numbers of equipment refer to Drawing No. 5-007-4, which is presented as Figure 11.4.5.

1. Maize and other feed stuffs will be received from trucks or by other means, and dumped into a grating covered receiving hopper (Ref. No. 2). Grain will be conveyed by drag-flight conveyor (Ref. No. 3)

.../...

and belt bucket elevator (Ref. No. 4) to the pre-cleaning department.

2. The pre-cleaning department consists of a grain receiving garner bin (Ref. No. 5), a pre-cleaner or scalping unit (Ref. No.6) and an automatic hopper scale (Ref. No. 9)

The pre-cleaning unit will scalp and aspirate the incoming grain. The foreign material is removed by scalping all the sticks or oversized material as the grain passes over a rotating "squirrel cage" scalping reel with wire mesh screen (or similar machine). This is followed by aspiration of dust and other light-weight foreign materials.

After leaving the pre-cleaner, the grain is weighed in bulk process scale, which provides for inventory control.

3. After the product has been pre-cleaned and weighed, it is elevated by belt bucket elevator (Ref. No. 11) and directed by a rotary distributor (Ref. No. 12) to one of the five receiving bins (Ref. No. 13) or to a large grain storage tank (Ref. No. 37).

The above mentioned receiving bins and the large grain storage tank could simultaneously feed the gravity hammer mill feed hopper (Ref. No. 14).

4. There are four gravity hammer mills, two right handed and two left handed (Ref. No. 15). These hammer mills will triturate and reduce the different products to the pre-determined sized particles of the feed.

5. The Hammer Mills will discharge the milled products into two drag-flight conveyors (Ref. No. 16, 17) which will transport the product to belt bucket elevator (Ref. No. 18).

6. From belt bucket elevator, the milled product will go by gravity to a steel hopper tank (Ref. No. 19) above the vertical mixers (Ref. No. 20). If desired, the milled product can by-pass the hopper tank and go directly from the elevator to the mixers.

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In the Vertical Mixers the various products will be thoroughly mixed in the pre-determined proportions before they are conveyed to the molasses mixer or conveyed to the bagging department.

7. The mixed feed is conveyed to the Molasses Mixer (Ref. No. 24) when mixing molasses, salt solution and/or concentrate solution into the mixed feed is required.

Molasses is stored in a tank (Ref. No. 31) and pumped by a reciprocating pump through a meter. Salt and concentrate solutions will be prepared in agitated tank and pumped by reciprocating pumps through a metering device.

8. A system for adding concentrate feed to the raw materials has been provided (Re. No. 34). The Concentrate Feed, after proper mixing, will be elevated by Screw elevator (Ref. No. 35) into steel hopper tank (Ref. No. 36) which feeds the gravity hammer mill feed hopper (Ref. No. 14).

9. The fortified mixed feed from the molasses mixer is dropped into a belt bucket elevator (Ref. NO 25) and elevated into a Bagging tank (Ref. No. 26) or into a Bulk Shipping Tank (Ref. No. 30).

From the Bagging Tank (Ref. No. 26) the final product will go into the bagging and weighing system (Ref. Nos. 27, 28, 29).

Conclusions : A compact feed mill plant is recommended. This plant could be designed and built according to the unit-composed system, whereby individual parts and machines can be exchanged, or the whole plant can be extended at a minimum cost. The plant could be used as a pilot plant for production of livestock feed in the Anambe Basin.

.../...

## 11.4.6. Projet Headquarters and Infrastructure

The Headquarters Unit for the agricultural Production Complex will provide offices for the project administrative staff; housing for expatriates and other upper level administrative personnel; workshops and garages for maintenance and repair of vehicules, agricultural and road building machinery and other equipment as needed; and the infrastructure (electricity, water supply, sewerage, communications, etc.) to permit proper functioning of the entire complex.

The following section describes each of these elements in the Headquarters Unit.

Offices : A centrally located administrative building will function as the "nerve center" for the project. It will provide offices for executive and advisory personnel, secretariat, accounting and record-keeping departments. A Conference Room, a storage room, and rest rooms will be included. The main scales (weigh bridge) for the cereals center will be adjacent to and controlled from the office building.

This building will be of one-story construction with double roof or heavily insulated roof, and designed to permit good air circulation, thus minimizing the need for air conditioning.

Appropriate furnishings and equipment will be provided for these offices, including desks, chairs, filing cabinets and related furniture as well as duplicators and the like.

Housing: Because of the remote location of the project and the lack of urban development in the immediate vicinity, it will be necessary for the project to provide housing for upper level administrative personnel and for all expatriates. Current plans for staffing the project indicate the needs to provide housing for 23 persons, about half Senegalese and half expatriates. Upon the departure of the expatriates, their houses will be available for additional local personnel.

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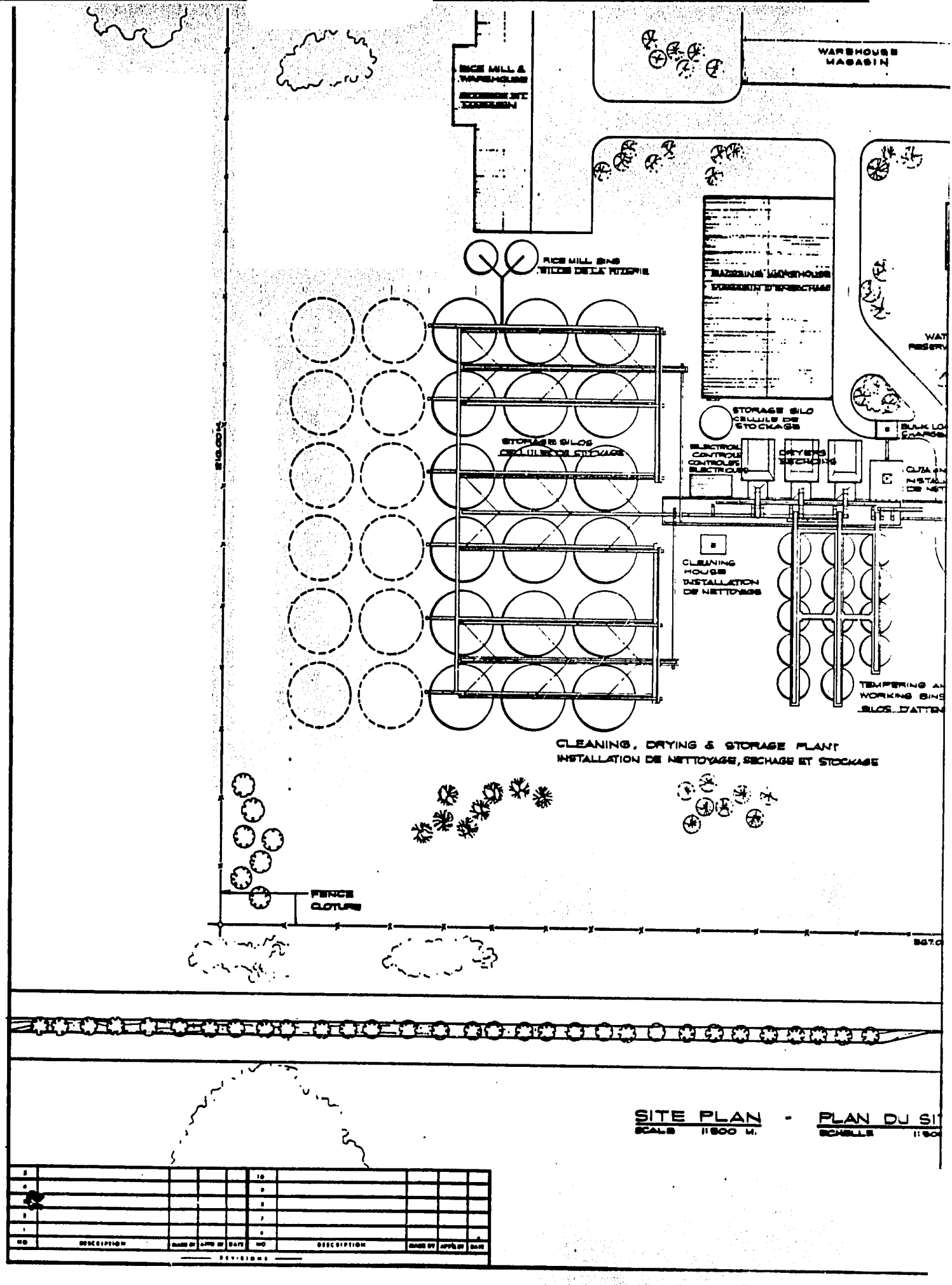


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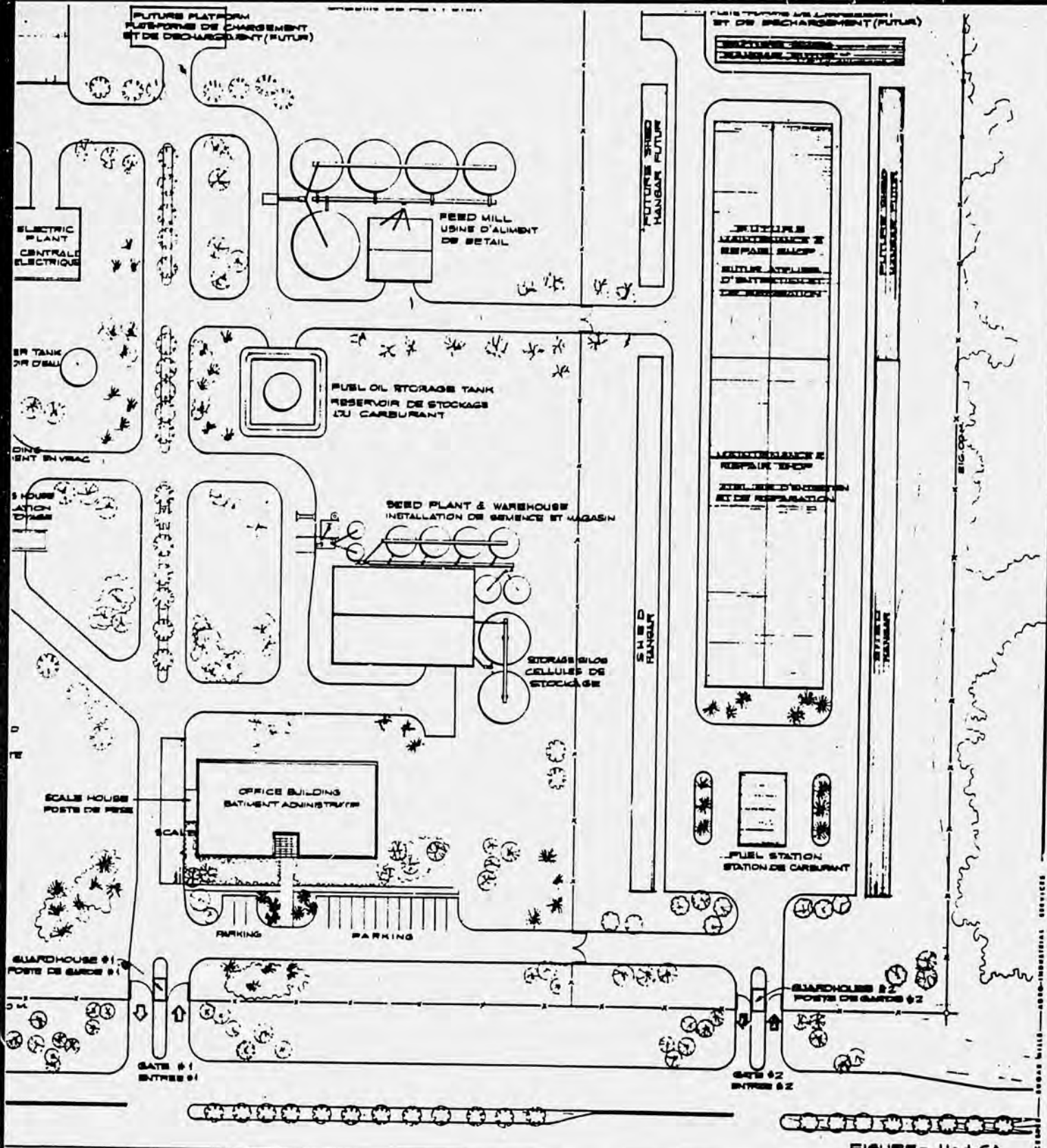


FIGURE- 11-4.GA

PROJECT SENERIZ
DEVELOPMENT OF THE ANAMBE BASIN
PROJET SENERIZ
AMENAGEMENT DU BASSIN DE L'ANAMBE

SITE PLAN
PLAN DU SITE

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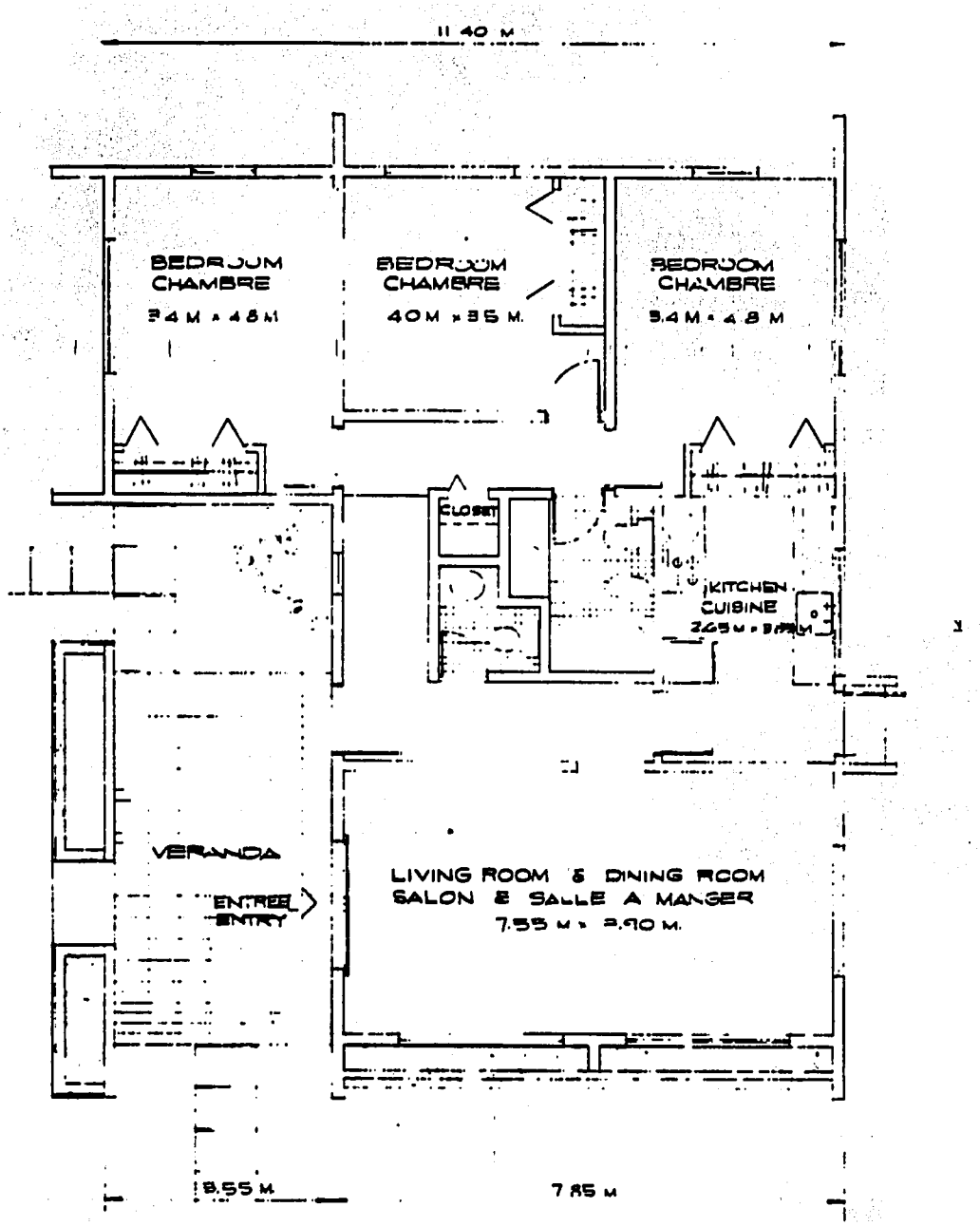


VUE EN PLAN / PLAN VIEW

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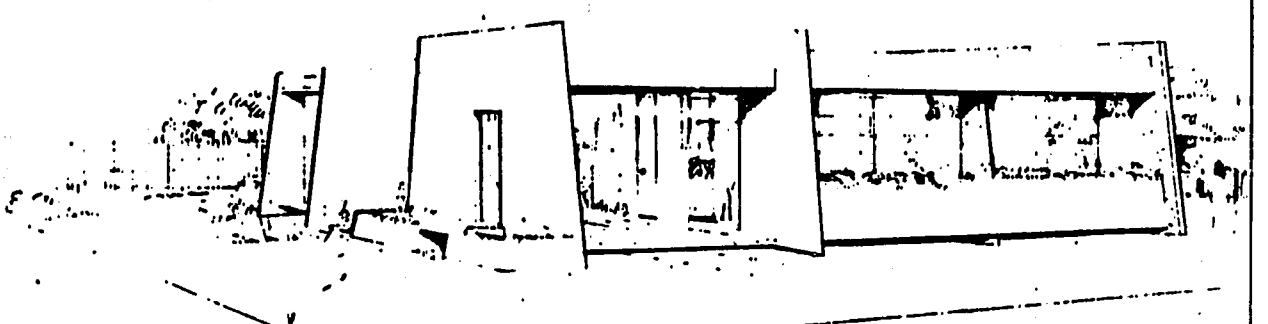

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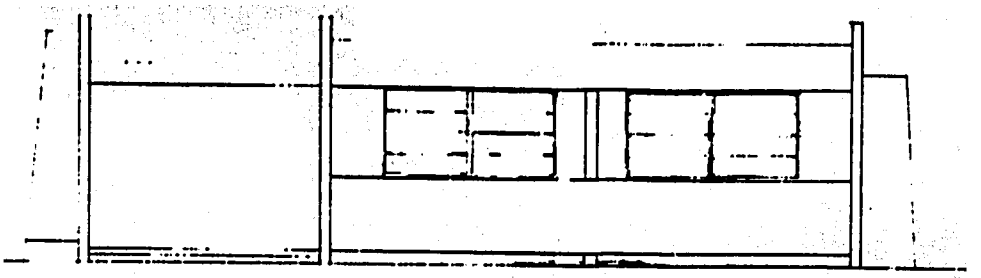
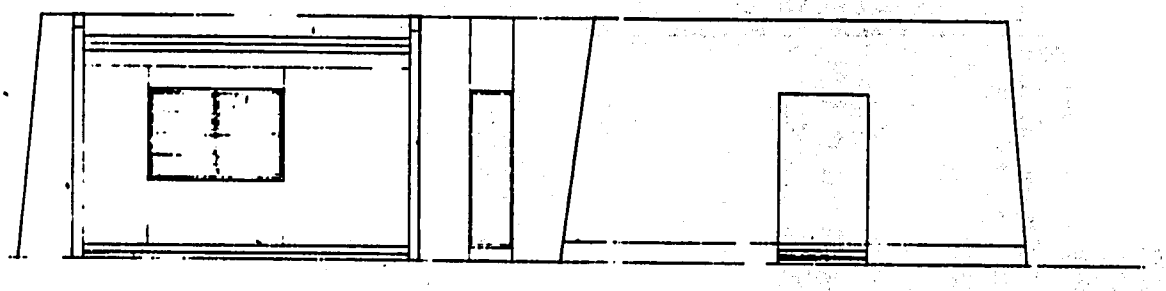
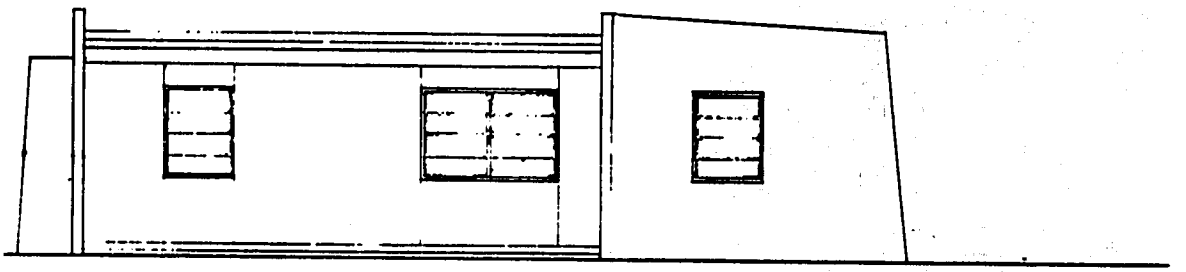


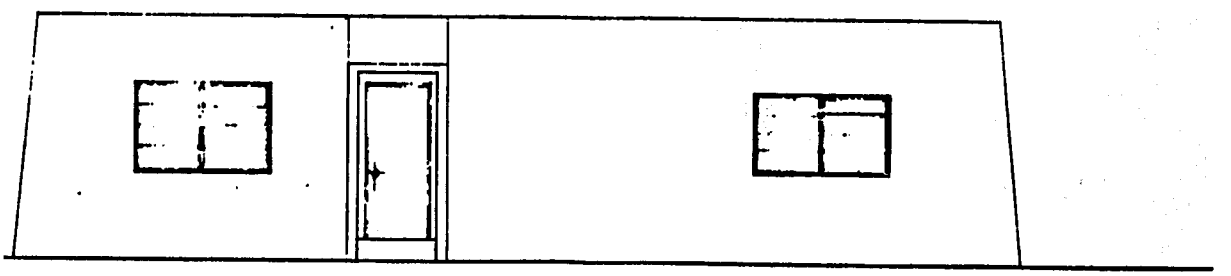
VUE DE FACE / FRONT ELEVATION



VUE DE COTE / SIDE ELEVATION



VUE DE L'ARRIERE / REAR ELEVATION



VUE DE COTE / SIDE ELEVATION

FIGURE - 11-4-6B

PROJECT SENERIZ
DEVELOPMENT OF THE ANAMBE BASIN

PROJET SENERIZ
AMENAGEMENT DU BASSIN DE L'ANAMBE

RESIDENCE DE CADRE - VILLA
STAFF HOUSING - BUNGALOW

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Two types of housing will be supplied : Bungalows for full-time staff employees with families, and duplexes for staff members not accompanied by families.

The project does not plan to supply housing for personnel of grades lower than level 8 (See personnel, data, in chapter 11), Government Officials have insisted that employment in Project SENERIZ be reserved for local residents to the extent possible, and local persons will of course have their own residences.

The houses will be located in a park-like residential center, outside but convenient to the Agro-Industrial Complex. This arrangement will facilitate electrical, water and the utility installations, will foster security, and will permit provision of the best possible residential environment.

Bungalow type houses will be durably constructed with concrete foundations and subfloors, 20 cm. sand/cement blockwork walls, and asbestos/cement sheeted roofs. The houses will be wired, plumbed and fitted to modern standards suited to the climatic conditions. Each house will have about 110 square meters of floor space, including living room, dining room, kitchen, three bedrooms, bathroom and two toilets. It is expected that 15 of these houses will be required.

Duplex type houses will be similarly well constructed and equipped, but they will be smaller, each having about 49 square meters of floor area. This space will be divided into living-dining room, bedroom, small kitchen, bathroom/toilet and large closet. Two units will be constructed together, back to back; 8 units (four pairs) are planned.

<u>Utilities</u> : Water will be provided to all parts of the complex from a common source. One or more of the wells drilled for exploration of the water table will be used as the source of supply.

.../...

The water will be treated, if necessary, to make it safe for human consumption. A water tower will provide pressure for distribution through underground pipes.

Electricity for residences and offices will be available from the project generating plant that will also provide electric power for the agro-industrial complex. Diesel-powered generators will supply electricity which will be distributed through a network of overhead lines with step-down transformers at appropriate points. Electric consumption is estimated at 10 kVA during peak load and 2kVA minimum per bungalow , and half that per duplex. Thus the total requirement of the residences will be about 200 kVA and 38 kVA during peak and low requirement periods, respectively.

Estimated electric requirement for the various units of the Agro-Industrial complex are shown below :

| | | | |
|---|---|---|---|
| Administrative Offices | 100 | kVA | kVA x 0.8 = KW. |
| Maintenace and Repair Unit | 100 | kVA | |
| Cereals Center | 400 | kVA | |
| Rice Mill | 400 | kVA | |
| Seed Plant | 100 | kVA | |
| Feed Mill | 200 | kVA | |
| Subtotal | 1 300 | kVA | |
| Residences | 200 | | |
| Total | 1 .500 | kVA | |

The foregoing needs are normal maxima, for full operation of the equipment. Such needs will continue 24 hours per day for the four main plants of the agro-industrial complex, during certain months of the year. The needs of the project -disregarding need for power for pumping irrigation or drainage water - can thus be met by a group of five diesel powered alternators of 250

.../...

Kv. each. One or more of these units would be in operation at all times the actual numbers depending on the need. An additional unit should be in stand-by.

Sanitation will be provided by use of one or more central septic tanks. The effluent from bathrooms, toilets, kitchens, etc., of the houses in the residential center will flow into a central septic tank for the microbiological destruction of organic wastes. The liquid will be conducted to leaching beds at suitable disposal units.

Workshops and repair facilities: A large and fully equipped maintenance and repair center will be established as part of the headquarters unit. This center will be subdivided as appropriate into an engine and mechanical repair shop; a tire repair shop; a welding and body shop; a wood-working and carpentry shop; a paint shop; a tool room and parts warehouse; a refueling, lubrication and service center for cars and trucks with storage for gasoline and diesel fuel. Equipment needed for this repair complex will include welders, air compressors, hydraulic and electric hoists, steam cleaners, etc., and a rather complete line of metal - and wood - working machines.

Because of the need for the maintenance and repair center to serve machinery in the cereals center and elsewhere in the complex, that cannot be brought to the workshop, one or more mobile crews will be organized and equipped with portable tools, transport, etc., to permit rapid and efficient response to any need that may develop. This mobile unit will also repair agricultural and road-building machinery in the field, and will provide emergency road service (depannage) for cars and trucks.

Repair and maintenance of buildings, including lodgings, will also be the responsibility of the Maintenance and repair unit, and a mobile crew will be organized and equipped for that purpose.

Warehouses and Storage Structures : Sheds will be provided for the protected storage of certain categories of equipment

.../...

that should have protection from rain and sun. Seeding and harvesting machinery is important among such equipment. The availability of a large storage area under roof will add to the efficiency of the agricultural operation by reducing "down time" resulting from equipment failure, and will also add greatly to flexibility in planning and conducting service and repair operations during inclement weather.

Warehouses will be provided for storage of agricultural supplies, especially fertilizer and agricultural chemicals (phytosanitary materials). Adequacy of warehouse space will make possible off-season delivery of purchased materials and will ensure their preservation in good condition until needed. Because Project SENERIZ will serve as a center for distribution of agricultural supplies for local farmers, it is essential that warehouse capacity be adequate.

The volume of materials to be received, unloaded, stored, reloaded and delivered dictates mechanized equipment. Thus, the warehouse floor should be of smooth concrete to permit the use of fork-lift trucks capable of handling heavily loaded pallets.

## 11.5. LAND DEVELOPMENT AND AGRICULTURAL PRODUCTION

Agricultural production is the "raison d'être" for the entire SENERIZ Project. The preparation of land to be used for production of high yielding crops of cereals is therefore critical to the success of the whole effort.

The land resources of the Anambe Basin are characterized by relatively level topography. While some areas of the basin are occupied by forests of mature trees with close spacing, most of the basin is forested less heavily and will be relatively easy to clear. The difficulty of the land preparation task, therefore, derives not from difficult vegetation but rather from the sheer scope of the job - 25000 hectares - and

the particular requirements of the portion of that area that will be irrigated.

11.5.1. Mode of operation

Land prepararation will be undertaken initially on a contract basis. Private firms will be asked to bid on clearing of specific tracts of land, with fixed schedules for completion, and with the possibility of continuing contracts for firms that perform satisfactorily.

Land preparation will also be undertaken by SODAGRI, on a limited scale at first. Complete and accurate records of costs and rates of accomplishment, will be kept. Analysis of these records as to unit production costs and rates of accomplishment will indicate whether SODAGRI'S land preparation unit should be expanded to handle the entire task; whether SODAGRI'S unit should be phased out in favor of private contractors, or whether the unit should continue on a small scale as a way of monitoring the work and the costs of the private contractors.

11.5.2. Schedule

The remote location of the project site, the nature and number of roads leading to the area, and the lack of infrastructure there add to the difficulty of the land preparation task. For this and other reasons, a schedule has been established for land preparation that permits a relatively small beginning with progressive expansion of the scale and speed of operation.

The land cleared and prepared in any given year is expected to be brought into agricultural use in the following year. The following table and Figure 11.5.1. show the targets for land preparation and use as cropland.

.../...

Year of project and calendar year

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
| Upland | 1000 | 1700 | 3700 | 4600 | 3600 | 6000 | ---- |
| Lowland | -- | 300 | 300 | 400 | 3400 | ---- | ---- |
| Total | 1000 | 2000 | 4000 | 5000 | 7000 | 6000 | ---- |
| Commulative Total : | 1000 | 3000 | 7000 | 12000 | 19000 | 25000 | 25000 |
| Cropland in Use | 0 | 1000 | 3000 | 7000 | 12000 | 19000 | 25000 |

"Upland" in this table, refers to land of Soil Groups I through 5 as described in Chapter 4 and delimited in the soils map, Figure 4.1. "Lowland" refers to Soil Groups 6,7 and 8 in the same sources. In general, lowlands are the regions that have traditionally been subject to annual flooding.

Because of the hard and heavy nature of the lowland soils, they have not been used for crops by the local peasants. In the upland regions, shifting cultivation has been practised, so that some of the land is in brush, in process of self-reforestation, and thus could be easy to clear.

However the intent of Project SENERIZ is to make use of lands that have not been and are not being used by local farmers; thus little brush land will be found in the tracts to be cleared for the project. On the other hand, much of the lowland area is grassland, with few or no trees.

.../...

As an indication of of the scope of the clearing operation, an appreciation can be gained by expression in terms of daily targets. If the land clearing is to be achieved during the 7 months that are substantially free of rain, and if the work procedes on a 6-day week or an average of 25 days per month, 5.7 hectares must be cleared every working day. This daily quota will increase year by year to 40 hectares per working day in year 5, which is equal to 4 hectares per hour.

11.5.3. Land development costs.

The main components of land development, considered apart from the provision and delivery of irrigation water, access roads, infrastructure etc., are the clearing and grubbing costs (removal of trees, roots, rocks, etc.); levelling and smoothing; drainage; and construction of dikes, field divisions etc. It is obvious that the cost of land development will depend on how much of each element is necessary.

For clearing and grubbing, of course, a complete job must be done. The land to be irrigated must also be levelled. The amount of soil to be moved in levelling depends on the slope and irregularity of the land, and this can be determined in advance. However, the precision of levelling and smoothing that is needed or permissable, and the need for installation of drainage such as underground tile drains, depends on factors less in evidence. Most of the heavy soils in the center of the Anambe Basin appear to have relatively impermeable clay on the surface, but with sandy texture below. Levelling operations must not remove all of the impermeable layer, or the suitability of the soil for rice culture will be drastically reduced as its water-holding capacity is reduced. Where levelling can be achieved with only shallow disturbance of the soil, the need for water retention ditches and field division barriers is also reduced, because very large fields can be

.../...

used. Some drainage channels must be cut to permit drainage in ponded areas, but because of the permeability of the subsoil very little underground tile drainage is likely to be needed. The real need can be determined only by field testing and experimentation.

The upland soils are known to be subject to erosion because of the intense rainfall and the high coefficient of runoff. Most of the upland soils should be farmed on the contour. Additional erosion control measures, such as terraces, divisions, etc., may be needed, but this need can be determined only by careful and detailed observation of the results of alternative measures installed on experimental or field test basis.

The estimates used in the Economic Analysis, and shown as Level A in the following table assume that moderate investment will be required for levelling, drainage, diking, and erosion control structures. To measure the effect on the profitability and the financing of the project if lesser or greater measures are found to be required, alternative levels of expenditures are considered in the sensitivity Analysis. Levels B and C respectively show near maximum investment, with extensive need for drainage, and low-cost land development with minimal expenditures for drainage and reduced costs of levelling.

| | CFA per Hectare | | | |
|---|---|---|---|---|
| | Level A | | Level B | Level C |
| Clearing, removal of roots and rocks. | 275,000 | 1,100 | 275,000 | 200,000 |
| Grading and levelling | 75,000 | 300 | 150,000 | 50,000 |
| Drainage and erosion control structures | 200,000 | 500 | 425,000 | 25,000 |
| Dikes | 50,000 | 200 | 50,000 | 25,000 |
| TOTAL : | 650,000<br>600,000 | 12,400 | 900,000 | 300,000 |

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11.5.4. Agricultural operations

Project SENERIZ plans to install in the Anambe Basin an agricultural production complex which will use mechanized techniques for producing large areas of crops known to be adapted to the region, but will add to mechanization the use of irrigation to produce even larger areas of rice, including counterseason production.

Because the agricultural production technology used in Project SENERIZ will include so much that is new, it is appropriate to present some information on that technology. However, such advance description can be at best conceptual, and many details will be subject to change as indicated by results in the field. The agricultural operations will be pragmatic: what succeeds will be followed; what does not succeed will be abandoned. The practices described below are generally used and are highly successful in producing rice (and similar crops) in the United States, but some of the details may have to be modified to fit Senegalese conditions.

a. Land grading. Following the initial grading of cropland done as a part of project development, individual fields will be graded to form a surface having a planed slope. Use of land plane or leveller is the final step in this operation which should result in a smooth surface and a slope of about 1%.

b. Seedbed preparation. A mellow, firm, weed-free seedbed is important. A turning plow can be used to bury the previous crop residue. A field cultivator or disk harrow may be used instead of or in addition to the plow, particularly if burying crop residues does not pose a problem. The land plane may be used as a tillage tool under some circumstances. A total of 3 to 7 times over the field will usually be necessary. Large rubber-tired tractors pulling wide implements will accomplish these operations rapidly. Most tillage operations can be done on a round-the-clock basis, with several shifts of drivers for the tractors.

c. Levee construction. Levees or small dikes are constructed using a tractor-drawn levee plow, which moves the soil in to the center from both sides. Several passes are usually necessary to construct a levee of proper dimensions.

The location of the levee is determined by surveying, to lay out the line for the levee following the contour of the land. This results in a curving or snake-like levee which is a uniform vertical interval (usually 30 to 60 mm) above or below the adjacent levees, but the horizontal interval varies depending on the slope of the land. If a vertical interval of 30 mm were used on land with a slope of 0.1%, a 1 km-wide field would have 33 levees, approximately parallel and spaced at distances averaging 30 meters. Along the length of such a level, if it is accurately placed on the contour, there will be no slope. Thus a flood of 120 cm. of water retained by this levee would give a minimum depth of water of 60 mm adjacent to the next levee on the uphill side, and a range of 60 to 120 mm in the entire "paddy" which could easily be 1 km. long. Levees can be constructed either before or after seeding. They must of course be constructed before irrigation.

Levee gates are installed in the levee (usually one per levee regardless of length of levee) to control the depth of water. Levee gates may be of metal or plastic. Their installation requires some hand-labor.

Water is normally introduced into the area above the upper-most levee in a given field. When that "paddy" is filled to the depth controlled by the setting of the levee gate, water flows over the gate to the next levee area downhill, and successively on to the rest of the field. Overflow from the lowest levee area, if any, runs into the drainage ditch.

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d. Seeding methods. Rice can be successfully seeded either with a seed drill or by broadcasting. Drill seeding normally will be used better to control the depth of seed placement. If timely seeding cannot be accomplished with available seed drills, broadcasting can be done, using somewhat more seed; the field will then be harrowed lightly to cover the seed.

Levees are seeded just prior to the final pass of the levee dish, to insure the best stand on the levees.

e. Seeding rates. Under average conditions, 100 to 130 kilograms of seed will be applied per hectare. This will be influenced by size and density of the grains, the germination rate, soil conditions and method of planting used. The objective is to plant enough seed to obtain a plant population of 130 to 160 plants per square meter.

f. Seeding dates. The seeding dates for rainfed rice grown the Casamance are tied to the beginning of the rainy season. Where irrigation is praticed, the date may better tied to temperature. A mean daily temperature of about 70°F (21°C) is necessary for germination and seeding growth. Monthly averages of daily mean temperatures in the Anambe basin are estimated in Chapter 5 of this report; there is no month when average temperatures are not warmer than 21°C, so there appears to be no temperature constraint on date of seeding rice. Therefore, seeding dates will be selected to mature the crop during months when dry weather for harvesting is likely. Thus, planting will normally occur in late June or July, depending on the length of season of the variety.

For rice production in the counterseason, there exists an even greater lack of data to guide selection of a seeding date because there is no local experience with winter-season rice.

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Minimum overnight temperatures normally encountered in December and January are cooler than ideal for rice production. Experimentation will be necessary to reveal the best planting date, but it appears that delaying planting until mid-January and using a midseason or shortseason variety would escape coldest weather and still permit completion of harvest before the onset of rains.

g. Varieties. The varieties of rainfed rice that have succeeded in Upper Casamance are TS 123, 302 G and I Kong Pao. These varieties will be used by the agro-production complex, but other varieties from a number of sources will also be tried. The modern technology that will be used includes better perparation of the land before planting, better water control (even for rainfed rice) thorough levelling and diking, and heavier fertilization. Taken together, these features will create an environment for the rice crop so different from that of the usual local plot that no one knows just how the "adopted" local varieties will perform. Exotic varieties with adaptation to some of the new environmental features, such as the American varieties Nova 75 and Lebonnet, may perform better than the traditional varieties, and they will be given the opportunity to demonstrate their suitability to Anambe Basin conditions.

h. Water Management. The principles presented here apply to irrigated rice. For rainfed rice, practices should approximate as nearly as possible the conditions desired for irrigated rice, recognizing that addition of water depends on rainfall or on runoff from fields at higher elevations.

After seed is drilled, the rice field will be "flushed" (thoroughly wetted, but not kept flooded). This gives the seed sufficient moisture for germination, and avoids crusting of the soil that may prevent emergence.

When seedlings are 10 to 15 cm. tall, which is usually 3 or 4 weeks after seeding, rice may be flooded. Grassy weeds should be brought under control with herbicides, and early season nitrogen should be applied, before the rice is flooded. The depth of water is increased gradually until it reaches 10 to 15 cm. depth. The flooded condition will be maintained until a fortnight before harvest, except as necessary to drain the field to combat chlorosis or to control certain weed, insect or disease problems. Draining the field permits the soil to dry and become firm enough to support harvesting machinery.

i. Fertilization. Supplying of sufficient nutrients to the rice plant to enable it to produce high yields, is complicated by problems of timing and of balance among the elements.

Relatively large amounts of nitrogen must be available to the rice crop in order to produce maximum grain yields. Excessive rates of nitrogen, however, may lead to increased lodging and disease incidence, delayed maturity, and poor quality grain. Proper timing is the key to reducing most of the problems associated with high rates of nitrogen fertilization.

Rice plants need sufficient nitrogen during the vegetative stage to produce optimum tillering. A small carryover of nitrogen is needed about midway in the growing season in order to promote the development of panicles with an optimum number of florets for high grain yields. As rice plants enter the period of reproductive growth, large amounts of nitrogen are needed for development and filling of florets (grains).

On soils low in organic matter, 35 to 55 kg./Ha. of nitrogen should be applied preplant or just prior to the first flood. This will provide adequate nitrogen for the vegetative stage of growth.

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A system of timing midseason nitrogen applications based on plant development will be used to minimise lodging and increase yields. The proper time to make the midseason nitrogen application is determined by splitting the main stems of representative rice plants and measuring the length of the elongating internodes. Optimum internode lengths for nitrogen application vary according to variety grown. Normally, if the midseason nitrogen rate is more than 55 kilograms per hectare, one-half is applied at the proper internode length for the variety and the remainder 10 to 14 days later. Timing of midseason nitrogen applications is especially critical for some varieties. Nitrogen applied too early will increase lodging; applying nitrogen too late will be of less benefit and may delay maturity.

Rates of nitrogen will vary with soil type, variety and crop history. Total amounts used will generally range up to 130 Kg./Ha. of nitrogen, and local experience will guide the decisions on amounts to be applied. Phosphorus is essential for optimum yield, but requirements are rather small compared to nitrogen. Phosphatic fertilizers will be used in modest amounts until local research determines the response of rice to application of phosphorus.

Potassium plays a key role in developing rice plant's resistance to lodging and disease. It is necessary for development of lignin and cellulos which give strength to stalks. Also, potassium contributes to plant vigor and disease resistance and helps plants manufacture and transfer food. The production of 3000 kg. of paddy rice removes only about 12 to 13kg. of potassium. Therefore, response to potash application has not been dramatic as far as increased yield is concerned. On soils testing low in potassium, a dose of 90 Kg./Ha of $K_2O$ will be applied.

Sulfur will be applied to neutralize iron and prevent iron toxicity if it is a problem.

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j. Control of Weeds. Weeds interfere with the production of rice by competing for water, nutrients, and light. Weeds reduce yields, increases the cost of harvesting, drying and cleaning; and reduce quality which lowers market value of the harvested crop. Weed problems, if not controlled, may make rice production unprofitable.

Traditional weed control in the Anambe basin has been by pulling up the weeds by hand or hoeing them out. To these time-tested ways, Project SENERIZ will add preventative treatment through use of weed-free seed, more thorough tillage before seeding, irrigation as a weed control measure, and the use of chemicals.

The first step in developing a satisfactory weed control program is to begin with weed-free seed. Once weeds infest a rice field, they are difficult to control. Project SENERIZ will produce its own seed, and the seed processing will include the most careful and complete cleaning to eliminate all weed seeds.

Seedbed preparation has already been discussed. The normal tillage operations planned, performed by heavy-duty implements maintained in good condition and pulled by powerful tractors, will be sufficiently thorough to eliminate most weed competition before seeding.

Irrigation, especially when adequate water is available to maintain a constant flood of adequate depth, is a powerful weapon against most weeds. It will be used in Project SENERIZ, as the entire project is structured around the planned availability of irrigation water.

A number of chemicals are available for use in the battle against weeds. The chemical that has proved most useful - the broadest spectrum of weed control combined with the least injury to the rice crop - is propanil.

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Propanil (3', 4' - dichloropropionanilide) is a selective postemergence herbicide that will control many grass and broadleaf weeds if applied when weeds and rice are in the early stages of development. From 3 1/2 to 6 Kg. per Ha. of propanil will be considered normal, routine treatment in Project SENERIZ. Other chemicals being developed and evaluated will be careully watehed, and these may also be adopted for general or specialized use.

k. Disease and insect control. The control of rice diseases is based primarily upon prevention. Therefore, control measures can best be employed before seeding time. The control measures to be used should be selected based on occurrence of diseases in previous years and on soil fertility tests.

Many serious disease losses may be avoided by using good seed of varieties that have resistance to the diseases. The seed should be properly treated with a recommended fungicide for further protection. Proper management (including timing) of seeding, fertilization, water application and removal will avoid most diseases and minimize the impact of the remainder.

The nature of the insect problem in irrigated rice, like other problems, is likely to follow the pattern observed in other commercial rice producing areas. The chemicals or other measures found effective in control elsewhere will be applied here. At all times care will be taken that the poisonous materials used for insect control do not contaminate rice that is to be used for food.

Insects cause major losses to rice in storages, but the Cereals Center of Project SENERIZ will be able to give effectively perfect control of insects in stored grain.

l. Harvest. Rice will be harvested with self-propelled combines, when the moisture content of the grain is between 17 and 23 percent. At this stage, the heads have turned downward and the kernels

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in the lower part of the heads are in the hard dough stage. Earlier harvest would result in light weight grain and lower yields, while delays beyond this stage may give serious losses from shattering of the grain.

Rice harvested at the recommended moisture content cannot be stored safety. It must be dried, and the Cereals Center of Project SENERIZ will have the facilities to dry the rice and maintain it in perfect condition until it is shipped or milled.

m. Rotations. Continued production of rice is planned in those fields to which irrigation water is supplied. This plan for rice monoculture will maximize the production of rice, and it follows the practice followed in most countries where climate and water availability permit it.

If difficulties such as build-up of weeds or diseases are encountered as a result of monoculture, it may be found necessary occasionally to follow certain fields or to use them for other crops.

The problems of erosion, compaction and general impoverishment of the soil that is observed with the traditional agricultural methods, and that result in shifting cultivation, will not be encountered. Land levelling and irrigation management will forestall erosion. Addition of chemical fertilizers will more than offset the removal of nutrient elements by the harvested crops. Structure and the state of being cultivated of the soil is likely to be improved by the combination of proper tillage and addition of large quantities of organic matter - "humus" - in the roots and stems of high-yielding crops.

n. Other crops. Much of the foregoing description of rice production technology is also applicable to crops of sorghum, maize, sugarcane or whatever may be produced. The major differences are listed below.

Seeding of sorghum and maize will be by drill or by special row-crop planter in rows approximately 75 cm. apart. Amount of seed used will vary with the variety but should give a plant approximately

every 15 to 25 cm. in the row. For rainfed crops, seeding date will depend on the onset of the rains. Study of the rainfall data for the region indicates in 3 years out of 4, crops planted by 20 June will have sufficient continued moisture. Based on this finding and on observation of farmers' practices, June 1-15 is set as the target planting date for sorghum and maize.

Much experimentation on varieties remains to be done for sorghum and maize. The low yields obtained from indigenous varieties in comparison with yields obtained in certain other countries indicates a need for introduction of new genetic material.

Weed control in sorghum and maize is facilitated by culture in rows. Tractor-mounted cultivators will be used to eliminate weeds between the rows. Chemical weed killers will be sprayed to kill weeds between the plants in the rows. Hand weeding or hoeing should rarely be needed.

Harvest of maize and sorghum will be done by self-propelled or tractor-drawn harvesting machines. While the risk of loss from shattering if harvest is delayed is less with these crops than with rice, the practice of harvesting moist grain will be followed to permit adherence to a schedule for mechanized harvest. The grain will the be dried in the Cereals Center, as for rice.

Crops of sorghum and maize can be alternated in the same field. With proper measures being taken against erosion, and with use of adequate fertilization and avoidance of excessive tillage, it should not be necessary to practice shifting cultivation. Occasionally, it may be desirable to leave a field fallow for a year, or to raise a crop of "green manure" that can be incorporated in the soil by plowing.

Exotic crops - sugarcane, fruits, vegetables - will be produced experimentally on the research plots of Project SENERIZ. The objective of this small- scale production will be to determine the feasibility of larger-scale, commercial production, and to develop

appropriate technology for such production. If such crops are found to be feasible, modifications of the project should be made to incorporate alternative crops and processing facilities for those crops.

## 11.6. PERSONNEL

### 11.6.0. Introduction and Generalities:

Project SEMERIZ, when in full operation, will be a major employer, probably the largest in Upper Casamance. The success of the project depends to a large extent on the effectiveness of the personnel, from the top-level management down through the ranks.

Local staff will be hired for all levels of work, including senior management, to the extent that qualified individuals can be found. Because of the introduction of technology and equipment that are unfamiliar to local persons, technical assistance from expatriate personnel will be required at the outset. A training program for technicians and administators is designed, in conjunction with proper in-the-job experience, to produce Senegalese that are fully qualified to take over the project from the expatriates by about the seventh year of the project.

The overall organization of the project is shown schematically in Figure 11.6.0.

### 11.6.1. Grades and costs of personnel

To facilitate estimation of labor costs for the various elements of the project, Table 11.6.1. has been developed. This table presents employer's costs for salary and allowances as well as for taxes and other expenses, for each of 12 grades of personnel. Nine grades (identified as grades 1,2,... 4) are established for Senegalese employees.

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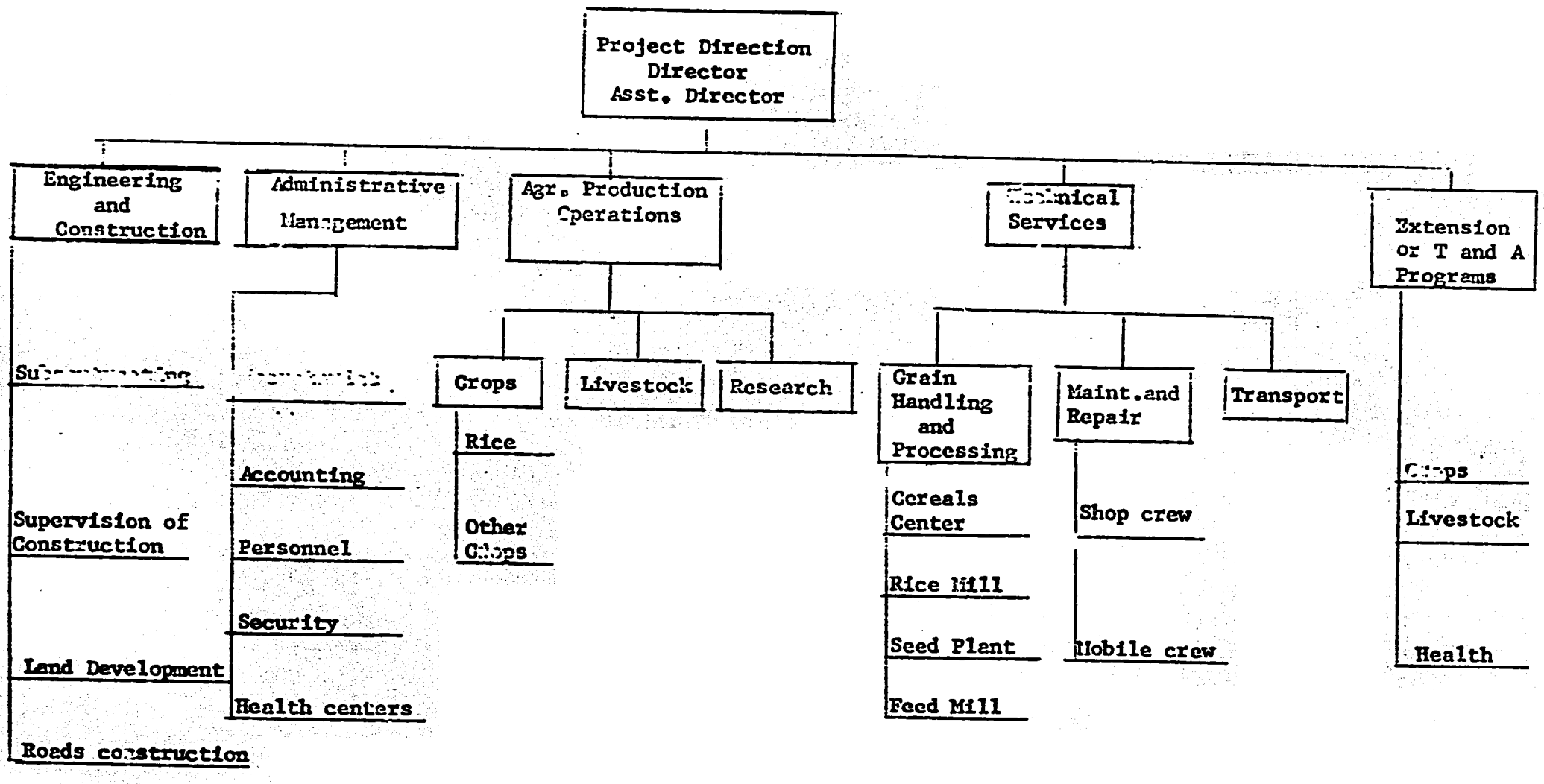
Figure 11.6.0. Organization of Project SENERIZ



## TABLE 11.6.1. Employer's Cost per Employee, By Grade

| Grade, Title | Average monthly salary | Average yearly salary | Contribution forfaitaire 2 - 4% | Caisse de sécurité sociale | Retirement (general) 4.8% |
|---|---|---|---|---|---|
| 1. Worker, Senegalese | 25 000 | 300 000 | 6 000 | [illegible] 000 | 14 400 |
| 2. Chauffeur, " | 35 000 | 420 000 | 8 400 | 29 400 | 20 160 |
| 3. Employee, " | 50 000 | 600 000 | 12 000 | 42 000 | 28 800 |
| 4. Technician, " | 65 000 | 780 000 | 15 100 | 50 400 | 34 560 |
| 5. Foreman, " | 80 000 | 960 000 | 19 200 | 50 400 | 34 560 |
| 6. Supervisor, " | 100 000 | 1 200 000 | 24 000 | 50 400 | 34 560 |
| 7. Engineer/Manager, " | 180 000 | 2 160 000 | 43 200 | 50 400 | 34 560 |
| 8. Civil Engineer, " | 300 000 | 3 600 000 | 72 000 | 50 400 | 34 560 |
| 9. Director, " | 500 000 | 6 000 000 | 120 000 | 50 400 | 34 560 |
| A. Expert expatriate | 300 000 | 3 600 000 | 144 000 | - - - - | 34 560 |
| B. Expert expatriate | 500 000 | 6 000 000 | 240 000 | - - - - | 34 560 |
| C. Expert expatriate | 800 000 | 9 600 000 | 384 000 | - - - - | 34 560 |

| | Retirement (executive) 3.6% | Expatriate allowances: Vacation travel | Expatriate allowances: Other | Total Annual cost to Employer | Rounded Annual cost, millions CFA |
|---|---|---|---|---|---|
| 1. Worker, Senegalese | - - - | - - - | - - - | 341 400 | .4 |
| 2. Chauffeur, " | - - - | - - - | - - - | 477 960 | .5 |
| 3. Employee, " | - - - | - - - | - - - | 682 800 | .7 |
| 4. Technician, " | - - - | - - - | - - - | 880 560 | .9 |
| 5. Foreman, " | - - - | - - - | - - - | 1 064 160 | 1.1 |
| 6. Supervisor, " | - - - | - - - | - - - | 1 308 960 | [illegible] |
| 7. Engineer/Manager, " | 77 760 | - - - | - - - | 2 365 920 | 2.4 |
| 8. Civil Engineer, " | 77 760 | - - - | - - - | 3 834 720 | 3.8 |
| 9. Director, " | 77 760 | - - - | - - - | 6 282 720 | 6.3 |
| A. Expert expatriate | 77 760 | 900 000 | 1 000 000 | 5 756 320 | 5.8 |
| B. Expert expatriate | 77 760 | 900 000 | 1 000 000 | 7 352 320 | 7.4 (8.4) |
| C. Expert expatriate | 77 760 | 900 000 | 1 000 000 | 11 [illegible] 000 | 12.0 |

Notes : 1. 2% for Senegalese, 4% for expatriates. 2. Senegalese only : 7% of salaries up to ceiling of 60 000 CFA/m 3. 4.8% of salaries, up to ceiling of 60 000 CFA/m. 4. In executives with salaries over 100 000 CFA/m : 3.6% of salaries, up to ceiling of 180 000. 5. Cost of round trip class Y to mid-USA for average family of 3 members. 6. Rounded average of serveral observed cases in West Africa.

These grades parallel the grades established by Senegalese labor laws, but they are not identical. It must be recognized that different persons employed to do comparable work inevitably come at varying costs, because of different education or training, differing age or experience, different allowances and variations in bargaining power.

This table establishes an estimated average cost for each grade of employee, with a salary somewhat above the minimum established by Senegalese law, and other costs based on that salary.

The three grades (A, B, and C) established for expatriates cover the range from technicians through project directors, and their estimated cost to the employer includes the standard expatriate allowances.

11.6.2. Personnel requirements by division :

Each of the administrative divisions shown in the organization chart (Fig. 11.6.0) will have its own needs for personnel. These needs are shown in list form with the grade for each post or type of work, and with the estimated number of employees in the seventh year of the project

a. Project Administration :

| | | | |
|---|---|---|---|
| Project Director | Level 10 | 1 | Required |
| Assistant Project | " 6 | 1 | " |

b. Business Management Division :

| | | | |
|---|---|---|---|
| Administrative Officer | Level 9 | 1 | " |
| Office Manager | " 5 | 1 | " |
| Secretary - typist | " 2 | 5 | " |
| Chief Accountant | " 5 | 1 | " |
| Accountants | Level 3 | 5 | " |
| Personnel officer | " 3 | 1 | " |
| Clerks | " 7 | 4 | " |
| Chief of Security | " 3 | 1 | " |

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| | | | | |
|---|---|---|---|---|
| Watchmen | " | 5 | 10 | " |
| Paramedical Personnel | " | 1 | 9 | " |
| " " | " | 3 | 6 | " |
| Division Total | | | 44 | |

c. Engineering and Construction Division :

| | | | | |
|---|---|---|---|---|
| Director of Contracts | Level | C | 1 | Required |
| Engineers | Level | 7 | 3 | |
| Supervisors | " | 6 | 3 | " |
| Foremen | " | 5 | 3 | " |
| Technical Employees | " | 3 | 2 | " |
| Equipment Operators | " | 2 | 7 | " |
| Laborers | " | 1 | 60 | " |
| Division Total | | | 79 | |

d. Production Operations Division

| | | | | |
|---|---|---|---|---|
| Director of operations | Level | C | 1 | Required |
| Director of livestock and research | " | B | 2 | " |
| Asst. director, operations | " | A | 1 | " |
| " " operations and research | " | 8 | 2 | " |
| Agriculturalists | " | 7 | 2 | " |
| Foremen | " | 5 | 52 | " |
| Labor and research technicians | " | 4 | 3 | " |
| Equipment operators | " | 2 | 242 | " |
| Laborers | " | 1 | 514 | " |
| Division Total | | | 819 | " |

e Teaching and Assistance Division

| | | | | |
|---|---|---|---|---|
| Director and Asst. Director | Level | B,A | 2 | Required |
| Unit Directors | " | 8 | 3 | " |
| Assistant unit directors | " | 7 | 2 | " |
| Supervisor | " | 6 | 1 | " |
| Technicians | " | 4 | 1 | " |

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| | | | | |
|---|---|---|---|---|
| Encadreurs | " | 3 | 47 | " |
| Drivers | " | 2 | 10 | " |
| Laborers | " | 1 | 2 | " |
| Division Total | | | 68 | |
| Grand Total | | | 1218 | |

## 11.6.3. Aggregative Personnel Requirements

Of the 1200 employees who will be needed in the sixth year, only 11 expatriates are planned. Numerically, over 99% of project employees will be Senegalese in year 7, and the expatriates will be completely phased out shortly after that. In order to obtain and keep the highly qualified employees who will be relied upon for the management of this complicated project with its sophisticated technology and equipment and its need for exactness and precision at all levels, it will be necessary to combine training with incentives. The incentives, both financial and in kind, are built into the cost schedule (Table 11.6.1.). Training is discussed below.

## 16.6.4. Selection Policies

An anomaly of this project is that for personnel at the upper end of the scale it will be difficult to obtain the needed people and to persuade them to live at the project site, while for personnel at the lower end of the scale it will be difficult to choose from among a probable surfeit of candidates, and people will be eager to migrate to the site of employment.

As requested by Government officals, employment will be reserved for local residents. Referral by the prefectures at Velingara and or Kolda will be a requirement for employment on a permanent basis, and every effort will be made to utilize local residents to fill any temporary or seasonal employment needs.

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16.6.5. Training Program and its Costs :

In Chapter 10.6, the project's training program was discussed as to In-service or "on-the-job" training and training not at the project site, including foreign training. Costs of the foreign program, presented in Table 10.6.2 B, amounted to 102.5 million CFA.

# CHAPTER 12 : ECONOMIC ANALYSIS

## 12.1. INTRODUCTION

## 12.2. CAPITAL INVESTMENT

2.1. General.
2.2. Fixed Assets.
2.3. Working Capital.
2.4. Preproduction Expenses.
2.5. Yearly Capital Investment.

## 12.3. SALES REVENUES

3.1. Cereals Revenues.
3.2. Cattle Revenues.
3.3. Processing revenues.
  a. Rice Mill.
  b. Grain Center.
  c. Feed Mill.
  d. Seed Plant.
3.4. Total Revenues.

## 12.4. OPERATING COSTS

4.1. Variable Costs for Cereals Production.
4.2. Variable Costs for Cattle Production.
4.3. Variable Costs for Processing Units.
  a. Rice Mill.
  b. Grain Center.
  c. Seed Plant.
  d. Feed Mill.
4.4. Variable Costs for Service Units.
  a. Generating Plant.
  b. Maintenance and Repair Unit.
  c. Transportation Unit.
  d. Road building and repairing crew.
  e. Mobile crew.

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4.5. Other Operating Costs.
4.6. Extension and T and A Program.
4.7. General Overhead Costs.
4.8. Determination of Total Costs of Processing Units.
4.9. Total Costs.

12.5. THE COMPUTER MODEL.

5.1. Role of the Computer.
5.2. Description of the Computer Model.

12.6. BASIC CASHFLOW FORECAST

12.7. SENSITIVITY ANALYSIS

7.1. Changes in Variable Costs.
7.2. Changes in Cereals Yields.
7.3. Changes in Processing Fees.
7.4. Changes in Cereals Prices.
7.5. Changes in Capital Costs.
7.6. Changes in Development Time Schedule.
7.7. Changes in Program Structure.
7.8. Summary.

12.8. OTHER COSTS AND BENEFITS

8.1. Effect of the Project on Incomes of Participating Farmers.
8.2. Effect of the Project on Government Revenues and Expenditures.

12.9. EFFECT ON THE BALANCE OF PAYMENTS

ANNEX : COMPUTER TABLES.

# CHAPTER 12 : ECONOMIC ANALYSIS

## 12.1. INTRODUCTION

The economic analysis examines the economic justification for the project, as measured by the internal rate of return, or economic rate of return. This is calculated from the annual project cashflows over a period of thirty years.

The cashflow forecast is based on :

a. An appraisal of the estimated capital investment requirements for the agro-industrial complex;
b. A forecast of revenue based on certain realistic assumptions concerning the market prices for cereals and cattle and the charges to be made to local farmers and to O.N.C.A.D. for ther service to be performed by the complex; and
c. An estimate of the annual fixed and variable operating costs for the complex.

In addition, the sensitivity analysis reviews the impact on the rate of return and on the project cashflow caused by changes in certain basic assumptions, e.g., higher or lower prices, greater or lesser agricultural yields, delay or acceleration in project execution, etc. This analysis examines the areas of uncertainty and reveals which parameters of the forecast have the greatest relative significance to the project.

An exchange rate of CFA 250 to one U.S. dollar has been used throughout the chapter.

The years indicated in the various tables are 12-month calendar years, unless otherwise indicated. Project years 1 through

30 and years 1978, 1979, etc. are used interchangeably, project year 1 being equivalent to 1978, year 2 being equivalent to 1979, etc.

## 12.2. CAPITAL INVESTMENT

### 12.2.1. General.

Total investment costs for implementing the project include all development expenses for erecting in the project area an agro-industrial complex capable of producing 115,000 tons of rice, 14,000 tons of sorghum, and 13,000 tons of maize per year. In addition, the complex will raise 15,000 head of cattle for sale every year, produce feed for these animals and seed for the plantation, and dry, store, and process the various cereals produced. The plantation will be irrigated by construction of a dam and reservoir, and the whole complex will be served by a generating plant, a maintenance and repair unit, central offices, and a residential center to house management personnel.

Investment costs have been divided between fixed assets, working capital, and intangible assets. The approximate and estimated breakdown between local and foreign costs is shown by categories.

It must be stressed that costs shown are order-of-magnitude estimates or budget estimates, based on current (June 1977) costs, and based on construction or installation of facilities in the agro-industrial complex under contract with the same contractor for all the component elements. Escalation and adjustment for inflation are not included.

### 12.2.2. Fixed Assets.

The technical report has described the various components

of the project. Table 12.2.2 shows the estimated capital costs for implementation of the project based on the development schedule presented in Chapters 10 and 11, using current prices. All costs for imported materials have been calculated without duties and taxes. A 10% contingency has been included as an over-all addition to estimated capital costs. Capital costs also include installation expenses.

It should be noted that the cost of the land has not been taken into account. As indicated in discussions of tenure and land use in Chapters 4 and 6, the project will be developed on land not claimed by local villages and thus remaining a part of the National Domain. Since the project will remain the property of the Senegalese Government, use of the government-owned land will be obtained at no cost.

12.2.3. Working Capital.

To the extent that current receipts are insufficient to pay for inputs and other expenses necessary to operate and maintain the complex, circulating capital must be available to finance these expenditures. During the growing season, for example, expenditures must be made for fuel and labor necessary for cultivation before any crops are harvested and sold. During the harvesting season, grain will be accumulated and stored before and after processing at the grain center and the rice mill before being sold, and the costs of drying, processing, and storage must be paid. After the crops are sold, however, cash receipts will be likely to exceed cash expenditures. If a temporary cash deficit is financed by the government or by SODAGRI or by short-term borrowing from local banks, it seems reasonable to conclude that, on the average, an amount equal to the cash deficit would be needed for only half the year, the cash surplus after harvesting being used to reduce the short-term indebtedness acquired earlier. This is the assumption used in calculating working capital, and it is shown as equal to 50% of the gross cashflow so long as the cashflow is negative.

### 12.2.4. Preproduction Expenses.

Preproduction expenses include operating expenses during the development period, and consist of agricultural supplies (including initial seed requirements), personnel and overhead costs. Although certain aspects of Project SENERIZ will not be productive until some time later (the dam and major irrigation scheme, for example) there will be some production of cereals in the second year. For simplicity, preproduction expenses are simply combined with other capitalized expenses.

### 12.2.5. Yearly Capital Investment.

Table 12.2.5 shows the yearly capital investment of the project, including fixed assets, working capital, and intangible assets. These are the same data used in the project cashflow analysis in subsequent sections.

## 12.3. SALES REVENUES.

Revenues of the project arise from sales of products of its fields and its industrial complex, and from charges made for processing. Revenues are thus a function of production.

Production of the complex and of local farmers is shown in Table 12.3.A.

Revenue from all sources is shown in Table 12.3.B (parts 1, 2, and 3) along with other information to be explained further on in the text. It will be noted that revenues stabilize in Year 7 (1984) and subsequently remain unchanged through the balance of the 30 years shown in Parts 1, 2, and 3 of Table 12.3.B.

TABLE 12.2.5 Yearly Capital Investment (in millions of francs CFA)

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 |
|---|---|---|---|---|---|---|
| **Data collection and research :** | | | | | | |
| Tenure and land use | 10 | 15 | - | - | - | - |
| Soil survey | 30 | 33 | - | - | - | - |
| Agronomic research | 10 | - | - | - | - | - |
| Topographic mapping | 68 | 2 | - | - | - | - |
| Geological study | 45 | - | - | - | - | - |
| Weather stations/stream gauges | 1 | | | | | |
| Sub-total | 164 | 50 | - | - | - | - |
| **Irrigation and water supply :** | | | | | | |
| Two deep wells | 37 | | | | | |
| Well enlargement | 40 | | | | | |
| Four shallow wells | 76 | | | | | |
| Dam and reservoir : Design | - | 250 | - | - | - | - |
| Dam and reservoir : Construction | - | - | 1 500 | 1 500 | - | - |
| Irrigation system : Design | - | 250 | - | - | - | - |
| Irrigation system : Construction | - | - | 1 950 | 1 950 | - | - |
| Sub-total | 153 | 500 | 3 450 | 3 450 | - | - |
| **Plantation development :** | | | | | | |
| Roads design | - | 25 | - | - | - | - |
| Land development | 600 | 1 200 | 2 400 | 3 000 | 4 200 | 3 600 |
| Sub-total | 600 | 1 225 | 2 400 | 3 000 | 4 200 | 3 600 |
| **Equipment :** | | | | | | |
| Irrigation equipment | 150 | - | - | - | - | - |
| Road building equipment | - | 270 | - | - | - | - |
| Farm machinery | 130 | 270 | 500 | 600 | 300 | 700 |

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TABLE 12.2.5 Yearly Capital Investment (continued)

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 |
|---|---|---|---|---|---|---|
| **Equipment, continued :** | | | | | | |
| Transport equipment | 78 | 49 | 53 | 65 | 159 | 74 |
| Sub-total | 358 | 589 | 553 | 665 | 959 | 774 |
| **Industrial facilities** | | | | | | |
| Headquarters unit | 400 | 400 | 400 | 400 | 400 | - |
| Cereals processing center | 1 000 | - | 1 000 | 2 400 | - | - |
| Seed plant | 70 | - | - | - | - | - |
| Rice mill | 50 | 100 | - | 300 | - | - |
| Feed manufacturing plant | - | - | 145 | - | - | - |
| Livestock facilities | 10 | 5 | 15 | 10. | 10 | - |
| Sub-total | 1 530 | 505 | 1 560 | 3 150 | 410 | |
| **Training programs :** | 27 | 36 | 19 | 20 | - | - |
| TOTALS | 2 832 | 2 905 | 7 982 | 10285 | 5 569 | 4 374 |

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w* 154, 304,
0 220

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TABLE 12.3.A.

TABLEAU 12.3.A.

TABLE 1

BASE CASE

CAS DU BASE

PROJECT SENERIZ PRODUCTION REPORT
(In units and tons)

RAPPORT PRODUCTION DU PROJECT SENERIZ
(En unites et tonnes)

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1020 COMPLEX PRODUCTION | | | | | | | | | | | PRODUCTION DU COMPLEXE |
| 1201 Rainfed rice net production | 0 | 442 | 2928 | 6886 | 12190 | 0 | 0 | 0 | 0 | 0 | Production Nette de Riz Pluvial |
| 1211 Irrigated rice net production | 0 | 900 | 3040 | 6920 | 10470 | 108463 | 115260 | 115260 | 115260 | 115260 | Production Nette de Riz Irrigue |
| 1221 Sorghum net production | 0 | 317 | 743 | 3101 | 6941 | 7648 | 13568 | 13568 | 13568 | 13568 | Production Nette de Sorgho |
| 1241 Maize net production | 0 | 434 | 856 | 3043 | 6563 | 6974 | 13194 | 13194 | 13194 | 13194 | Production Nette de Mais |
| 1250 Calves purchased | 0 | 300 | 800 | 1500 | 5000 | 10000 | 10000 | 10000 | 10000 | 10000 | Veaux achetes |
| 1251 Calves sold | 0 | 0 | 300 | 800 | 1500 | 5000 | 10000 | 10000 | 10000 | 10000 | Veaux vendus |
| 1255 Feeder cattle | 0 | 50 | 300 | 800 | 1500 | 5000 | 5000 | 5000 | 5000 | 5000 | Betail d'engraissement |
| 1300 FARMERS PRODUCTION | | | | | | | | | | | PRODUCTION DES FERMIERS |
| 1300 Rainfed rice net production | 0 | 33 | 98 | 261 | 526 | 1069 | 2283 | 2283 | 2283 | 2283 | Production Nette de Riz Pluvial |
| 1305 Sorghum net production | 0 | 119 | -177 | 1118 | 2971 | 6526 | 13201 | 13201 | 13201 | 13201 | Production Nette de Sorgho |
| 1310 Millet net production | 0 | 20 | 42 | 171 | 469 | 1022 | 2197 | 2197 | 2197 | 2197 | Production Nette de Mil |
| 1315 Maize net production | 0 | 70 | 480 | 1344 | 3168 | 6537 | 12714 | 12714 | 12714 | 12714 | Production Nette de Mais |
| 1320 Total cereals production | 0 | 242 | 443 | 2894 | 7134 | 15154 | 30395 | 30395 | 30395 | 30395 | Production Totale de Cereales |
| 1360 Farmers cattle raised | 0 | 113 | 150 | 697 | 1640 | 3419 | 6743 | 6743 | 6743 | 6743 | Betail elev par les fermiers |

NOTES: 1) Production data for years 1988-2007 are identical to those of 1987.

2) Production data for most other cases are identical to the Base cases.

N.B.: 1) Donnees de production pour les annees 1988-2007 sont identiques a ceux de 1987.

2) Donees de production pour la plupart des cas son identique au cas de base.

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TABLE 12.3.B.

TABLEAU 12.3.B.

TABLE 2, PART 1

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

BASE CASE

CAS DU BASE

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales 15 240 x 41.5 | 0 | 50 | 240 | 573 | 940 | 4418 | 4783 | 4783 | 4783 | 4783 | Ventes de riz |
| 1420 Sorghum sales 13 569 x 35 | 0 | 11 | 26 | 109 | 243 | 268 | 475 | 475 | 475 | 475 | Ventes de sorgho |
| 1440 Maize sales 13 194 x 35 | 0 | 15 | 30 | 107 | 230 | 244 | 462 | 462 | 462 | 462 | Ventes de mais |
| 1450 Cattle revenue | 0 | 4 | 38 | 101 | 189 | 632 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees 30.000 x 20 | 0 | 27 | 122 | 281 | 464 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling 9635 CFA/TON | 0 | 2 | 4 | 24 | 60 | 127 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers) |
| 1475 Farmers grain storage 2596 CFA TON RICE/MO. | 0 | 1 | 5 | 13 | 27 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1479 Complex grain handling 3552 CFA OTHER/MO. | 0 | 18 | 66 | 168 | 304 | 1017 | 1193 | 1193 | 1193 | 1193 | Commission manutention (complexe) |
| 1480 Cattle feed sales | 0 | 3 | 13 | 34 | 62 | 204 | 241 | 241 | 241 | 241 | Commission stockage (complexe) |
| 1500 Seed center sales | 0 | 1 | 1 | 7 | 16 | 33 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1550 TOTAL REVENUE | 0 | 1 | 1 | 2 | 4 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| | 0 | 139 | 549 | 1411 | 2525 | 9577 | 9995 | 9995 | 9995 | 9995 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 7 | 35 | 76 | 121 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 0 | 12 | 36 | 74 | 127 | 909 | 1082 | 1082 | 1082 | 1082 | Riz irrigue |
| 1630 Sorghum | 0 | 4 | 7 | 25 | 51 | 52 | 88 | 88 | 88 | 88 | Sorgho |
| 1640 Maize | 0 | 4 | 9 | 25 | 50 | 51 | 92 | 92 | 92 | 92 | Mais |
| 1650 Cattle costs | 0 | 9 | 35 | 80 | 197 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 0 | 2 | 4 | 13 | 28 | 63 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 0 | 1 | 8 | 9 | 27 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 0 | 5 | 17 | 41 | 75 | 255 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 0 | 3 | 10 | 17 | 44 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 0 | 187 | 385 | 590 | 969 | 1260 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1785 SUBTOTAL, VARIABLE COSTS | 0 | 234 | 543 | 949 | 1598 | 3270 | 4076 | 4076 | 4076 | 4076 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 0 | 16 | 21 | 34 | 50 | 61 | 71 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 0 | 141 | 288 | 452 | 710 | 826 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 0 | 31 | 35 | 40 | 48 | 52 | 55 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 0 | 18 | 18 | 18 | 18 | 18 | 18 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 0 | 44 | 91 | 149 | 241 | 478 | 510 | 501 | 501 | 501 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 0 | 250 | 453 | 693 | 1067 | 1435 | 1536 | 1435 | 1435 | 1435 | TOTAL PARTIEL, COUTS FIXES |
| 1790 TOTAL OPERATING COSTS | 0 | 484 | 996 | 1642 | 2850 | 5254 | 5612 | 5511 | 5511 | 5511 | COUTS TOTAUX D'OPERATION |
| 1799 GROSS CASHFLOW | 0 | -346 | -447 | -231 | -325 | 3323 | 4383 | 4484 | 4484 | 4484 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 1285 | 2369 | 6418 | 7125 | 5169 | 4374 | 0 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 Investment, facilities | 1520 | 500 | 1400 | 3285 | 400 | 0 | 0 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 28 | 36 | 19 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 173 | 224 | 116 | 63 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 2833 | 3078 | 8061 | 10546 | 5632 | 4374 | 0 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | -2833 | -3424 | -8508 | -10777 | -5757 | -1051 | 4383 | 3473 | 3473 | 3473 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | -2833 | -6257 | -14765 | -25542 | -31299 | -32350 | -27967 | -24494 | -21021 | -17548 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | -11332 | -25028 | -59060 | -102168 | -125196 | -129400 | -111868 | -97976 | -84084 | -70192 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 12.3.B [redacted]ontinued

TABLEAU 12.3.B. su[redacted]e

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

TABLE 2, PART 2

BASE CASE

CAS DU BASE

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | Ventes de riz |
| 1420 Sorghum sales | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | Ventes de sorgho |
| 1440 Maize sales | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | Ventes de mais |
| 1450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers) |
| 1475 Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1476 Complex grain handling | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | Commission manutention (complexe) |
| 1479 Complex grain storage | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de pourriture pour le betail |
| 1500 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1590 TOTAL REVENUE | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | Riz irrigue |
| 1630 Sorghum | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | Sorgho |
| 1640 Maize | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | Mais |
| 1650 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1660 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1670 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1680 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1690 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | TOTAL PARTIEL, COUTS VARIABLES |
| 1719 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1731 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | TOTAL PARTIEL, COUTS FIXES |
| 1790 TOTAL OPERATING COSTS | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | COUTS TOTAUX D'OPERATION |
| 1799 GROSS CASHFLOW | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | CASHFLOW BRUT |
| 1940 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1950 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1955 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1961 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1970 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1999 PROJECT CASHFLOW | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | CASHFLOW DU PROJET |
| 2881 CUMULATIVE CASHFLOW | -14075 | -10602 | -7129 | -3656 | -183 | 3290 | 6763 | 10236 | 13709 | 17182 | CASHFLOW CUMULATIF |
| 2883 CUMULATIVE CASHFLOW DOLLARS 000 | -56300 | -42408 | -28516 | -14624 | -732 | 13160 | 27052 | 40944 | 54836 | 68727 | CASHFLOW CUMULATIF DOLLARS 000 |

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TABLE 12.3.B [redacted]onclusion

TABLEAU 12.3.B. fin

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

TABLE 2, PART 3

BASE CASE

CAS DU BASE

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4924 | Ventes de riz |
| 1420 Sorghum sales | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 476 | Ventes de sorgho |
| 1440 Maize sales | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 464 | Ventes de mais |
| 1450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers |
| 1474 Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1222 | Commission manutention (complexe) |
| 1479 Complex grain storage | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 246 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 10173 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | Riz irrigue |
| 1630 Sorghum | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | Sorgho |
| 1640 Maize | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | Mais |
| 1650 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | TOTAL PARTIEL, COUTS FIXES |
| 1790 TOTAL OPERATING COSTS | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | COUTS TOTAUX D'OPERATION |
| 1799 GROSS CASHFLOW | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4662 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3651 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | 20655 | 24128 | 27601 | 31074 | 34547 | 38020 | 41493 | 44966 | 48439 | 52090 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | 82620 | 96512 | 110404 | 124296 | 138188 | 152080 | 165972 | 179864 | 193756 | 208360 | CASHFLOW CUMULATIF DOLLARS 000 |

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12.3.1. Cereals Revenues.

The various cereals will be grown on the plantation under carefully controlled conditions, using the most modern methods of mechanical cultivation. This should assure a high quality of product and an incresing yield per hectare as land development, irrigation, and personnel training proceed. After purchase of seed at the outset, seed for the following year's planting will be derived from the current year's production. Revenues are therefore calculated by multiplying the current year's net production (after deducting next year's seed requirements) by the current official prices for the various cereals, that is, CFA 41.5 per kilogram for rice and CFA 35 per kilogram for the other grains.

The facilities of the agro-industrial complex of Project SENERIZ will be the finest and the most modern in all Senegal. The services performed by the cereals center, the rice mill, and the other units will relieve ONCAD of the need to provide installations, personnel, and management for a major cereals producing region. It is clearly necessary to reflect in the revenues of the complex the services that are provided. Therefore, handling charges for the cereals received, handled, conditioned, and loaded out are computed and charged to ONCAD. The costs of storage of cereals are charged separately, as is the practise in the international grain trade. A rice milling fee is also charged.

The revenues from the processing of cereals will be discussed in Section 12.3.3. The cereals production goals for the plantation (forecast to be realized by Year 7) will yield total annual revenues from cereals sales alone of CFA 5,720 million.

The forecast yields are based on studies of local resources and conditions, by Senegalese and expatriate experts having a broad base of training, experience and observation. The studies included comparisons and contrasts with resources and conditions in the rice-

growing regions of the United States, South America, and other parts of Africa and several countries in Asia. The forecast yields are intended to be realistic. To the extent that actual yields exceed forecast yields, realized revenues will exceed forecast revenues; to the extent that yields are lower than anticipated, revenues will fall short of forecasts. A number of possibilities are examined in the section on sensitivity analysis.

12.3.2. Cattle Revenues.

Cattle raised on the complex will utilize the waste products of the cereals operation and will provide an additional source of revenue. Both calves and mature cattle will be raised, the number of head being increased annually as the fodder production of the cereals operation increases. In addition, the cattle will be fed a protein-mineral supplement designed to balance the ration and fully meet nutritional requirements, permitting more rapid gain in weight and producing a superior quality of beef. The assumption is made that calves purchased in the current year will be fed for about 10 months and thus on the average sold in the following year, but that mature cattle will be sold, after fattening, in the same year in which they were bought. Calves will be purchased at 200 francs per kilo and sold at 225 francs, and they will gain an average of 146 kilos. In the case of mature cattle, the profit from the operation derives solely from the gain in weight of the fed animal, since they are assumed to be purchased at the current price per kilogram of CFA 225 and to be sold at the same price per kilogram. It is estimated that each of these animals will gain 136 kilograms of weight during the period of feeding. A one percent mortality rate is assumed for both groups of cattle, for purposes of forecasting revenues. Since this type of operation envisions no breeding program, a fertility rate of zero has been assumed.

Total revenue from cattle sales is estimated to amount to CFA 861 million per year by Year 7.

12.3.3. Processing Revenues.

In addition to the cereals and cattle operations, the complex will process the grains, produce and prepare seed for the plantation and for local farmers involved in the training and assistance program, and produce a feed supplement for sale to the local farmers.

a. Rice Mill : The paddy rice will be brought to the grain center and dried, and then milled at the rice mill. This processing will result in a quality far superior to rice currently imported or locally available from most sources. At the present time, ONCAD buys rice from farmers at CFA 41.5 per kilogram. This rice is milled under contract, the standard fee being CFA 10 per kilogram. If a milled rice yield of 70 percent of the original paddy is assumed, the cost of the milled rice amounts to CFA 73.57 per kilogram. The typical product from this contract milling is, however, more than 50 percent broken and is frequently dirty. Imported rice of a quality superior to the above sells at higher prices. The best grade of imported rice currently sells in Dakar for CFA 100 per kilogram in bulk or even more in packages.

Since the product of the complex's rice mill will be equal in quality to the best imported rice, it seems logical that this quality should be reflected in the revenues of the complex. Accordingly, the assumption is made that in addition to the standard fee for rice milling, an additional CFA 10 per kilo will be charged to ONCAD as a fee for blending the milled rice to ONCAD's specifications. Thus, the total revenue from the rice mill will be CFA 20 per kilogram for all paddy rice sold to ONCAD. If, as assumed, the complex's product can be sold for at least CFA 100 per kilogram, its market price will be CFA 20 per kilogram higher than the imported, badly broken, dirty rice. The additional value added by the complex, comparing SENERIZ rice to the imported product, is thus far more than the additional milling fee charged by the complex for blending.

The rice milling fee of CFA 20 per kilogram results in a maximum revenue of CFA 1600 million per year, once the complex is in full operation. This maximum revenue is determined by the limitation on the capacity of the rice mill, which is 80,000 tons per year.

b. Grain Center : At the present time, ONCAD buys all the grain sold legally by local farmers. The prices established for the various cereals represent essentially "farm gate" prices (producer prices). After the producer delivers the grain to ONCAD, all subsequent handling, additional drying if needed, and storage is the responsibility of ONCAD.

SODAGRI is assumed to act for ONCAD as a buyer and processor of cereals for the Anambé Basin and Project SENERIZ, and in this role will handle, dry, and store the cereals produced by the complex as well as by the local farmers. As compensation for performance of these functions, charges for handling and for storage are levied against ONCAD. The handling charge, applied to all of the grain, is based on the total cost per ton of performing the service of handling and drying. This cost, including amortization of investment, repair of equipment, personnel, energy charges and other costs, and a 10% margin, is 7 635 F CFA per ton. Revenue for the handling fee reaches 1 448 million F CFA at full operation in Year 7.

The storage charge is based on the logical need for ONCAD to pay a reasonable fee for this necessary service, which will in fact substitute to some extent for ONCAD's planned but tardily implemented program of constructing storage where needed throughout Senegal. The amount of the storage charge is based on the rate currently in effect in grain storage centers in the rice producing parts of the U.S.A., and approved by the Commodity Credit Corporation of the U.S. Government : 3 1/2 cents per 45 pounds per month for rice and 2 1/2 cents per 45 pounds per month for other cereals.

.../...

This is increased by 30% to adjust for storage problems in hot climates and for higher energy costs in Senegal. The adjusted charge converts to 6 686 F CFA per ton for rice and 3 582 F CFA per ton for other cereals. The planned pattern for use of the storage facilities is to store all of the current crop at harvest time, to deliver to ONCAD a steady stream of cereals (including milled rice) throughout the year, and to empty the silos just before the next harvest. Thus, on the average, rice will be stored fir three months (half the time until the next harvest) and other cereals will be stored an average of six months.

Revenue derived from storage charges is CFA 295 million at full operation. Thus the total revenue from handling and storage of grain by the grain center will reach CFA 1 743 million per year, in Year 7 and after.

c. Feed Mill : The feed mill will will supply a feed supplement both to the complex's cattle and to those of cooperating farmers. Revenue will be derived, however, only from sales to farmers. The price to be charged for this feed supplement is equal to its total cost for purchased ingredients plus the prorated costs of operating the feed mill, plus 10%. This cost is calculated to be CFA 86.59 per kilogram. The revenue from feed sales is calculated by multiplying this price times 100 kilograms times the number of head of cattle estimated to be raised by cooperating farmers per year. Each animal would be fed 100 kilograms of feed supplement per year. Total revenue from this source amounts to CFA 54 million by Year 7.

d. Seed Plant : The seed plant will prepare seed for next year's planting for both the complex and cooperating farmers. This seed will be of far higher quality than seed typically used in normal current peasant production, because it will be subjected to rigorous quality control during growing and processing, will be of known varieties and germinating power, and will be treated with appropriate chemicals to rid it of parasites and to control certain plant

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12.4.1. Variable Costs for Cereals Production.

Motor Fuel : Estimates for motor fuel consumption have been based on the experience of farmers in the Delta of the Arkansas and Mississippi rivers in the state of Arkansas, U.S.A., in the late 1960's. In this geographic region, rice, maize, and other cereals are important crops, and the technology and degree of mechanization of crop production is comparable to that planned for Project SENERIZ. While the machinery used in Project SENERIZ will be larger and more powerful than that used by individual farmers in the reference region, variations in size of machinery used make very little difference in the fuel required per hectare.

Fuel requirements, as reported in the bulletin "Enterprise Costs and Returns on Rice Farms in the Delta, Arkansas", Report Series 170 (June 1968) Agricultural Experiment Station, Fayetteville, Arkansas, average 53.74 liters per hectare for growing, and 69.25 liters per hectare for harvesting. Multiplying the figure for fuel consumption by CFA 61.1 per liter and adding 10% for lubricants produces the estimate of CFA 3,611.87 per hectare for growing activities. This was then multiplied by the number of hectares in cultivation to get the estimate of total fuel costs of growing the crops.

The costs of fuel for harvesting were converted to a cost per ton of cereals harvesting in Year 7, since the production of that year, when the plantation reaches its designed capacity, most closely resembles the Arkansas situation cited above. Harvesting fuel costs per ton, however, vary by crop, since yields per hectare are different for the various cereals. The estimates are as follows :

| Cereal | Cost per ton |
|---|---|
| Rainfed Rice | CFA 2,115.59 |
| Irrigated Rice | CFA 1,496.47 |
| Sorghum | CFA 1,551.43 |
| Millet | CFA 3,337.15 |
| Maize | CFA 1,551.43 |

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Fertilizer : The quantity and analysis of fertilizers used differs from one cereal to another. Furthermore, the price of urea differs from that of other fertilizers. Consequently, the fertilizer component of growing costs per hectare differs among the various cereals. The following table shows the derivation of the fertilizer cost estimates.

| | Quantity per hectare of : | | Price, CFA/kg : | | Total fertilizer cost/hectare |
|---|---|---|---|---|---|
| | Urea | Other fert. | Urea | Other | |
| Rainfed rice | 100 kg. | 150 kg. | 17.5 | 12.5 | CFA 3,625 |
| Irrigated rice | 300 kg. | 300 kg. | 17.5 | 12.5 | CFA 9,000 |
| Sorghum | 150 kg. | 150 kg. | 17.5 | 12.5 | CFA 4,500 |
| Millet | 100 kg. | 150 kg. | 17.5 | 12.5 | CFA 3,625 |
| Maize | 200 kg. | 200 kg. | 17.5 | 12.5 | CFA 6,000 |

Fertilizer requirements are based on information contained in Le Programme "4S" : Programme linéaire pour les exploitations agricoles du Sine-Saloum au sud du Sénégal, published by the Institut de Recherches Agronomiques Tropicales et des Cultures Vivrières, in September, 1976.

Chemicals : Chemicals include fungicides, insecticides, herbicides, and growth regulators. Chemical cost per hectare is estimated to be CFA 5,000.

Variable Labor : Costs of personnel are divided into two categories. One, overhead labor, is assumed to include upper level personnel (project directors, engineers, supervisors, etc.) and other personnel such as the project office staff, whose cost should be borne by the project as a whole rather than by specific parts. Overhead labor is discussed in 12.4.7. The other category, variable labor, is the personnel needed for a specific portion of the project, the number and cost of whom depends on the activities of that specific portion.

Variable labor requirements for cereal production vary with the amount of cereal grown. The requirements are somewhat

different for the various cereals. In general, rice requires more labor than the other grains, but irrigated rice requires more than rainfed rice because of the necessity of maintaining levees and canals, controlling the water, and so on. Three types and grades of labor were assumed to make upvariable labor for crop production : (1) ordinary unskilled labor (grade 1); (2) tractor drivers (grade 2); and (3) foremen. (grade 5). These three grades make up, respectively, 60%, 35%, and 5% of variable labor. The estimated labor costs per employee per year for each grade are, respectively, CFA 400,000, CFA 500,000, and CFA 1,100,000. Table 12.4.1 shows the labor cost by grade of worker.

TABLE 12.4.1 Labor Cost by Grade of Worker (in thousands of F CFA).

| Senegalese, variable labor : | Average Yearly Salary | Taxes and other costs | Total annual cost to employer |
|---|---|---|---|
| 1. Worker | 300 | 100 | 400 |
| 2. Chauffeur | 420 | 80 | 500 |
| 3. Employee | 600 | 100 | 700 |
| 4. Technician | 780 | 120 | 900 |
| 5. Foreman | 960 | 140 | 1 100 |
| **Senegalese, Supervisory :** | | | |
| 6. Supervisor | 1 200 | 100 | 1 300 |
| 7. Engineer/manager | 2 160 | 240 | 2 400 |
| 8. Chief Engineer | 3 600 | 200 | 3 800 |
| 9. Director | 6 000 | 300 | 6 300 |
| **Expatriate :** | | | |
| A. Expert | 3 600 | 2 200 | 5 800 |
| B. Expert | 6 000 | 1 400 | 7 400 |
| C. Expert | 9 600 | 2 400 | 12 000 |

The variable labor requirement per hectare for growing and harvesting of cereal crops is as follows :

| Cereal | Hours per ha Growing | Hours per ha Harvesting |
|---|---|---|
| Rainfed rice | 22 | 7 |
| Irrigated rice | 37 | 8 |
| Sorghum | 10 | 8 |
| Millet | 10 | 6 |
| Maize | 10 | 8 |

Harvesting labor costs were converted to a cost per ton of cereals harvested in Year 7, similarly to the treatment of fuel costs. The resulting unit labor costs for growing and harvesting are shown below :

| Cereal | Labor cost per unit | |
|---|---|---|
| | Growing (per ha) | Harvesting (per ha) |
| Rainfed rice | CFA 4,309 | CFA 623.49 |
| Irrigated rice | CFA 7,245 | CFA 503.67 |
| Sorghum | CFA 1,957 | CFA 522.67 |
| Millet | CFA 1,961 | CFA 591.50 |
| Maize | CFA 1,957 | CFA 522.67 |

Seed : Seed requirements after the first year will be supplied from plantation production. Therefore, only the first year's seed input requires a cash outlay, and this is treated as a capital cost in that year.

Total variable costs for cereals production : Total variable costs per unit (including fuel, fertilizer, chemicals, and labor) are shown separately for harvesting and growing in the table below :

| Cereal | Cost per unit | |
|---|---|---|
| | Growing (per ha) | Harvesting (per ha) |
| Rainfed rice | CFA 16,543.54 | CFA 2,739.53 |
| Irrigated rice | CFA 24,857.57 | CFA 2,000.14 |
| Sorghum | CFA 15,068.87 | CFA 2,074.10 |
| Millet | CFA 14,197.87 | CFA 2,918.65 |
| Maize | CFA 16,568.87 | CFA 2,074.10 |

12.4.2. Variable Costs for Cattle Production.

The variable costs of raising cattle consist of the purchase cost of the cattle, the labor for herding and caring for them, and the feed supplement to be fed to them. Only the first two costs will be analyzed here, since the feed supplement will be considered when the feed mill is discussed.

Variable Labor : It is assumed that one herdsman (grade 1) can care for approximately 70 head of cattle, and that one foreman (grade 5) is required for every 7 herdsmen. Labor costs per head, therefore, are CFA 7,381 per head for calves that are kept 10 months and CFA 2,214 per head for feeder cattle that are kept only three months.

Animal cost : Calves will be purchased weighing, on the average, 70 kilograms, at a price of CFA 200 per kilogram, or a cost per head of CFA 14,000. Feeder cattle will be bought weighing, on the average, 115 kilograms at a price of CFA 225 per kilogram, or a cost per head of CFA 50,625.

12.3.2. Variable Costs for Processing Units.

a. Rice Mill : Variable Labor : In full scale operation, the rice mill will operate 24 hours per day, processing 10 tons per hour for 333 days per year. Maximum production will therefore be 80,000 tons per year. At this level of production, it is estimated that labor requirements will be 12 ordinary unskilled laborers (grade 1), six technicians (grade 4), and three foremen (grade 5). This level of operation requires three shifts per day, each shift being manned by one-third of the above personnel. At employee costs specified in Table 12.4.1., a labor cost of CFA 168.75 per ton is estimated.
10.615

Fuel : The rice mill will require 44 liters of diesel fuel per hour for milling. This is based on the power requirements for milling rice and the fuel requirements of comparable rice mills. At CFA 61.1 per liter, plus 10% for lubricants, fuel costs will be CFA 295.72 per ton.
11.829

Bags : Milled rice for the Senegalese market is handled in bags. Assuming that a bag capable of holding 80 kilograms costs CFA 300 and can be reused six times before being discarded and replaced, the bags cost per ton of paddy rice is CFA 625.

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Total Variable Costs for Milling Rice : The sum of these costs is CFA 1,099.47 per ton.

b. Grain Center : The volume of grain handled and stored by the grain center is shown in Table 12.4.3.A and the operating cost is shown in Table 12.4.3.B.

Variable Labor : In full scale operation in Year 7, the grain center will process 176,666 tons of all types of cereals per year, including both the grain of the complex and that of cooperating farmers. It will receive, clean, buy, and store the grain for delivery to ONCAD. To operate this center, 24 ordinary unskilled workers (grade 1), and nine foremen (grade 5) will be needed. Thus, a labor cost of CFA 123.67 per ton is estimated.

Fuel : Fuel requirements of 25 liters per ton are estimated. At a diesel fuel price of CFA 61.1 per liter, this amounts to CFA 1,527.5 per ton. However, drying requirements for grains other than rice are estimated to be only one-quarter of that for rice, so that the fuel cost per ton of all grain handled in CFA 1,165.0.

Bags : 80 kilogram bags costing CFA 300 per bag will be used. If, as assumed, each bag is reusable six times, the bags cost per ton is CFA 625.

Total Variable Costs : The sum of these costs is CFA 1,913.67 per ton.

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TABLE 12.4.3.A Grain Center Volume

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 |
|---|---|---|---|---|---|---|
| Cereals handled : | | | | | | |
| Total cereals (tons) | 2 450 | 8 460 | 21 973 | 42 292 | 125 501 | 157 682 |
| Cereals other than rice, total | 893 | 2 133 | 8 055 | 18 607 | 27 027 | 49 894 |
| Cereals to be dried [1] | 1 780 | 6 860 | 15 932 | 28 337 | 105 231 | 120 262 |
| Average inventory of cereals stored (in 000 F CFA) : | | | | | | |
| Rice [2] | 16 154 | 65 643 | 144 399 | 245 732 | 1 021 668 | 1 118 300 |
| Other cereals [3] | 15 628 | 37 328 | 140 962 | 325 622 | 472 972 | 873 145 |
| Total | 31 782 | 102 971 | 285 361 | 571 354 | 1 494 640 | 1 991 445 |

Footnotes :

1. All rice plus one-fourth of other cereals.
2. One-fourth of total tonnage at CFA 41.5/kg.
3. One-half of total tonnage, at CFA 35/kg.

TABLE 12.4.3.B. Grain Center Costs

| | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 |
|---|---|---|---|---|---|---|---|
| Capital costs (in CFA 000) : | | | | | | | |
| Bldg., equip., and installation | 1 000 000 | 1 000 000 | 2 000 000 | 4 400 000 | 4 400 000 | 4 400 000 | - |
| Fixed costs (in CFA 000) : | | | | | | | |
| Annuity (20 yr. life) 1 | 101 850 | 101 850 | 203 700 | 452 224 | 452 224 | 452 224 | 452 224 |
| Mobile crew (mntnce labor) 2 | 3 465 | 5 445 | 8 505 | 8 505 | 11 475 | 11 475 | 11 475 |
| Electricity 3 | 2 957 | 3 099 | 3 424 | 3 767 | 4 080 | 4 072 | 4 054 |
| Spare parts 4 | 50 000 | 50 000 | 100 000 | 220 000 | 220 000 | 220 000 | 220 000 |
| Interest on average inventory 5 | 2 152 | 6 655 | 20 078 | 41 916 | 123 390 | 158 718 | - |
| Insurance on average inventory 6 | 269 | 832 | 2 510 | 5 240 | 15 424 | 19 840 | 19 840 |
| Supervisory labor costs 7 | 21 800 | 21 800 | 28 000 | 30 400 | 30 400 | 30 400 | 11 000 |
| General project overhead 8 | 817 | 1 330 | 2 317 | 3 244 | 4 592 | 5 378 | 3 941 |
| Total | 183 310 | 191 011 | 368 534 | 765 296 | 861 585 | 902 107 | 881 252 |
| Variable costs (in CFA 000) : | | | | | | | |
| Labor (direct) 9 | 303 | 1 046 | 2 717 | 5 230 | 15 520 | 19 500 | 19 500 |
| Fuel cost, drying 10 | 2 719 | 10 479 | 24 336 | 43 285 | 160 740 | 183 700 | 183 700 |
| Bags cost 11 | 1 531 | 5 288 | 13 733 | 26 432 | 78 438 | 98 551 | 98 551 |
| Total variable costs | 4 553 | 16 813 | 40 786 | 74 947 | 254 698 | 301 751 | 301 751 |
| Labor cost/ton (F) 12,13 | | | | | | 126.54 | 123.67 |
| Fuel cost/ton (F) 12 | | | | | Per ton dried : | 1 125.53 | 1 527.5 |
| Bags cost/ton (F) 12,13 | | | | | | 625.00 | 625.00 |
| TVC/ton (F) | | | | | | | 2 276.17 |
| Total costs (Fixed+Variable) F 000 | 187 863 | 207 824 | 409 320 | 840 243 | 1 116 283 | 1 203 858 | 1 183 003 |
| Total cost/ton (F) 13 | 76 679 | 24 565 | 18 628 | 19 867 | 8 895 | 7 635 | 7 502 |

Notes : 1. Annual charge that, at 8% interest, would equal the amount of the original investment, compounded at 8% over the life of the equipment; i.e., the annual charge necessary to amortize the original investment, including interest and replacement at original costs.

(Notes continued on p. 22)

Notes accompanying Table 12.4.3.B. Grain Center Costs (continued):
2. 45% of mobile crew labor costs.
3. 45% of offices and shops electricity use.
4. 5% of capital cost.
5. Interest at 8% on value of stored grain.
6. Insurance premium equal to 1% of value of average inventory of stored grains.
7. Allocated in same proportion as total variable costs.
8. Allocated in same proportion as total variable costs.
9. Grade 1 through 5. Labor requirements in Year 6 for these grades used to compute variable labor/ton. This coefficient is used to compute labor costs in earlier years.
10. F 1 527.5/ton on all rice and 1/4 of other grains tonnage (25 liters/ton at F 61.1/liter).
11. F 625/ton (bags at F 300/bag of 80 kilograms, reusable six times per year.
12. For tonnage, see Table 12.4.3.A.
13. On all tonnage.

c. Seed Plant : The volume of grain handled by the seed plant is shown in Table 12.4.3.C. and the operating costs are shown in Table 12.4.3.D.

Variable Labor : The seed plant will process all the seed required for the following year's planting by both the complex and cooperating farmers. In full scale operation in Year 7, six unskilled workers (grade 1) and two foremen (grade 5) will be required. A labor cost of CFA 989.23 per ton results.

Fuel : Fuel consumption is estimated at 25 liters per ton of seed processed. At a diesel fuel price of CFA 61.1 per liter, the fuel cost will be CFA 1,527.5 per ton.

Bags : 80 kilogram bags costing CFA 300 per bag will be used for the seed, as in the case of the grain center and the rice mill. The bags can only be used once per year, however, as the seed must be stored for the next growing season. The bags cost per ton, therefore, is CFA 3,750.

TABLE 12.4.3.C. Seed Plant Volume

| Volume (tons) : | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 |
|---|---|---|---|---|---|---|
| Rice, Complex | 248 | 752 | 1 294 | 3 600 | 4 200 | 4 200 |
| Rice, Local farmers | 15 | 32 | 60.8 | 105.6 | 184 | 184 |
| Rice, Total | 263 | 784 | 1 354.8 | 3 705.6 | 4 384 | 4 384 |
| Sorghum, Complex | 2.8 | 9.6 | 19.2 | 19.2 | 32 | 32 |
| Sorghum, Local farmers | 4.4 | 9.6 | 18.2 | 31.7 | 55.2 | 55.2 |
| Sorghum, Total | 7.2 | 19.2 | 37.4 | 50.9 | 88.2 | 88.2 |
| Millet, Complex | 0 | 0 | 0 | 0 | 0 | 0 |
| Millet, Local farmers | 1.1 | 2.4 | 4.6 | 7.9 | 13.8 | 13.8 |
| Maize, Complex | 6.0 | 18.7 | 37.4 | 37.4 | 66.3 | 66.3 |
| Maize, Local farmers | 7.9 | 17 | 32.3 | 56.1 | 97.8 | 97.8 |
| Millet and Maize, Total | 13.9 | 35.7 | 69.7 | 93.5 | 164.1 | 164.1 |
| Total Cereals | 285.2 | 841.3 | 1 466.5 | 3 857.9 | 4 650.1 | 4 650.1 |
| Average inventory [1] in F CFA 000 : | | | | | | |
| Rice | 8 186 | 14 402 | 42 168 | 115 337 | 136 452 | 136 452 |
| Other Cereals | 583 | 1 504 | 2 932 | 3 998 | 6 985 | 6 985 |
| Total | 8 769 | 25 906 | 45 100 | 119 355 | 143 437 | 143 437 |

Notes : 1. Seed will be stored from harvest until planting time, and some will be carried over. On the average, nine months storage is expected, so average storage inventory will be 3/4 of annual volume.

TABLE 12.4.3.D. Seed Plant Costs

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 |
|---|---|---|---|---|---|---|---|
| **Capital costs (F CFA 000):** | | | | | | | |
| Bldg, equip., installation | 70 000 | 70 000 | 70 000 | 70 000 | 70 000 | 70 000 | 70 000 |
| **Fixed costs (F CFA 000):** | | | | | | | |
| Annuity (20 yr. life) 1 | 7 130 | 7 130 | 7 130 | 7 130 | 7 130 | 7 130 | 7 130 |
| Mobile crew (mntnc.labor) 2 | 385 | 605 | 945 | 945 | 1 275 | 1 275 | 1 275 |
| Electricity 3 | 329 | 344 | 380 | 419 | 453 | 452 | 450 |
| Spare parts 4 | 7 000 | 7 000 | 7 000 | 7 000 | 7 000 | 7 000 | 7 000 |
| Interest on average invntry 5 | 630 | 1 302 | 2 383 | 6 805 | 9 148 | 9 148 | 9 148 |
| Insurance on avrge invntry 6 | 79 | 163 | 298 | 851 | 1 144 | 1 144 | 1 144 |
| Supervisory labor costs 7 | 3 800 | 3 800 | 3 800 | 3 800 | 3 800 | 3 800 | 3 800 |
| General project overhead 7 | 632 | 630 | 728 | 1 440 | 889 | 796 | 583 |
| Total Fixed Costs | 19 985 | 20 974 | 22 663 | 28 390 | 30 839 | 30 745 | 30 530 |
| **Variable Costs (F CFA 000):** | | | | | | | |
| Labor (direct) 8 | 282 | 832 | 1 450 | 3 816 | 4 600 | 4 600 | 4 600 |
| Fuel costs 9 | 436 | 1 285 | 2 240 | 5 892 | 7 103 | 7 103 | 7 103 |
| Bags cost 10 | 1 070 | 3 155 | 5 499 | 14 467 | 17 438 | 17 438 | 17 438 |
| Chemicals, testing, etc 11 | 1 426 | 4 206 | 7 332 | 19 290 | 23 250 | 23 250 | 23 250 |
| Total variable costs | 3 214 | 9 478 | 16 521 | 43 465 | 52 391 | 52 391 | 52 391 |
| Labor cost/ton (F) 12 | | | | | | 989.23 | |
| Fuel cost/ton (F) 12 | | | | | | 1 527.50 | |
| Bags cost/ton (F) 12 | | | | | | 3 750.00 | |
| Chemicals cost/ton 12 | | | | | | 5 000.00 | |
| TVC/ton (F) 12 | | | | | | 11 266.73 | |
| Total cost (Fixed+variable) | 23 199 | 30 452 | 39 184 | 71 855 | 83 230 | 83 230 | 82 921 |
| Total cost/ton (F) | 81 343 | 36 196 | 26 719 | 18 625 | 17 899 | 17 899 | 17 832 |

Notes : 1. Annual charge for amortization (principal and interest) at 8%.
2. 5% of mobile crew labor costs.
3. 5% of offices and shops electricity use.
4. 10% of capital costs, each year.
5. Interest at 8% on value of stored grain. See Table 12.4.3.C. for average inventory.
6. Insurance premium equal to 1% of value of average inventory.
7. Allocated in same proportion as total variable costs.
8. Grades 1 - 5. Labor requirements in Yea 6 for these grades used to compute variable la per ton. This coefficient is used to compute labor cost in earlier years.
9. F 1 527.5/ton (25 lit./ton at F 61.1/lit).

(continued next page)

Notes accompanying Table 12.4.3.D. Seed Plant Costs (continued) :
10. F 3 750/ton (F 300/bag of 80 kg. usable once).
11. F 5 000/ton.
12. For tonnage, see Table 12.4.3.C.

Chemicals : The seed will be treated chemically for control of insect infestations in storage and to improve the viability of the seed after planting. Fungicides, either mercurials or Arasan (Thiram) will be used at recommended rates. Cost of chemicals for seed treatment is estimated at CFA 5,000 per ton.

Total Variable Costs : The sum of these costs is CFA 11,266.73 per ton.

d. Feed Mill : The volume handled by the feed mill is shown in Table 12.4.3.E. and operating costs are shown in Table 12.4.3.F.

Variable Labor : In full scale operation in Year 7, the feed mill will produce 1,674 tons of cattle feed supplement per year, to supply both the complex and cooperating farmers, in addition to processing and mixing cereals by-products with the supplement. Labor requirements are ten unskilled workers (grade 1) and two foremen (grade 5). Labor cost per ton of supplement will therefore be CFA 3,703.04.

Fuel : Fuel consumption is estimated at 20 liters per ton of supplement feed. At CFA 61.1 per liter of diesel fuel, the fuel cost per ton is CFA 1,222.

Bags : In the early years of the project, while cereals production is still low, cattle production and the resulting need for feed processing will also be low. At this stage, feed will be mixed on a hand-labor basis, and transported in bags. As the cattle operation

## TABLE 12.4.3.E. Feed Mill Volume

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 |
|---|---|---|---|---|---|---|
| Tonnage (tons) [1] | 26.3 | 75.0 | 219.7 | 464.0 | 1 041.9 | 1 674.3 |
| Value of average inventory (F CFA 000) [2] | 145 | 413 | 1 208 | 2 552 | 5 731 | 9 209 |

Notes : 1. 100 kg/head of cattle of complex and local T and A farmers.
2. 10% of tonnage at F 55/kg.

TABLE 12.4.3.F. Feed Mill Costs

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 |
|---|---|---|---|---|---|---|---|
| **Capital costs (F CFA 000)[1] :** | | | | | | | |
| Building, eqpmnt, install. | - | - | - | 145 000 | 145 000 | 145 000 | - |
| **Fixed costs (F CFA 000) :** | | | | | | | |
| Annuity (10 yr.life)[2] | - | - | - | 21 609 | 21 609 | 21 609 | 21 609 |
| Mobile crew (mntnc.labor)[3] | 385 | 605 | 945 | 945 | 1 275 | 1 275 | 1 275 |
| Electricity[4] | 329 | 344 | 380 | 419 | 453 | 452 | 450 |
| Spare parts[5] | - | - | - | 14 500 | 14 500 | 14 500 | 14 500 |
| Interest/avrge.invntry[6] | 12 | 33 | 97 | 204 | 458 | 737 | 737 |
| Insurance/avrge.invntry[7] | 1 | 4 | 12 | 26 | 57 | 92 | 92 |
| Supervisory labor costs[8] | 3 800 | 3 800 | 3 800 | 3 800 | 3 800 | 3 800 | 3 800 |
| General project overhead | 333 | 457 | 847 | 1 261 | 1 300 | 1 872 | 1 371 |
| | 4 860 | 5 243 | 6 081 | 42 764 | 43 452 | 44 337 | 43 834 |
| **Variable costs (F CFA 000) :** | | | | | | | |
| Labor (direct)[9] | 97 | 278 | 814 | 1 718 | 3 859 | 6 200 | 6 200 |
| Fuel costs[10] | - | - | - | 567 | 1 273 | 2 046 | 2 046 |
| Bags costs[11] | 10 | 28 | 82 | 87 | 195 | 314 | 314 |
| Ingredients costs[12] | 1 447 | 4 131 | 12 084 | 25 520 | 57 305 | 92 087 | 92 087 |
| Total, variable costs | 1 554 | 4 431 | 12 980 | 27 892 | 62 632 | 100 647 | 100 647 |
| Labor cost/ton (F)[13] | | | 3 703.04 | | | 3 703.04 | |
| Fuel cost/ton (F)[13] | | | - | | | 1 222.00 | |
| Bags cost/ton (F)[13] | | | 375.00 | | | 187.50 | |
| Ingredients cost/ton (F)[13] | | | 55 000.00 | | | 55 000.00 | |
| TVC/ton (F)[13] | | | 59 078.04 | | | 60 112.54 | |
| Total costs (fixed+variable) | 6 414 | 9 674 | 19 061 | 70 656 | 106 084 | 144 984 | 144 481 |
| Total cost/ton (F) | 243 878 | 128 987 | 86 759 | 152 276 | 101 818 | 86 594 | 86 293 |

Notes :

1. Feed mill will operate in unused space of grain center or rice mill with hand labor methods in Year 1 - 3.
2. Annual charge for amortization (principal and interest) at 8%.
3. 5% of mobile crew labor costs.
4. 5% of offices and shops electricity use.
5. 10% of capital costs.
6. Foregone interest on value of ingredients inventory at 8

(notes continued next page)

Notes accompanying Table 12.4.3.F. Feed Mill Costs (continued) :
7. Insurance premium equal to 1% of ingredients inventory. For inventory, see Table 12.4.3.E.
8. Allocated in same proportion as total variable costs.
9. Grades 1 through 5. Labor requirements in Year 6 for these grades used to compute variable labor/ton. This coefficient is used to compute labor cost in earlier years.
10. 1 222 CFA per ton (20 liters of diesel fuel at 61.1 CFA per liter, per ton of feed).
11. F 375/ton, first 3 years (all feed bagged, F 300/bag of 80 kg., usable 10 times).
12. F 55 000/ton.
13. For tonnage, see Table 12.4.3.E.

increases in scale, mechanization will be increased. The feed mill will be installed in Year 4, and at that time bulk handling of feed for part of the complex's cattle will be inaugurated. Subsequently, only half the feed will be bagged. Bags can be reused more often for feed than for grain; ten cycles per bag costing CFA 300 results in a bag cost per ton of CFA 187.5.

Ingredients : The ingredients to be processed into cattle feed consist of cottonseed, peanut or palm oilcake or comparable sources of protein, to which will be added by-products of meat and fish processing industries, minerals, and salt. Molasses will also be used if available at a reasonable price. The foregoing ingredients will be purchased, and mixed with rice milling by-products and other suitable by-products of the agro-industrial complex. The cost of these ingredients is estimated at CFA 55 per kilogram.

Total Variable Costs : The sum of these costs is CFA 60 112.54 per ton.

### 12.4.4. Variable Costs for Service Units.

The service units consist of : the generating plant, which will supply electricity fo the entire complex; the maintenance and

repair unit, which will maintain all the mechanical equipment of the complex in operating condition, including the agricultural machinery and the processing units; the transportation unit, which will maintain a vehicle pool to provide transportation of farm crops, complex personnel, and agents of the training and assistance program; the road building and repairing crew, which will build and maintain the roads linking the plantation and the cooperating farmers with the complex center; and the mobile crew, which consistsof mechanics who can be sent to the site of any mechanical failure to repair it, using the equipment of the maintenance and repair unit.

a. Generating Plant : The capacity of the generating plant is presented in Table 12.4.4.A. and the costs in Table 12.4.4.B.

The variable costs of the generating plant consist of variable labor and fuel. Labor requirements for this plant in Year 7 are 18 ordinary laborers (Grade 1), six technicians (Grade 4), and three foremen (Grade 5). This produces a labor cost of CFA 15 900 000 in Year 7. The generating plant will have a capacity of 18 250 horsepower, which means 159 879 999 horsepower hours per year (24 hours per day, 365 days per year). It is expected to be operated, on average, at 50 percent of capacity. On this basis, labor cost per horsepower hour is CFA 0.2.

Fuel used will be 0.3 liters of diesel fuel per horsepower hour at a price of CFA 61.1 per liter. The fuel cost, therefore, will be CFA 1 465 209 in Year 7, or CFA 18.33 per horsepower hour. Total variable costs, thus, are CFA 1 481 109 000 in Year 7, or CFA 18.53 per horsepower hour.

b. Maintenance and Repair Unit : The variable costs of the maintenance and repair unit consist only of variable labor. The parts that they will install and the supplies they will use are included in spare parts allowances for the various units they service. The shop crew will include a broad spectrum of skills providing capability

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TABLE 12.4.4.A. Generating Plant's Capacity and Use

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 |
|---|---|---|---|---|---|---|
| Generating Capacity : | | | | | | |
| Residdential use [1] | 60 | 80 | 105 | 130 | 150 | 150 |
| Officesand shops | 60 | 70 | 80 | 90 | 100 | 100 |
| Pumps | 1 000 | 3 000 | 5 000 | 8 000 | 18 000 | 18 000 |
| Total capacity (HP) | 1 120 | 3 150 | 5 185 | 8 220 | 18 250 | 18 250 |
| HP hours of use [2] | 4 906 | 13 797 | 22 710 | 36 004 | 79 935 | 79 935 |

Notes :
1. Power requirement equivalent to 3 one-horsepower airconditioners for each residence.
2. 50% of capacity, 24 hr/day, 365 days/year.

TABLE 12.4.4.B. Generating Plant's Costs

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 |
|---|---|---|---|---|---|---|---|
| **Capital costs (F CFA 000):** | | | | | | | |
| Units of 500 HP in operation | 3 | 7 | 11 | 17 | 37 | 37 | - |
| Bldgs, electr.network,instll[1] | 45 000 | 105 000 | 165 000 | 255 000 | 555 000 | 555 000 | 555 000 |
| **Fixed costs (F CFA 000):** | | | | | | | |
| Annuity (10 yr. life)[2] | 6 706 | 15 648 | 24 590 | 38 003 | 82 711 | 82 711 | 82 711 |
| Mobile crew (mntnc.labor)[3] | 1 079 | 1 690 | 2 463 | 2 463 | 3 380 | 3 380 | 3 380 |
| Spare parts [4] | 4 500 | 10 500 | 16 500 | 25 500 | 55 500 | 55 500 | 55 500 |
| Supervisory labor costs[5] | - | - | 1 300 | 1 300 | 1 300 | 1 300 | 1 300 |
| General project overhead[6] | 19 472 | 26 385 | 27 453 | 30 159 | 30 741 | 27 539 | 20 180 |
| | 31 757 | 54 223 | 72 306 | 97 425 | 173 632 | 170 430 | 163 071 |
| **Variable costs (F CFA 000):** | | | | | | | |
| Labor (direct) [7] | 976 | 2 744 | 4 517 | 7 162 | 15 900 | 15 900 | 15 900 |
| Fuel costs [8] | 89 927 | 152 899 | 416 274 | 659 953 | 1 465 209 | 1 465 209 | 1 465 209 |
| Total variable costs | 90 903 | 255 643 | 420 791 | 667 115 | 1 481 109 | 1 481 109 | 1 481 109 |
| Labor cost/HP hr. | | | | | | 0.1989 | |
| Fuel cost/HP hr. | | | | | | 18.3300 | |
| TVC/HP hr. | | | | | | 18.5289 | |
| Total costs (fixed+variable) | 122 660 | 309 866 | 493 097 | 764 540 | 1 654 741 | 1 651 539 | 1 644 180 |
| **Dist. of electricity cost [9]** | | | | | | | |
| Residential A/C | 6 571 | 7 870 | 9 986 | 12 091 | 13 600 | 13 574 | 13 514 |
| Offices and shops | 6 571 | 6 886 | 7 608 | 8 371 | 9 067 | 9 049 | 9 009 |
| Pumps | 109 518 | 295 110 | 475 503 | 744 078 | 1 632 073 | 1 628 915 | 1 621 657 |

Notes :

1. Estimated at F CFA 15 000 000 per 500 HP capacity.
2. Annual charge for amortization (principal and interest) at 8%.
3. 15% of mobile crew labor costs.
4. 10% of capital costs.
5. Supervision provided by maintenance unit until Year 3.
6. Allocated in same proportion as total variable costs.
7. Grades 1 through 5.
8. 50% of capacity, 24 hrs/day, 365 days/year, 0.3 lit/HP hr. at F 61.1/lit.
9. Based on total use as shown in Table 12.4.4.A.

for repairing almost anything that breaks down. In Year 7, labor requirements will be ten ordinary laborers (Grade 1), 20 drivers (Grade 2), five clerical employees (Grade 3), 30 technicians (Grade 4), and two foremen (Grade 5). In earlier years, manpower requirements are smaller, and so, therefore, are labor costs, increasing from CFA 11 600 000 in Year 2 to CFA 46 700 000 in Year 7.

c. Transportation Unit : Labor required in the transportation unit in Year 7 consists of 50 ordinary laborers (Grade 1). Total labor costs in Year 7 are, therefore, CFA 56 100 000. Since it is estimated that a total of 5 300 000 kilometers will be driven in that year, labor cost per kilometer will be CFA 10.58. The equipment inventory, fuel consumption, and the number of kilometers driven by each type of equipment are shown in Table 12.4.4.C.

Fuel costs were estimated, using a gasoline price of CFA 94 per liter, adding 10% for lubricants, and applying this figure to the data for fuel consumption per kilometer and the number of kilometers driven. The fuel cost per kilometer is estimated to be CFA 24.2 per kilometer.

Total variable cost per kilometer is, thus, CFA 34.78.

d. Road Building and Repairing Crew : Labor for the road building and repairing crew in Years 1 through 6 consists of 15 ordinary laborers (Grade 1), ten drivers (Grade 2), and one foreman (Grade 5), for a total variable labor cost of CFA 12 100 000. In Year 7 and thereafter, labor requirements are diminished to ten ordinary laborers, seven drivers, and one foreman, since maintenance of existing roads is the principal requirement after Year 7. Variable labor costs thus fall to CFA 8 067 000.

Road building machinery required will have a total of 1000 horsepower. It is estimated that it will be used 1500 hours per year,

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TABLE 12.4.4.C. Transportation Unit : Equipment Inventory and Use.

Equipment Inventory (number of units) :

| | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 |
|---|---|---|---|---|---|---|
| Automobiles | 6 | 6 | 8 | 8 | 10 | 10 |
| Station wagon-ambulance | 1 | 2 | 3 | 4 | 4 | 4 |
| Land rovers | 3 | 6 | 8 | 8 | 9 | 9 |
| Pickup trucks | 3 | 6 | 8 | 8 | 9 | 9 |
| Busses | 0 | 1 | 2 | 2 | 2 | 2 |
| Medium trucks | 1 | 2 | 3 | 3 | 2 | 2 |
| Heavy trucks | 4 | 6 | 8 | 15 | 32 | 40 |
| Mopeds | 5 | 10 | 15 | 20 | 30 | 40 |

Kilometers and Fuel Consumption

| | Fuel Consumption | Kms drivenper year per unit |
|---|---|---|
| Automobiles, station wagons | 13.3. lit/100 km | 50 000 |
| Pickup trucks, Land Rovers | 18 lit/100 km | 35 000 |
| Busses, trucks | 35 lit/100 km | 60 000 |
| Mopeds | 3 lit/100 km | 25 000 |

and that fuel consumption will be 0.3 liters per horsepower hour. Diesel fuel costs are CFA 61.1 per liter plus 10% for lubricants. Total fuel costs are CFA 30 245 000 per year in Years 1 through 6. Thereafter, they are reduced in the same proportion as labor costs.

e. Mobile Crew : The mobile crew will consist, in Year 2, of six ordinary laborers (Grade 1), three drivers (Grade 2), three technicians (Grade 4), and one foreman. This team will be

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increased each year until, by Year 7, it will include 20 laborers, ten drivers, ten technicians, and two foremen. Total variable labor cost will thus increase from CFA 7 700 000 in Year 2 to CFA 24 200 000 in Year 7.

### 12.4.5. Other Operating Costs.

Other operating costs consist of supervisory labor and spare parts. Table 12.4.5.A. details the supervisory labor costs by year. In Year 8, they are estimated to decrease substantially, due to the replacement of expatriates by Senegalese, who will have been trained to take over management and operation of the complex.

Spare parts are estimated as percentages of capital costs that will be required annually. They are shown in Table 12.4.5.B. together with their method of estimation.

### 12.4.6. Extension and Training and Assistance Program.

The costs of these programs consist entirely of labor, since they will depend on other units of the complex (whose costs have already been explained) for support in terms of repairs, fuel, and general overhead. The number of people involved in these programs will be increased each year until, in Year 7, they will be staffed by two ordinary laborers (Grade 1), ten drivers (Grade 2), 47 trained workers (Grade 3), two technicians (Grade 4), and six supervisors (Grade 6 through 8). Table 12.4.6 shows the analysis of these costs by year.

### 12.4.7. General Overhead Costs.

These are the labor costs of the headquarters unit (including directors, office staff, health centers, supervision of contract construction, and land development), and the ongoing agronomic

TABLE 12.4.5.A. Supervisory Labor Costs

| | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 |
|---|---|---|---|---|---|---|---|
| Cereals | 17 800 | 20 200 | 24 000 | 24 000 | 24 000 | 24 000 | 6 200 |
| Livestock | 7 400 | 9 800 | 9 800 | 9 800 | 9 800 | 9 800 | 2 400 |
| Grain center | 21 800 | 21 800 | 28 000 | 30 400 | 30 400 | 30 400 | 11 000 |
| Seed plant | 3 800 | 3 800 | 3 800 | 3 800 | 3 800 | 3 800 | 3 800 |
| Rice mill | 7 400 | 7 400 | 11 200 | 11 200 | 11 200 | 11 200 | 3 800 |
| Feed mill | 3 800 | 3 800 | 3 800 | 3 800 | 3 800 | 3 800 | 3 800 |
| Maintenance & repair unit | 7 400 | 7 400 | 8 700 | 12 500 | 12 500 | 12 500 | 5 100 |
| Transport unit | 2 400 | 2 400 | 2 400 | 2 400 | 2 400 | 2 400 | 2 400 |
| Generating plants | - | - | 1 300 | 1 300 | 1 300 | 1 300 | 1 300 |
| Road building-repair crew | 2 400 | 2 400 | 2 400 | 2 400 | 2 400 | 2 400 | 2 400 |
| Mobile crew | - | - | 1 300 | 1 300 | 1 300 | 1 300 | 1 300 |
| Total | 74 200 | 79 000 | 96 700 | 102 900 | 102 900 | 102 900 | 43 500 |

TABLE 12.4.5.B. Spare Parts Allowance (F CFA 000)

| | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Method of estimation |
|---|---|---|---|---|---|---|---|
| Grain center | 50 000 | 50 000 | 100 000 | 220 000 | 220 000 | 220 000 | 5% of capital costs/yr. |
| Seed plant | 7 000 | 7 000 | 7 000 | 7 000 | 7 000 | 7 000 | 10% of capital costs/yr. |
| Feed mill | - | - | - | 14 500 | 14 500 | 14 500 | 10% of capital costs/yr. |
| Rice mill | 2 100 | 6 300 | 6 300 | 18 900 | 18 900 | 18 900 | 10% of eqpmnt. cap.costs/yr. |
| Mntnce.& repair unit | 20 000 | 50 000 | 80 000 | 100 000 | 100 000 | 100 000 | 10% of capital costs/yr. |
| Generating plants | 4 500 | 10 500 | 16 500 | 25 500 | 55 500 | 55 500 | 10% of capital costs/yr. |
| Rd.building-repair crew | 27 000 | 27 000 | 27 000 | 27 000 | 27 000 | 27 000 | 10% of capital costs/yr. |
| Transportation unit | 7 830 | 12 730 | 18 040 | 24 540 | 40 400 | 15 750 | 10% of capital costs/yr. |
| Cereals equipment | 15 000 | 45 000 | 100 000 | 170 000 | 240 000 | 300 000 | 10% of capital costs/yr. |
| Total | 133 430 | 208 530 | 354 840 | 607 440 | 723 300 | 778 650 | |

TABLE 12.4.6. Labor Cost of Training and Assistance Program.

| | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 |
|---|---|---|---|---|---|---|---|
| Support unit | 8 600 | 10 900 | 13 500 | 20 900 | 22 800 | 24 900 | 11 700 |
| Crops unit | 6 600 | 8 000 | 13 200 | 13 900 | 18 800 | 23 700 | 23 700 |
| Livestock unit | 700 | 1 400 | 5 900 | 6 600 | 8 000 | 9 400 | 9 400 |
| Health unit | - | 700 | 1 400 | 9 000 | 11 100 | 13 200 | 13 200 |
| Total | 15 900 | 2 100 | 34 000 | 50 400 | 60 700 | 71 200 | 58 000 |

research and development unit. Table 12.4.7. shows these costs by year.

12.4.8. Determination of Total Costs of Processing Units.

The total costs per unit of the grain center, the seed plant, and the feed mill were calculated so as to determine the charge to be made for the services of these units. In order to do this, the total costs of the generating plant had to be calculated as well, since the processing units use electricity supplied by the generating plant.

In each case, the fixed costs were estimated as follows :

1. An annuity was calculated sufficient to amortize the capital cost, based on the expected life and on interest rate of 8 percent.

2. A certain percentage of the labor cost of the mobile crew was allocated to each processing unit for repairs to equipment.

3. A certain percentage of the generating plant's total costs were allocated to each processing unit, based on its anticipated use of electricity.

4. An allowance for spare parts was made for each unit.

5. Interest and insurance costs on average inventory (where applicable) were calculated, based on an interest rate of 8 percent and an insurance premium of one percent of the value of average inventory.

6. Supervisory labor appropriate to each unit was added.

TABLE 12.4.7. General Overhead Personnel Costs (in F CFA 000)

| | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 |
|---|---|---|---|---|---|---|---|
| Project Directors | 18 300 | 18 300 | 18 300 | 18 300 | 18 300 | 18 300 | 6 300 |
| Headquarters Staff | 12 200 | 13 700 | 16 400 | 20 200 | 21 200 | 22 300 | 22 300 |
| Health Centers | - | 2 500 | 5 400 | 9 400 | 13 000 | 14 100 | 14 100 |
| Total | 30 500 | 34 500 | 40 100 | 47 900 | 52 400 | 54 700 | 42 700 |

7. General complex overhead was allocated to each unit in the same proportion that each unit's variable costs bore to total variable costs.

Tables 12.4.3.B., D., and F. show the analysis of total costs for each of these units.

12.4.9. Total Costs.

The sum of the variable costs of all units of the complex, the other operating costs, the training and assistance program costs, and the general overhead costs is shown in Table 12.3.B. which illustrates the "base case", i.e., the assumptions that are considered most likely in the development of the project. These total operating costs rise from CFA 484 million in Year 2 (the first year in which the complex will be in operation) to CFA 5,612 million in Year 7. They then decline to a permanent level of CFA 5,511 million, due to the Senegalization of the project.

12.5. THE COMPUTER MODEL.

12.5.1. Role of the Computer.

In the foregoing sections, capital investment, revenues from various sources and operating costs of project SENERIZ have been presented and discussed. These elements are now assembled to show annual and cumulated cashflow over a period of 30 years, and internal rate of return is calculated.

In order to expedite the complicated and burdensome, but necessary, calculations, a computer was used. The computer has the capability to make long, involved and difficult computations with extreme rapidity and without errors of calculation. This capability made it possible to determine the profitability of the program while

it was still being finalized, and to modify the project design so as to benefit from relationships and profit opportunities revealed by the computerized analysis. The same capability made it possible to determine the effect on cashflow, rate of return and other economic measures of certain changes in the basic assumptions of the project design, and thus to analyze the sensitivity of the project design to these changes.

12.5.2. Description of the Computer Model.

In order to identify the various inputs, intermediate products and final results necessary to the operation of the computer, each element is identified by a line number. In subsequent tables, presenting the results of the computerized analysis, line numbers are shown. The following section explains the meaning of the lines that appear in those computer-generated tables. Tables 12.3.A. and 12.3.B. can be used as illustrations.

The first table (Table 12.3.A.) shows production estimates for the complex and the cooperating farmers.

- Complex production :

Lines 1201 through 1241 show the net production of cereals by the complex. This is calculated by multiplying the area devoted to each crop by the yield per hectare and subtracting seed requirements for the following year's production.

Line 1250 (calves purchased) shows the number of calves purchased each year. Line 1251 (calves sold) shows the number of animals sold each year that were purchased as calves in the preceding year. Line 1255 (feeder cattle) shows the number of mature animals purchased each year. It is anticipated that mature cattle can be fattened for sale within the same year that they are purchased, so that this line shows the number of mature cattle sold each year, as well.

-Farmers' production :

Lines 1300 through 1315 show the net production of farmers cooperating in the training and assistance program for each of the cereals produced. They are calculated in the same way as complex net production figures, i.e., by multiplying total acreage by yield per hectare and subtracting seed requirements for the following year.

Line 1320 (total cereal production) shows total net tonnage of cereals produced by cooperating farmers, and is the sum of lines 1300 through 1315.

Line 1360 (farmers cattle raised) shows the total number of cattle raised by cooperating farmers each year.

The second table (Table 12.3.B.) shows the economic structure of the project.

- Sales receipts :

Lines 1410 through 1440 show the revenue derived from the sale to O.N.C.A.D. of the various grains produced by the complex. In each case, net production (lines 1201 through 1241) is multiplied by the market price of the grain in question.

Line 1450 (cattle revenue) equals the annual revenue derived from cattle sales. It is calculated by multiplying the number of calves and the number of feeder cattle each by the average weight of animals of that category sold, adding the products, multiplying this total by 99% to give effect to the 1% mortality estimate, and then multiplying by the market price per kilogram.

Line 1461 (rice mill fee) equals the annual tonnage of rice that will be milled, multiplied by the CFA 20 milling fee. A maximum revenue of CFA 1600 million is established, to correspond to the

maximum capacity of the rice mill, 80,000 tons per year.

Line 1470 (farmers' grain handling) is calculated by multiplying the total cost per ton of grain handling at the grain center, plus 10 percent, by farmers' total net cereal production (line 1320).

Line 1474 (farmers' grain storage) is calculated by multiplying the storage fee applicable to each grain by the average quantity of that grain stored for farmers.

Lines 1475 and 1479 (complex grain handling and storage) are calculated exactly as lines 1470 and 1474, except that the fees are applied to complex net production and storage.

Line 1480 (cattle feed sales) is the result of multiplying the total cost per ton of feed at the feed mill, plus 10 percent, by 100 kilograms per animal, by the number of cattle raised by cooperating farmers (line 1360).

Line 1500 (seed center sales) is calculated by multiplying the total cost per ton at the seed center, plus 10 percent, by the total quantity of seed required by cooperating farmers for the next year's production.

- Complex variable costs :

Lines 1610 through 1650 show the variable costs of harvesting and growing the various cereals. In each case, the labor, fuel, fertilizer, and chemicals cost per hectare (for growing costs) and per ton (for harvesting costs) were calculated for Year 7, and these same unit costs were assumed for earlier years.

Line 1660 (cattle costs) is calculated by multiplying the sum of the labor costs and purchase costs of the animals by the number of head purchased (line 1250 and 1255). Costs of cattle feed are not included here, since they are shown separately as the variable costs

.../...

of the feed mill.

Line 1670 (feed mill) shows the costs of labor, fuel, bags, and feed supplement ingredients used by the feed mill.

Lines 1680 through 1700 show, similarly, the labor, fuel, and bags costs of the rice mill, the grain center, and the seed plant.

Line 1710 shows the sum of all the labor and fuel costs of the service units, i.e., the generating plant, the maintenance and repair unit, the transport unit, the road building and repair unit, and the mobile crew.

- Complex fixed costs :

Line 1720 (aid program for farmers) shows all the labor costs for the training and assistance program.

Line 1725 (complex fixed expenses) shows all the costs of supervisory labor and spare parts for all units of the complex.

Line 1730 (complex fixed overhead) shows the labor costs of the headquarters unit, including the directors, the office staff, the health centers, and contract supervision personnel; and the land development unit.

Line 1740 (research and development) shows the labor costs of the ongoing agronomic research team.

Line 1765 (contingency) is calculated as 10 percent of all variable and fixed costs.

- Economic return :

Line 1790 (gross cashflow) equals total annual revenues (line 1550) minus total operating costs (line 1780), which itself is the sum of variable and fixed costs (lines 1715 and 1775).

Line 1840 (investment, ag. development) includes all the capital costs of developing the plantation, including the various studies, the dam and irrigation works, the land development, and the farm machinery, as shown in Table 12.2.2., Fixed Assets. An allowance of CFA 768 million has been made every year after Year 7 for replacement of road building, irrigation, and farm equipment.

Line 1850 (investment, facilities) shows the capital costs of all of the processing and support units of the complex, also shown in Table 12.2.2. An allowance of CFA 243 millions has been made every year after Year 7 for replacement of components of the processing facilities.

Line 1855 (training program) shows the preparation ,travel, schooling, and living expenses cost of the programs to train complex managers and workers.

Line 1861 (working capital) is calculated as 50 percent of the difference between total revenue and total cost (line 1790), so long as that difference is negative. Once gross cashflow becomes positive, the allowance for working capital becomes zero.

Line 1880 (project cashflow) is equal to gross cashflow (line 1790) minus total capital investment (line 1870). Project cashflow shows its greatest negative figures in the years when construction is under way and annual investment is greatest.

Line 1881 (cumulative cashflow) adds the cashflow of the present year to the accumulated cashflow of the preceding year. This line shows the estimated total need for financing to get the project to this point.

Line 1883 translates the cumulative cashflow of line 1881 into U.S. dollars at an exchange rate of CFA 250 = $1.

.../...

## 12.6. BASIC CASHFLOW FORECAST

The assumptions set forth in the earlier sections of this chapter result in the cashflow shown in line 1880 of Table 12.3.B., the "base case", or most likely forecast.

Line 1880 shows the cashflow before financing of the project. The economic return for the project is measured by the internal rate of return for this line. It is a measure of the project's earning power, using a discounted cashflow technique. In other words, it measures the extent to which, over a period of thirty years, the discounted present value of positive returns exceeds the discounted present value of negative returns. This rate, if used to discount both positive and negative cashflows, would make the sum of their discounted present values equal to zero.

In the base case, Table 12.4.B., the economic return for the project is 7.53 percent. The annual net cashflow (line 1880) reaches CFA 4,383 million in Year 7, but then declines to a permanent level of CFA 3,473 million in Year 8 and thereafter, because of the initiation of the replacing of capital equipment. The peak cumulative negative cashflow reaches CFA 32,350 million in Year 5. The point at which cumulative cashflow ceases to be negative is in Year 16, i.e., in 1993 if the project is initiated in 1978.

## 12.7. SENSITIVITY ANALYSIS

The base case has presented an inflation-free forecast of the most likely development of the project. It would not be useful to assume that <u>all</u> prices and costs change in the same proportion, as that would leave the real situation, and therefore, the internal rate of return on project cashflow (line 1880) unchanged. A general, uniform rate of inflation would, of course, reduce the burden of a debt fixed in monetary terms, but that would only affect the rate of

return on cashflow after financing; and the methods of financing the project are sufficiently uncertain at this time to make such and exercise of doubtful value.

It is, however, useful to examine the effects of differential rates of change in revenues and costs. A number of cases are examined below, grouped according to changes in variable costs, yields, processing fees, prices, capital costs, schedule, and program structure. Table 12.7. summarizes the resulting rates of return, and indicates the supporting tables for each case. These supporting tables, 3 through 27, which contain production and financial reports generated by the computer for all of the 17 modified programs or "cases", are included as an annex to this chapter.

### 12.7.1. Sensitivity to changes in variable costs.

Cases Nos. 1 and 2 show the effects on rate of return and cashflow of an increase in variable costs, revenues being assumed to remain unchanged. In Case No. 1, all variable costs are assumed to be 10 percent higher than in the base case. In Case No. 2, all variable costs are assumed to be 5.4 percent higher. This latter case simulates the effect of a 10 percent increase in fuel costs, since fuel accounts for approximately 54 percent of total variable costs. In Case No. 1, the rate of return is reduced to 6.04 percent, the peak negative cumulative cashflow increases to CFA 33,310 million, and the breakeven point in cumulative cashflow is delayed by one year, to Year 17 (1994 if the project begins in 1978).

In Case No. 2, the rate of return is reduced to 6.75 percent and the peak negative cumulative cashflow is increased to CFA 32,861 million, but the breakeven point still occurs in Year 16 (1993).

### 12.7.2. Sensitivity to changes in cereals yields.

Cases Nos. 3 and 5 examine the effects of increased yields,

TABLE 12.7. Internal Rate of Return Before Financing.

| Description | Case No. | Table Numbers: Production | Table Numbers: Economics | Rate of Return |
|---|---|---|---|---|
| BASE CASE | BASE | 12.3A | 12.3B | 7.53 |
| All variable costs 10% higher | 1 | * | 3 | 6.04 |
| All variable costs 5.4% higher | 2 | * | 4 | 6.75 |
| Rice yields increased 10% | 3 | 5 | 6 | 9.25 |
| Rice yields reduced 10% | 4 | 7 | 8 | 5.66 |
| All crop yields increased 10% | 5 | 9 | 10 | 9.57 |
| All crop yields reduced 10% | 6 | 11 | 12 | 5.27 |
| Rice milling fee = CFA 10 | 7 | * | 13 | 6.09 |
| Grain fees eliminated | 8 | * | 14 | 1.40 |
| 7 and 8 combined | 9 | * | 15 | -0.73 |
| Cereals prices 10% higher | 10 | * | 16 | 9.17 |
| Land dev. costs 50% higher | 11 | * | 17 | 5.82 |
| Land dev. costs 50% lower | 12 | * | 18 | 9.74 |
| Dam financed by grant | 13 | * | 19 | 8.69 |
| Implementation delayed 1 year | 14 | 20 | 21 | 5.57 |
| Accelerated land development | 15 | 22 | 23 | 6.40 |
| Anambé forest included | 16 | 24 | 25 | 6.48 |
| Training and assistance elimntd. | 17 | 26 | 27 | 7.15 |

* Production is unchanged from the Base Case.

while Cases Nos. 4 and 6 show the results of reduced yields. In Cases 3 and 4, only rice yields are changed, whereas in Cases 5 and 6, the yields of all grains are changed.

In Case No. 3, rice yields are assumed to be 10 percent higher than in the base case. This causes a significant increase in the rate of return, as it rises to 9.25 percent. Maximum negative cumulative

cashflow declined to CFA 31,332 million, and the breakeven point is postponed two years, to Year 18 (1995).

In Case No. 5, all crop yields are assumed to be 10 percent higher. The rate of return rises to 9.57 percent, the peak negative cumulative cashflow falls to CFA 31,153 million, and the breakeven point is reached in Year 14 (1991), the same as in Case 3.

In Case No. 6, all crop yields are assumed to be 10 percent lower than in the base case. The rate of return is reduced to 5.27 percent, the maximum negative cumulative cashflow is increased to CFA 33,596 million, and the breakeven point is again reached in Year 18 (1995).

Since rice production constitutes by far the largest part of total cereal production, it is obvious that the rate of return is much more sensitive to changes in its yield than to changes in the yields of sorghum and maize. It should be noted also that a change in yields affects revenues much more than it does costs, since it only affects harvesting costs, not growing costs, whereas it affects total cereals revenues from both sales and processing. The importance of the research and development unit, in finding ways to increase yields, becomes evident.

It should be noted also that a 10 percent decrease in rice yields alone reduces the rate of return by considerably more than does a 10 percent increase in all variable costs.

12.7.3. Sensitivity to changes in processing fees.

Cases Nos. 7, 8, and 9 examine the effects of reducing or eliminating the processing fees charged to O.N.C.A.D. and cooperating farmers by the complex. In Case No. 7, the rice milling fee is cut in half, to CFA 10 per kilogram, from the CFA 20 of the base case. The effect of this is to reduce the rate of return to 6.09

percent, to increase the peak negative cumulative cashflow to CFA 33,544 million, and to postpone the breakeven point to Year 17 (1994).

In Case 8, the grain handling and storage fees charged to O.N.C.A.D. and cooperating farmers are eliminated. The effect is to reduce the rate of return to 1.4 percent, to increase the maximum negative cumulative cashflow to CFA 34,887 million, and to extend the breakeven point to Year 26 (2003).

Case No. 9 is a combination of Cases 7 and 8. That is, the rice milling fee is assumed to be reduced to CFA 10 per kilogram and, in addition, the grain handling and storage fees are eliminated. The effect is to reduce the rate of return to 0.73 percent, and to increase the peak negative cumulative cashflow to CFA 36,080 million. The breakeven point would not be reached within the 30-year forecast. It would take 34 years (i.e., until 2011) to reach a breakeven position.

The economic feasibility of the project, it can be seen, is extremely sensitive to changes in these processing fees; and this fact underscores the importance of deriving revenue from the industrial components of the complex.

12.7.4. Sensitivity to changes in cereals prices.

If the selling prices of the various cereals were to increase relative to costs, the position of the project would be much improved. Case No. 10 assumes that selling prices of all cereals are 10 percent higher, while assuming no change in costs. The effect is to increase the rate of return to 9.17 percent, reduce the maximum negative cumulative cashflow to CFA 31,481 million, and to reduce the pay-off period (to the breakeven point) from 16 years to 14 years (1991).

The reason that the project is more sensitive to an increase

in yields of 10 percent (Case No. 5) than to an increase in cereals prices of an equal percentage is that increased yields mean increased revenue, not only from the sale of grain, but also from processing fees at the grain center, since it would be handling larger quantities.

12.7.5. Sensitivity to changes in capital costs.

The cost of land development is one of the most difficult costs to estimate precisely. For this reason, two alternatives to the base case were examined, one in which land development costs were increased by 50 percent (Case No. 11), and one in which they were reduced by 50 percent (Case No. 12).

In Case No. 11, the rate of return fell to 5.82 percent, the maximum negative cumulative cashflow increased to CFA 39,563 million, and the breakeven point was delayed to Year 18. (1995). In Case No. 12, the rate of return rose to 9.74 percent, the maximum negative cumulative cashflow fell to CFA 25,997 million, and the pay-off period was reduced to 13 years (1990).

It can be seen that an increase in capital costs of 50 percent reduces the rate of return less than a 10 percent decline in crop yields (Case No. 6). This is because the increase in capital costs occurs in the early years of the project, and the remaining years are unaffected, whereas the decline in yields is spread over the entire 30 year forecast period. The maximum negative cumulative cashflow is considerably larger in Case No. 11 than in Case No. 6, however.

It can also be observed that a change in capital costs is symmetrical, whether they are increased or decreased. That is, the 7.53 percent rate of return of the base case is 77.3 percent of the 9.74 percent return of Case No. 12 (land development costs reduced by 50 percent), and the 5.82 percent rate of return of Case No. 11 (land development costs increased by 50 percent) is 77.3 percent of the 7.53 percent rate of the base case. The effect of a change in yields up or

down is not quite symmetrical, however. The increase in yields does not increase the rate of return as much as the decrease in yields reduces it. The explanation lies in the fact that, in the case of a decrease in yields (Case No. 6), the working capital requirements (50 percent of the excess of costs over revenues) increase more, relative to the base case, than the increase of yields (Case No. 5) reduces these requirements.

Another case (No. 13) was also examined in this connection. Since the dam will serve a number of purposes, of a more general "social" nature, than are required by the SENERIZ complex itself, it seemed at least possible that it might be financed outside of the SENERIZ project. If this should be done, either by the Senegalese government or by a foreign grant, the rate of return on the project itself could be expected to be higher.

The effect of the elimintation of the capital costs of the dam is to increase the rate to return to 8.69 percent, to reduce the maximum negative cumulative cashflow to CFA 28,600 million, and to reduce the pay-off period to 14 years (1991). The project is thus more sensitive to changes in land development costs than to elimination or inclusion of the costs of constructing the dam. The main factor in both cases is the reduction of effective capital investment of the project.

### 12.7.6. Sensitivity to changes in development time schedule.

It is always difficult to be absolutely certain how rapidly production may be expected to begin in a project of this sort. On the one hand, land development might not proceed as rapidly as anticipated, while the industrial processing units proceed on schedule, but for this reason lack materials to process. On the other hand, agricultural production might proceed faster than anticipated. If the processing units are available, revenues would increase more rapidly than expected.

In the base case, it is assumed that construction of facilities, land clearing, road building, etc., will begin during the first year of the project, but that no agricultural production could be expected until the second year. Two variations on this theme are examined below. Case No. 14 assumes that cereal production does not begin until Year 3 (although production by cooperating farmers begins in Year 2, as does cattle raising). Case No. 15 assumes that, although cereal production still does not begin until Year 2, land preparation proceeds more rapidly than in the base case, with an accelerated capital spending program, thus accelerating cereal production. Case No. 15 therefore also assumes an accelerated capital spending program.

In Case No. 14 (delayed production), the rate of return falls to 5.57 percent, the maximum negative cumulative cashflow rises to CFA 40,462 million, and the pay-off period increases to 18 years (1995).

In Case No. 15, the rate of return falls to 6.4 percent, the maximum negative cumulative cashflow rises to CFA 38,496 million, and cumulative cashflow becomes positive in the 16th year (1993).

12.7.7. Sensitivity to changes in program structure.

Two cases are examined here. The first asks the question, "What would be the effect of expanding the project to include an additional 6200 hectares in the Anambé national forest ?" (Case No. 16). The second examines the effect of eliminating the training and assistance program (Case No. 17).

In Case No. 16, capital costs of land clearing and road building would have to be increased and, although total production would be increased, most of the increased output would be from maize and sorghum, since limited water availability from the reservoir would not permit an extension of irrigated rice production. The available water would be used for irrigation of heavier, somewhat more productive soils of the Anambé forest area. The result is that the rate

of return is lower than in the base case (6.48 percent), the peak negative cumulative cashflow is larger (CFA 36,219 million), and the pay-off period is longer (17 years, or 1994).

In Case No. 17, the elimination of the training and assistance program reduces the revenues from fees to farmers and, although the fixed costs and capital costs attributable to the training and assistance program are also eliminated, the net effect is to reduce the rate of return to 7.15 percent. The maximum negative cumulative cashflow is somewhat lower, however, and the pay-off period stays the same, at 16 years (1993).

### 12.7.8. Summary.

It can be seen that the economic return of the project is reduced most by the elimination of the grain handling and storage fees. The next largest reduction in the rate of return occurs with a reduction in grain yields; the third largest if agricultural production is delayed by one year; the fourth largest with a 50 percent increase in land development costs, and the fifth and sixth largest (roughly the same) with an increase of 10 percent in all variable costs or a reduction in the rice milling fee from CFA 20 to CFA 10 per kilogram.

The most favorable effect on the rate of return is produced by the reduction of 50 percent in land development costs, the second most favorable effect by a 10 percent increase in all crop yields, the third by a 10 percent increase in rice yields alone, and the fourth by the grant financing of the dam. Table 12.7. summarizes the internal rates of return for the various cases.

## 12.8. OTHER COSTS AND BENEFITS

### 12.8.1. Effect of the Project on Incomes of Cooperating Farmers.

The local farmers who take part in the training and assistance program can expect to benefit from increased net revenues. Table 12.8. shows the analysis of these benefits. Farmers are assumed to supply themselves with grain for their own consumption and with seed for this subsistence production in the traditional manner, so that only the incremental production is assumed to be sold, and only the seed required for the commercially sold production is assumed to be purchased from the complex. Similarly, only the commercial portion of their production is stored and processed by SENERIZ. Similarly, only the increment in cattle raised by these farmers is counted in revenue.

The result, as shown by Table 12.8., is an increase in annual net revenue (after subtracting incremental costs) of CFA 40 300 per farm from Year 8 on. Lacking information on income per farm, it is not possible to say exactly how much an increase this represents in farm income. However, if one takes the latest estimates of gross domestic product per capita as a measure of comparison, one can get a rough estimate. In 1976, gross domestic product per capita is estimated to be CFA 75 279.[1] Disposable income information from Senegal is lacking, but data from similar neighboring countries shows disposable income to be approximately 90% of GDP. Applying the same percentage to Senegalese data, we get disposable income per capita of CFA 67 751. Assuming that this income applies to the six economically active persons in the typical Anambé basin farm family, one gets an estimate for disposable income per farm of CFA 406 505.

Thus it can be seen that local farmers cooperating in the training and assistance program might expect nearly to double their level of living.

There will also be wider repercussions, as the increased incomes of local farmers tend to increase demand for other goods and

1. Source : Foreign Economic Trends 77-018 (Senegal), Department of Commerce, United States, January 1977 (report prepared by the American Embassy, Dakar).

TABLE 12.8. Impact of the Tand A Program : Production, Costs, and Revenues of Cooperating Farmers.

| CEREALS : | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 |
|---|---|---|---|---|---|---|---|---|
| **Total gross production (tons) :** | | | | | | | | |
| Rice | 720 | 768 | 850 | 1 042 | 1 352 | 1 973 | 3 187 | 3 187 |
| Sorghum | 5 500 | 5 623 | 5 333 | 6 636 | 8 503 | 12 081 | 18 756 | 18 756 |
| Millet | 2 340 | 2 361 | 2 384 | 2 516 | 2 817 | 3 376 | 4 551 | 4 551 |
| Maize | 1 360 | 1 438 | 1 857 | 2 736 | 4 584 | 7 995 | 14 172 | 14 172 |
| Total | 9 920 | 10 190 | 10 424 | 12 930 | 17 256 | 25 425 | 40 666 | 40 666 |
| **Increase in gross production (over Year 1) - tons :** | | | | | | | | |
| Rice | - | 48 | 130 | 322 | 632 | 1 253 | 2 467 | 2 467 |
| Sorghum | - | 123 | - 167 | 1 136 | 3 003 | 6 581 | 13 256 | 13 256 |
| Millet | - | 21 | 44 | 176 | 477 | 1 036 | 2 211 | 2 211 |
| Maize | - | 78 | 497 | 1 376 | 3 224 | 6 635 | 12 812 | 12 812 |
| Total | - | 270 | 504 | 3 010 | 7 336 | 15 505 | 30 746 | 30 746 |
| **Seed requirements for following year (tons) :** | | | | | | | | |
| Rice | 6[illegible] | 14.8 | 32.[illegible] | 60.8 | 105.6 | 184 | 184 | 184 |
| Sorghum | - | 4.44 | 9.6 | 18.24 | 31.68 | 55.2 | 55.2 | 55.2 |
| Millet | - | 1.11 | 2.4 | 4.56 | 7.92 | 13.8 | 13.8 | 13.8 |
| Maize | - | 7.85 | 17 | 32.3 | 56.1 | 97.75 | 97.75 | 97.75 |
| Total | - | 18.20 | 61.00 | 115.90 | 201.30 | 250.75 | 350.75 | 350.75 |
| **Increase in net production (over Year 1) :** | | | | | | | | |
| Rice | - | 33.2 | 98 | 261.2 | 526.4 | 1 069 | 2 283 | 2 283 |
| Sorghum | - | 118.56 | -176.6 | 1 117.76 | 2 971.32 | 6 525.8 | 13 200.8 | 13 200.8 |
| Millet | - | 19.89 | 41.6 | 171.44 | 469.08 | 1 022.2 | 2 197.2 | 2 197.2 |
| Maize | - | 70.15 | 480 | 1 343.7 | 3 167.9 | 6 537.25 | 12 714.25 | 12 714.25 |
| Total | - | 241.80 | 796.20 | 2 894.10 | 7 134.70 | 15 154.25 | 30 395.25 | 30 395.25 |
| **Revenue from increased net production (CFA 000) : 1** | | | | | | | | |
| Rice | - | 1 378 | 4 067 | 10 840 | 21 846 | 44 364 | 94 745 | 94 745 |
| Sorghum | - | 4 150 | -6 181 | 39 122 | 103 996 | 228 403 | 462 028 | 462 028 |
| Millet | - | 696 | 1 456 | 6 000 | 16 418 | 35 777 | 76 902 | 76 902 |
| Maize | - | 2 455 | 16 800 | 47 030 | 110 877 | 228 804 | 444 999 | 444 999 |
| Total | - | 8 679 | 16 142 | 102 992 | 253 137 | 537 348 | 1 078 674 | 1 078 674 |

cont.

TABLE 12.8. Impact of the T and A Program : Production, Costs, and Revenues of Cooperating Farmers (continued).

| Costs of T and A farmers' production : | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 |
|---|---|---|---|---|---|---|---|
| Grain handling charges | 2 032 | 3 721 | 24 305 | 59 915 | 127 271 | 255 272 | 255 272 |
| Grain storage charges-Rice | 55 | 164 | 437 | 880 | 1 787 | 3 817 | 3 817 |
| Grn. storage chrg - Other | 374 | 618 | 4 716 | 11 835 | 25 226 | 50 349 | 50 349 |
| Fertilizer [2] | 2 146 | 6 612 | 14 300 | 27 170 | 47 190 | 82 226 | 82 226 |
| Chemicals [2] | 2 250 | 6 935 | 15 000 | 28 500 | 49 500 | 86 250 | 86 250 |
| Fuel [2] | 2 894 | 8 578 | 21 606 | 43 176 | 78 952 | 142 516 | 142 516 |
| Seed cost | 358 | 1 201 | 2 282 | 3 963 | 6 906 | 6 906 | 6 906 |
| Total costs [3] | 10 109 | 27 829 | 82 646 | 175 439 | 336 832 | 627 336 | 627 336 |
| Net incremental cereals revenue (CFA 000) : | -1 430 | -11 687 | 20 346 | 77 698 | 200 516 | 451 338 | 451 338 |
| No. of T & A farmers : | 100 | 200 | 400 | 600 | 1 000 | 1 500 | 1 500 |
| Incr. cereal net rev/farm | - 14 | - 58 | 51 | 129 | 201 | 301 | 301 |
| CATTLE : | | | | | | | |
| No. of head (increase from Year 1) : | | | | | | | |
| Calves | 66 | 97 | 632 | 1 556 | 3 296 | 6 545 | 6 545 |
| Feeder cattle | 47 | 53 | 65 | 84 | 123 | 198 | 198 |
| Revenue [4] (CFA 000) : | | | | | | | |
| Calves bought last year | - | 2 135 | 3 138 | 20 445 | 50 337 | 106 626 | 2 11 731 |
| Cattle | 1 438 | 1 622 | 1 989 | 2 570 | 3 764 | 6 059 | 6 059 |
| Total | 1 438 | 3 751 | 5 127 | 23 015 | 54 101 | 112 685 | 217 790 |
| Less feeding costs [5] | 1 076 | 1 429 | 6 639 | 15 622 | 32 567 | 64 229 | 64 229 |
| Net incr. revenue, cattle (F CFA 000) | 362 | 2 328 | -1 512 | 7 393 | 21 534 | 48 456 | 153 561 |
| Total increase/net rev. (F CFA 000) | -1068 | -9 309 | 18 834 | 85 091 | 222 050 | 499 794 | 604 889 |
| Increase in net rev./farm | - 11 | - 47 | 47 | 142 | 222 | 333 | 403 |

(Accompanying notes following page)

Notes accompanying Table 12.8. Impact of the T and A Program :
1. F 41.5/kg for rice, F 35/kg for other cereals.
2. Growing costs per hectare and harvesting costs per ton are assumed to be the same as on the complex.
3. Capital costs and depreciation of equipment are not included.
4. Incremental revenue, assuming that each animal gains 136 kg between purchase and sale. Price per kg : CFA 225. Calves are fed for a year before sale. Mature animals are assumed to gain required weight within the same year they are purchased.
5. Since only weight gain is included in revenue estimates, no allowance for cost of purchased animals is necessary. Each animal is fed 100 kg. of feed supplement priced at cost ex feed mill plus 10%.

services throughout Sénégal, in the familiar multiplier process. In the absence of reliable data on marginal propensities to save and to import, however, no attempt has been made to measure the impact on the gross domestic product of Senegal.

### 12.8.2. Effect of the Project on Government Revenues and Expenditures.

The lack of firm commitments for financing the majority of the project makes it impossible to draw up a profit and loss statement for the complex, and it is therefore not possible to estimate the increased profits taxes that might be realized by the government. If soft loans can be obtained for the project, it is likely that the profits, and therefore profits tax revenues (at one-third of net profits) might be subtantial.

It is possible to estimate the revenue to be derived from the turnover tax, however. At 11 percent of total sales, annual revenue from this source should amount to CFA 1 099 million in Year 7 and beyond. In addition, the fixed tax on salaries, the social security tax and the retirement fund tax will all yield additional revenue. A rough estimate of these tax revenues in Year 7 and beyond is shown below :

Additional Tax Revenues
(in 1000 CFA annually)

| | |
|---|---|
| Fixed tax on salaries | 11 834 |
| Social Security tax | 36 074 |
| Retirement Fund tax | 26 369 |
| Total | 74 277 |

In addition, additional income tax revenue can be expected to be derived from the higher incomes of complex employees and local farmers cooperating in the training and assistance program.

As partial offsets to these additional tax revenues, there would probabaly be some loss of revenue from customs duties on imported rice and maize. In addition, more government expenditure would very probably have to be devoted to building and maintaining the roads that link th Vélingara area to the rest of Senegal, since the evacuation of processe grain from the complex to markets elsewhere would require fairly large numbers of heavy trucks for transport. The importation of heavy equipment during the six years of development will also tend to deteriorate the roads.

## 12.9. EFFECT ON THE BALANCE OF PAYMENTS

Rice has constituted a growing percentage of Senegal's imports by value, rising from approximately 6 percent in 1972 to 12 percent in 1973, 15 percent in 1974, and 13 percent in 1975. This has occured despite an increase in production. Production has varied widely over the past 15 years, partly because of changing weather and other growing conditions, but if we compare 1971 (not a particularly bad production year) with 1975, we can see that even though production in 1975 was considerably higher, the tonnage of rice imported fell by no more than the increase in production, so that total availability of rice remained almost constant. This occurred despite a very significant rise in the

.../...

price of imported rice.

Production and Imports of Rice

| | 1971 | 1972 | 1973 | 1974 | 1975 | |
|---|---|---|---|---|---|---|
| Production (1000 tons) | 108.2 | 43.6 | 64.3 | 117.0 | 144.0 | (1) |
| Imports (1000 tons) | 187.2 | 169.9 | 192.0 | 175.2 | 150.3 | (2) |
| Import value (CFA millions) | 4653 | 4193 | 9562 | 18041 | 16168 | (2) |
| Unit value (CFA/ton) | 24816 | 24679 | 49802 | 102974 | 107572 | |

(1) Actions Planifèresde Production Céréalière, Ministère du Développement Rural et de l'Hydraulique, December 1976.
(2) Trade Yearbook, 1975. United Nations Food and Agriculture Organization.

Maize imports have constituted a very small percentage of total imports by value, and neither production nor imports has grown very much in recent years.

Production and Imports of Maize

| | 1971 | 1972 | 1973 | 1974 | 1975 | |
|---|---|---|---|---|---|---|
| Production (1000 tons) | 38.5 | 20.2 | 33.8 | 43.2 | 45.2 | (1) |
| Imports (1000 tons) | 32.8 | 10.4 | 51.5 | 26.9 | 29.9 | (2) |
| Imports val (CFA million) | 726.0 | 21.2 | 1353.1 | 841.5 | 750.1 | (2) |
| Unit value (CFA/ton) | 22134 | 20977 | 26274 | 31283 | 27886 | |

Production by the SENERIZ project will have a substantial effect on imports of both rice and maize, since the project's total rice production, when fully operative (115 000 tons) will exceed the average production of all of Senegal in the period 1971-1975 (95 400). This should make it possible to reduce rice imports to a small fraction of their present level and, thus, to have a significant effect on Senegal's.

balance of payments.

The complex's maize production, in full operation (13 000 tons) will be equal to nearly half of average maize imports over the period 1971-1975 (30 000 tons) and thus, will also contribute to an improvement in the balance of payments.

Partially offsetting these savings will be an increased requirement for imported petroleum for use by the complex's machinery. Total annual fuel costs of the complex in Year 7 and thereafter have been estimated at CFA 2,197,865. This figure represents the value of fuels at current domestic prices of CFA 61.1 per liter for diesel fuel and CFA 94 per liter for gasoline. However, if the fuels can be refined locally from imported crude petroleum, this offset to the savings on imported grain would be considerably smaller.

Table 12.9. shows the effects of the project on the balance of payments. It has been assumed, lacking hard information on the financing plan, that all of the foreign currency cost of imported capital goods and services will be financed by foreign borrowing, so that the net savings before debt service are unaffected by the capital outlays. No attempt has been made here to calculate the debt service on foreign loans.

There is a deficit before debt service in Year 2, but thereafter there is a surplus rising to CFA 11,076 million in Year 7. In Year 8 and beyond, provision is made for replacement investment, and it is assumed that this is met out of net revenues of the project. The net savings therefore remain at CFA 10,247 million before debt service from year 8 on.

x

x x

## TABLE 12.9. Foreign Exchange Analysis (in millions of CFA francs)

| In-flows of foreign currencies : | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 30 |
|---|---|---|---|---|---|---|---|---|---|
| 1. Import savings (1) | - | 162 | 692 | 1 635 | 2 765 | 11 944 | 13 366 | 13 366 | - |
| 2. Foreign borrowing (2) 16397 US | 1 322 | 1 744 | 3 817 | 5 240 | 2 420 | 1 854 | - | - | - |
| Total q = 65,588,000 US | 1 322 | 1 906 | 4 509 | 6 875 | 5 185 | 13 798 | 13 366 | 13 366 | 13 366 |
| **Cutflow of foreign currencies :** | | | | | | | | | |
| 1. Increased fuel imports | - | 155 | 360 | 597 | 934 | 2 113 | 2 198 | 2 198 | 2198 |
| 2. Expatriate personnel | - | 86 | 86 | 86 | 92 | 92 | 92 | - | - |
| 3. Imported capital goods and services (2) | 1 322 | 1 744 | 3 817 | 5 240 | 2 420 | 1 854 | - - | 921 | 921 |
| Total | 1 322 | 1 985 | 4 263 | 5 923 | 3 446 | 4 059 | 2 290 | 3 119 | 3119 |
| Net savings before debt service | - | ( 79) | 246 | 952 | 1 739 | 9 739 | 11 076 | 10 247 | 10 247 |
| Cumulative net savings | - | ( 79) | 167 | 1 119 | 2 858 | 12 597 | 23 673 | 33 920 | 259 354 |

Notes : 1. Net production of rice and maize by complex and cooperating farmers valued at 1975 unit values.
2. Foreign borrowing assumed to equal foreign currency cost of imported capital goods and services.

TABLE 3, PART 1

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 1

CAS 1

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA franc

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1420 Rice sales | 0 | 56 | 249 | 573 | 940 | 4418 | 4783 | 4783 | 4783 | 4783 | Ventes de riz |
| 1440 Sorghum sales | 0 | 11 | 26 | 109 | 243 | 268 | 475 | 475 | 475 | 475 | Ventes de sorgho |
| 1460 Maize sales | 0 | 15 | 30 | 107 | 230 | 244 | 462 | 462 | 462 | 462 | Ventes de mais |
| 1650 Cattle revenue | 0 | 4 | 38 | 101 | 189 | 632 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1661 Rice mill fees | 0 | 27 | 122 | 261 | 464 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1675 Farmers grain handling | 0 | 2 | 4 | 24 | 60 | 127 | 255 | 255 | 255 | 255 | Commission manutention grain (fermier |
| 1675 Farmers grain storage | 0 | 0 | 1 | 5 | 13 | 27 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1679 Complex grain handling | 0 | 18 | 64 | 168 | 304 | 1017 | 1193 | 1193 | 1193 | 1193 | Commission manutention (complexe) |
| 1680 Complex grain storage | 0 | 3 | 13 | 34 | 62 | 204 | 241 | 241 | 241 | 241 | Commission stockage (complexe) |
| 1690 Cattle feed sales | 0 | 1 | 1 | 7 | 16 | 33 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 0 | 1 | 1 | 2 | 4 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 0 | 138 | 549 | 1411 | 2525 | 8577 | 9995 | 9995 | 9995 | 9995 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 7 | 39 | 84 | 133 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 0 | 13 | 40 | 82 | 139 | 1098 | 1191 | 1191 | 1191 | 1191 | Riz irrigue |
| 1630 Sorghum | 0 | 4 | 6 | 27 | 56 | 57 | 97 | 97 | 97 | 97 | Sorgho |
| 1650 Maize | 0 | 5 | 8 | 27 | 55 | 56 | 101 | 101 | 101 | 101 | Mais |
| 1660 Cattle costs | 0 | 10 | 39 | 88 | 217 | 562 | 562 | 562 | 562 | 562 | Cout du betail |
| 1670 Feed mill | 0 | 2 | 5 | 14 | 31 | 69 | 111 | 111 | 111 | 111 | Usine d'alimentation |
| 1680 Rice mill | 0 | 2 | 7 | 9 | 24 | 96 | 96 | 96 | 96 | 96 | Couts variables de la rizerie |
| 1690 Grain center | 0 | 5 | 18 | 45 | 82 | 280 | 332 | 332 | 332 | 332 | Couts variables du centre de grains |
| 1700 Seed plant | 0 | 4 | 10 | 18 | 48 | 58 | 58 | 58 | 58 | 58 | Couts variables de l'usine de semence |
| 1710 Service units | 0 | 205 | 423 | 649 | 954 | 1925 | 1937 | 1937 | 1937 | 1937 | Couts variables des unites de servic |
| 1715 SUBTOTAL, VARIABLE COSTS | 0 | 257 | 597 | 1043 | 1739 | 4201 | 4485 | 4485 | 4485 | 4485 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 0 | 16 | 21 | 34 | 50 | 61 | 71 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 0 | 141 | 288 | 452 | 710 | 826 | 882 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 0 | 31 | 35 | 40 | 48 | 52 | 55 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 0 | 18 | 18 | 18 | 18 | 18 | 18 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 0 | 46 | 96 | 159 | 257 | 516 | 551 | 542 | 542 | 542 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 0 | 252 | 458 | 703 | 1083 | 1473 | 1577 | 1476 | 1476 | 1476 | TOTAL PARTIEL, COUTS FIXES |
| 1780 TOTAL OPERATING COSTS | 0 | 509 | 1055 | 1746 | 2822 | 5674 | 6062 | 5961 | 5961 | 5961 | COUTS TOTAUX D'OPERATION |
| 1790 GROSS CASHFLOW | 0 | -371 | -506 | -335 | -297 | 2903 | 3933 | 4034 | 4034 | 4034 | CASHFLOW BRUT |
| 1940 Investment, ag. development | 1283 | 2369 | 6418 | 7125 | 5169 | 4374 | 0 | 768 | 768 | 768 | Investissement, developpement agricol |
| 1950 Investment, facilities | 1520 | 530 | 1400 | 3285 | 400 | 0 | 0 | 243 | 243 | 243 | Investissement, installations |
| 1955 Training programs | 28 | 36 | 19 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1961 Working capital | 0 | 186 | 253 | 168 | 149 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1970 TOTAL CAPITAL INVESTMENT | 2833 | 3091 | 8090 | 10598 | 5718 | 4374 | 0 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1820 PROJECT CASHFLOW | -2833 | -3462 | -8596 | -10933 | -6015 | -1471 | 3933 | 3023 | 3023 | 3023 | CASHFLOW DU PROJET |
| 1991 CUMULATIVE CASHFLOW | -2833 | -6295 | -14891 | -25824 | -31839 | -33310 | -29377 | -26354 | -23331 | -20308 | CASHFLOW CUMULATIF |
| 1993 CUMULATIVE CASHFLOW DOLLARS 000 | 11332 | -25180 | -59564 | -103296 | -127356 | -133240 | -117508 | -105416 | -93324 | -81232 | CASHFLOW CUMULATIF DOLLARS 000 |

PROJECT SEMERIZ FINANCIAL REPORT
(In millions of CFA francs)

TABLE 3, PART 2

CASE 1

CAS 1

| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | |
| 1400 Sales receipts | | | | | | | | | | |
| 1420 Rice sales | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 |
| 1440 Sorghum sales | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 |
| 1460 Maize sales | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 |
| 1450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 |
| 1461 Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 |
| 1470 Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 |
| 1474 Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 |
| 1475 Complex grain handling | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 |
| 1479 Complex grain storage | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 |
| 1480 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 |
| 1500 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| 1550 TOTAL REVENUE | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1620 Irrigated rice | 1191 | 1191 | 1191 | 1191 | 1191 | 1191 | 1191 | 1191 | 1191 | 1191 |
| 1630 Sorghum | 97 | 97 | 97 | 97 | 97 | 97 | 97 | 97 | 97 | 97 |
| 1650 Maize | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 |
| 1660 Cattle costs | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 |
| 1670 Feed mill | 111 | 111 | 111 | 111 | 111 | 111 | 111 | 111 | 111 | 111 |
| 1680 Rice mill | 96 | 96 | 96 | 96 | 96 | 96 | 96 | 96 | 96 | 96 |
| 1690 Grain center | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 |
| 1700 Seed plant | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 |
| 1710 Service units | 1937 | 1937 | 1937 | 1937 | 1937 | 1937 | 1937 | 1937 | 1937 | 1937 |
| 1715 SUBTOTAL, VARIABLE COSTS | 4485 | 4485 | 4485 | 4485 | 4485 | 4485 | 4485 | 4485 | 4485 | 4485 |
| 1719 COMPLEX FIXED COSTS | | | | | | | | | | |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 |
| 1765 Contingency | 542 | 542 | 542 | 542 | 542 | 542 | 542 | 542 | 542 | 542 |
| 1775 SUBTOTAL, FIXED COSTS | 1476 | 1476 | 1476 | 1476 | 1476 | 1476 | 1476 | 1476 | 1476 | 1476 |
| 1790 TOTAL OPERATING COSTS | 5961 | 5961 | 5961 | 5961 | 5961 | 5961 | 5961 | 5961 | 5961 | 5961 |
| 1799 GROSS CASHFLOW | 4034 | 4034 | 4034 | 4034 | 4034 | 4034 | 4034 | 4034 | 4034 | 4034 |
| 1840 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 |
| 1850 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 |
| 1855 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1861 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1870 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 |
| 1880 PROJECT CASHFLOW | 3023 | 3023 | 3023 | 3023 | 3023 | 3023 | 3023 | 3023 | 3023 | 3023 |
| 1881 CUMULATIVE CASHFLOW | -17265 | -14242 | -11239 | -8216 | -5193 | -2170 | 853 | 3876 | 6899 | 9922 |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | -69140 | -57046 | -44956 | -32864 | -20772 | -8680 | 3412 | 15504 | 27596 | 39688 |

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

STRUCTURE ECONOMIQUE
Recettes de ventes
Ventes de riz
Ventes de sorgho
Ventes de mais
Revenu du betail
Commission rizerie
Commission manutention grain (fermier
Commission stockage (fermiers)
Commission manutention (complexe)
Commission stockage (complexe)
Ventes de nourriture pour le betail
Ventes de Centre de Semences
REVENU TOTAL

COUTS VARIABLES DU COMPLEXE
Riz pluvial
Riz irrigue
Sorgho
Mais
Cout du betail
Usine d'alimentation
Couts variables de la rizerie
Couts variables du centre de grains
Couts variables de l'usine de semen
Couts variables des unites de servi
TOTAL PARTIEL, COUTS VARIABLES

COUT FIXE DU COMPLEXE
Assistance aux fermiers
Depenses fixes du complexe
Frais generaux du complexe
Recherche et developpement
Imprevus
TOTAL PARTIEL, COUTS FIXES

COUTS TOTAUX D'OPERATION

CASHFLOW BRUT

Investissement, developpement agric
Investissement, installations
Programmes de formation
Investissement des fonds de roulem
INVESTISSEMENT TOTAL DES FONDS

CASHFLOW DU PROJET
CASHFLOW CUMULATIF
CASHFLOW CUMULATIF DOLLARS 000

PROJECT SEMERIZ FINANCIAL REPORT
(In millions of CFA francs)

TABLE 3, PART 3

CASE 1

CAS 1

RAPPORT FINANCIER DU PROJECT SEN
(En millions de CFA francs)

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4924 | Ventes de riz |
| 1420 Sorghum sales | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 476 | Ventes de sorgho |
| 1440 Maize sales | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 464 | Ventes de mais |
| 1450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1451 Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fe |
| 1474 Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1222 | Commission manutention (complexe |
| 1479 Complex grain storage | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 246 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le bet |
| 1500 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 10173 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 1191 | 1191 | 1191 | 1191 | 1191 | 1191 | 1191 | 1191 | 1191 | 1191 | Riz irrigue |
| 1630 Sorghum | 97 | 97 | 97 | 97 | 97 | 97 | 97 | 97 | 97 | 97 | Sorgho |
| 1650 Maize | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Mais |
| 1660 Cattle costs | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | Cout du betail |
| 1670 Feed mill | 111 | 111 | 111 | 111 | 111 | 111 | 111 | 111 | 111 | 111 | Usine d'alimentation |
| 1680 Rice mill | 96 | 96 | 96 | 96 | 96 | 96 | 96 | 96 | 96 | 96 | Couts variables de la rizerie |
| 1690 Grain center | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | Couts variables du centre de grai |
| 1700 Seed plant | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Couts variables de l'usine de ser |
| 1710 Service units | 1937 | 1937 | 1937 | 1937 | 1937 | 1937 | 1937 | 1937 | 1937 | 1937 | Couts variables des unites de se |
| 1715 SUBTOTAL, VARIABLE COSTS | 4485 | 4485 | 4485 | 4485 | 4485 | 4485 | 4485 | 4485 | 4485 | 4485 | TOTAL PARTIEL, COUTS VARIABLES |
| 1719 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 542 | 542 | 542 | 542 | 542 | 542 | 542 | 542 | 542 | 542 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1476 | 1476 | 1476 | 1476 | 1476 | 1476 | 1476 | 1476 | 1476 | 1476 | TOTAL PARTIEL, COUTS FIXES |
| 1780 TOTAL OPERATING COSTS | 5961 | 5961 | 5961 | 5961 | 5961 | 5961 | 5961 | 5961 | 5961 | 5961 | COUTS TOTAUX D'OPERATION |
| 1790 GROSS CASHFLOW | 4034 | 4034 | 4034 | 4034 | 4034 | 4034 | 4034 | 4034 | 4034 | 4212 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agr |
| 1850 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roule |
| 1870 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | 3023 | 3023 | 3023 | 3023 | 3023 | 3023 | 3023 | 3023 | 3023 | 3201 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | 12945 | 15968 | 18991 | 22014 | 25037 | 28060 | 31083 | 34106 | 37129 | 40330 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | 51780 | 63872 | 75964 | 88056 | 100148 | 112240 | 124332 | 136424 | 148516 | 161320 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 4, PART 1

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 2

CAS 2

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 0 | 56 | 249 | 573 | 940 | 4418 | 4783 | 4783 | 4783 | 4783 | Ventes de riz |
| 1420 Sorghum sales | 0 | 11 | 26 | 109 | 243 | 268 | 475 | 475 | 475 | 475 | Ventes de sorgho |
| 1440 Maize sales | 0 | 15 | 30 | 107 | 230 | 244 | 462 | 462 | 462 | 462 | Ventes de mais |
| 1450 Cattle revenue | 0 | 4 | 38 | 101 | 189 | 632 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 0 | 27 | 122 | 281 | 464 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 0 | 2 | 4 | 24 | 60 | 127 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers) |
| 1474 Farmers grain storage | 0 | 0 | 1 | 5 | 13 | 27 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 0 | 18 | 64 | 168 | 304 | 1017 | 1193 | 1193 | 1193 | 1193 | Commission manutention (complexe) |
| 1479 Complex grain storage | 0 | 3 | 13 | 34 | 62 | 204 | 241 | 241 | 241 | 241 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 0 | 1 | 1 | 7 | 16 | 33 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 0 | 1 | 1 | 2 | 4 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 0 | 138 | 549 | 1411 | 2525 | 8577 | 9995 | 9995 | 9995 | 9995 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 7 | 37 | 80 | 126 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 0 | 13 | 38 | 78 | 133 | 1052 | 1141 | 1141 | 1141 | 1141 | Riz irrigue |
| 1630 Sorghum | 0 | 4 | 7 | 26 | 53 | 55 | 93 | 93 | 93 | 93 | Sorgho |
| 1650 Maize | 0 | 4 | 8 | 26 | 53 | 54 | 97 | 97 | 97 | 97 | Mais |
| 1660 Cattle costs | 0 | 10 | 37 | 84 | 208 | 539 | 539 | 539 | 539 | 539 | Cout du betail |
| 1670 Feed mill | 0 | 2 | 5 | 14 | 29 | 66 | 106 | 106 | 106 | 106 | Usine d'alimentation |
| 1680 Rice mill | 0 | 1 | 6 | 9 | 23 | 92 | 92 | 92 | 92 | 92 | Couts variables de la rizerie |
| 1690 Grain center | 0 | 5 | 18 | 43 | 79 | 268 | 318 | 318 | 318 | 318 | Couts variables du centre de grains |
| 1700 Seed plant | 0 | 3 | 10 | 17 | 46 | 55 | 55 | 55 | 55 | 55 | Couts variables de l'usine de semences |
| 1710 Service units | 0 | 197 | 405 | 622 | 915 | 1844 | 1856 | 1856 | 1856 | 1856 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 0 | 246 | 571 | 999 | 1667 | 4025 | 4297 | 4297 | 4297 | 4297 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 0 | 16 | 21 | 34 | 50 | 61 | 71 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 0 | 141 | 288 | 452 | 710 | 826 | 882 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 0 | 31 | 35 | 40 | 48 | 52 | 55 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 0 | 18 | 18 | 18 | 18 | 18 | 18 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 0 | 45 | 93 | 154 | 249 | 498 | 532 | 523 | 523 | 523 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 0 | 251 | 455 | 698 | 1075 | 1455 | 1558 | 1457 | 1457 | 1457 | TOTAL PARTIEL, COUTS FIXES |
| 1780 TOTAL OPERATING COSTS | 0 | 497 | 1026 | 1697 | 2742 | 5480 | 5855 | 5754 | 5754 | 5754 | COUTS TOTAUX D'OPERATION |
| 1900 GROSS CASHFLOW | 0 | -359 | -477 | -286 | -217 | 3097 | 4140 | 4241 | 4241 | 4241 | CASHFLOW BRUT |
| 1940 Investment, ag. development | 1285 | 2369 | 6418 | 7125 | 5169 | 4374 | 0 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1950 Investment, facilities | 1520 | 500 | 1400 | 3285 | 400 | 0 | 0 | 243 | 243 | 243 | Investissement, installations |
| 1955 Training programs | 28 | 36 | 19 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1961 Working capital | 0 | 180 | 239 | 143 | 109 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1970 TOTAL CAPITAL INVESTMENT | 2833 | 3085 | 8076 | 10573 | 5678 | 4374 | 0 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1980 PROJECT CASHFLOW | -2833 | -3444 | -8553 | -10859 | -5895 | -1277 | 4140 | 3230 | 3230 | 3230 | CASHFLOW DU PROJET |
| 1981 CUMULATIVE CASHFLOW | -2833 | -6277 | -14830 | -25689 | -31584 | -32861 | -28721 | -25491 | -22261 | -19031 | CASHFLOW CUMULATIF |
| 1983 CUMULATIVE CASHFLOW DOLLARS 000 | -11332 | -25108 | -59320 | -102756 | -126336 | -131444 | -114884 | -101964 | -89044 | -76124 | CASHFLOW CUMULATIF DOLLARS 000 |

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

TABLE 4, PART 2

CASE 2

CAS 2

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 | ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 | Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 | Rice sales | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | Ventes de riz |
| 1420 | Sorghum sales | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | Ventes de sorgho |
| 1440 | Maize sales | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | Ventes de mais |
| 1450 | Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 | Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 | Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fermier |
| 1474 | Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 | Complex grain handling | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | Commission manutention (complexe) |
| 1479 | Complex grain storage | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | Commission stockage (complexe) |
| 1480 | Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 | Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 | TOTAL REVENUE | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | REVENUE TOTAL |
| 1600 | COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 | Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 | Irrigated rice | 1141 | 1141 | 1141 | 1141 | 1141 | 1141 | 1141 | 1141 | 1141 | 1141 | Riz irrigue |
| 1630 | Sorghum | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | Sorgho |
| 1650 | Maize | 97 | 97 | 97 | 97 | 97 | 97 | 97 | 97 | 97 | 97 | Mais |
| 1660 | Cattle costs | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 | Cout du betail |
| 1670 | Feed mill | 106 | 106 | 106 | 106 | 106 | 106 | 106 | 106 | 106 | 106 | Usine d'alimentation |
| 1680 | Rice mill | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | Couts variables de la rizerie |
| 1690 | Grain center | 318 | 318 | 318 | 318 | 318 | 318 | 318 | 318 | 318 | 318 | Couts variables du centre de grains |
| 1700 | Seed plant | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | Couts variables de l'usine de semences |
| 1710 | Service units | 1856 | 1856 | 1856 | 1856 | 1856 | 1856 | 1856 | 1856 | 1856 | 1856 | Couts variables des unites de service |
| 1715 | SUBTOTAL, VARIABLE COSTS | 4297 | 4297 | 4297 | 4297 | 4297 | 4297 | 4297 | 4297 | 4297 | 4297 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 | COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 | Aid program for farmers | 58 | 58 | 56 | 58 | 58 | 58 | 58 | 56 | 58 | 58 | Assistance aux fermiers |
| 1725 | Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 | Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 | Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 | Contingency | 523 | 523 | 523 | 523 | 523 | 523 | 523 | 523 | 523 | 523 | Imprevus |
| 1775 | SUBTOTAL, FIXED COSTS | 1457 | 1457 | 1457 | 1457 | 1457 | 1457 | 1457 | 1457 | 1457 | 1457 | TOTAL PARTIEL, COUTS FIXES |
| 1790 | TOTAL OPERATING COSTS | 5754 | 5754 | 5754 | 5754 | 5754 | 5754 | 5754 | 5754 | 5754 | 5754 | COUTS TOTAUX D'OPERATION |
| 1799 | GROSS CASHFLOW | 4241 | 4241 | 4241 | 4241 | 4241 | 4241 | 4241 | 4241 | 4241 | 4241 | CASHFLOW BRUT |
| 1840 | Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 | Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1855 | Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 | Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 | TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 | PROJECT CASHFLOW | 3230 | 3230 | 3230 | 3230 | 3230 | 3230 | 3230 | 3230 | 3230 | 3230 | CASHFLOW DU PROJET |
| 1881 | CUMULATIVE CASHFLOW | -15801 | -12571 | -9341 | -6111 | -2881 | 349 | 3579 | 6809 | 10039 | 13269 | CASHFLOW CUMULATIF |
| 1883 | CUMULATIVE CASHFLOW DOLLARS 000 | -63204 | -50284 | -37364 | -24444 | -11524 | 1396 | 14316 | 27236 | 40156 | 53076 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 4, PART 3

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 2

CAS 2

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4924 | Ventes de riz |
| 1420 Sorghum sales | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 476 | Ventes de sorgho |
| 1440 Maize sales | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 464 | Ventes de mais |
| 1450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fermie |
| 1475 Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1479 Complex grain handling | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1222 | Commission manutention (complexe) |
| 1480 Complex grain storage | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 246 | Commission stockage (complexe) |
| 1500 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1550 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 10173 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 1141 | 1141 | 1141 | 1141 | 1141 | 1141 | 1141 | 1141 | 1141 | 1141 | Riz irrigue |
| 1630 Sorghum | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | Sorgho |
| 1650 Maize | 97 | 97 | 97 | 97 | 97 | 97 | 97 | 97 | 97 | 97 | Mais |
| 1660 Cattle costs | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 | Cout du betail |
| 1670 Feed mill | 106 | 106 | 106 | 106 | 106 | 106 | 106 | 106 | 106 | 106 | Usine d'alimentation |
| 1680 Rice mill | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | Couts variables de la rizerie |
| 1690 Grain center | 318 | 318 | 318 | 318 | 318 | 318 | 318 | 318 | 318 | 318 | Couts variables du centre de grains |
| 1700 Seed plant | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | Couts variables de l'usine de semenc |
| 1710 Service units | 1856 | 1856 | 1856 | 1856 | 1856 | 1856 | 1856 | 1856 | 1856 | 1856 | Couts variables des unites de servic |
| 1715 SUBTOTAL, VARIABLE COSTS | 4297 | 4297 | 4297 | 4297 | 4297 | 4297 | 4297 | 4297 | 4297 | 4297 | TOTAL PARTIEL, COUTS VARIABLES |
| 1719 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 523 | 523 | 523 | 523 | 523 | 523 | 523 | 523 | 523 | 523 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1457 | 1457 | 1457 | 1457 | 1457 | 1457 | 1457 | 1457 | 1457 | 1457 | TOTAL PARTIEL, COUTS FIXES |
| 1780 TOTAL OPERATING COSTS | 5754 | 5754 | 5754 | 5754 | 5754 | 5754 | 5754 | 5754 | 5754 | 5754 | COUTS TOTAUX D'OPERATION |
| 1790 GROSS CASHFLOW | 4241 | 4241 | 4241 | 4241 | 4241 | 4241 | 4241 | 4241 | 4241 | 4419 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agrico |
| 1850 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulemen |
| 1870 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | 3230 | 3230 | 3230 | 3230 | 3230 | 3230 | 3230 | 3230 | 3230 | 3408 | CASHFLOW DU PROJET |
| 1891 CUMULATIVE CASHFLOW | 16499 | 19729 | 22959 | 26189 | 29419 | 32649 | 35879 | 39109 | 42339 | 45747 | CASHFLOW CUMULATIF |
| 1893 CUMULATIVE CASHFLOW DOLLARS 000 | 65996 | 78916 | 91836 | 104756 | 117676 | 130596 | 143516 | 156436 | 169356 | 182988 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 5

CASE 3

CAS 3

PROJECT SENERIZ PRODUCTION REPORT
(In units and tons)

RAPPORT PRODUCTION DU PROJECT SENERIZ
(En unites et tonnes)

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1010 COMPLEX PRODUCTION | | | | | | | | | | | PRODUCTION DU COMPLEXE |
| 1201 Rainfed rice net production | 0 | 499 | 3248 | 7617 | 13409 | 0 | 0 | 0 | 0 | 0 | Production Nette de Riz Pluvial |
| 1211 Irrigated rice net production | 0 | 1002 | 3390 | 7652 | 11830 | 117449 | 127126 | 127126 | 127126 | 127126 | Production Nette de Riz Irrigue. |
| 1221 Sorghum net production | 0 | 317 | 743 | 3101 | 6941 | 7648 | 13568 | 13568 | 13568 | 13568 | Production Nette de Sorgho |
| 1241 Maize net production | 0 | 434 | 856 | 3043 | 6563 | 6974 | 13194 | 13194 | 13194 | 13194 | Production Nette de Mais |
| 1250 Calves purchased | 0 | 300 | 800 | 1500 | 5000 | 10000 | 10000 | 10000 | 10000 | 10000 | Veaux achetes |
| 1251 Calves sold | 0 | 0 | 300 | 800 | 1500 | 5000 | 10000 | 10000 | 10000 | 10000 | Veaux vendus |
| 1255 Feeder cattle | 0 | 50 | 300 | 800 | 1500 | 5000 | 5000 | 5000 | 5000 | 5000 | Betail d'engraissement |
| 1300 FARMERS PRODUCTION | | | | | | | | | | | PRODUCTION DES FERMIERS |
| 1300 Rainfed rice net production | 0 | 33 | 98 | 261 | 526 | 1069 | 2283 | 2283 | 2283 | 2283 | Production Nette de Riz Pluvial |
| 1305 Sorghum net production | 0 | 119 | -177 | 1118 | 2971 | 6526 | 13201 | 13201 | 13201 | 13201 | Production Nette de Sorgho |
| 1310 Millet net production | 0 | 20 | 42 | 171 | 469 | 1022 | 2197 | 2197 | 2197 | 2197 | Production Nette de Mil |
| 1315 Maize net production | 0 | 70 | 480 | 1344 | 3168 | 6537 | 12714 | 12714 | 12714 | 12714 | Production Nette de Mais |
| 1320 Total cereals production | 0 | 242 | 443 | 2894 | 7134 | 15154 | 30395 | 30395 | 30395 | 30395 | Production Totale de Cereales |
| 1360 Farmers cattle raised | 0 | 113 | 150 | 697 | 1640 | 3419 | 6743 | 6743 | 6743 | 6743 | Betail eleve par les fermiers |

NOTES: 1) Production data for years 1988-2007 are identical to those of 1987.

2) Production data for most other cases are identical to the Base cases.

N.B.: 1) Donnees de production pour les annees 1988-2007 sont identiques a ceux de 1987.

2) Donees de production pour la plupart des cas son identique au cas de base.

TABLE 6, PART 1

PROJECT SEMERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 3

CAS 3

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 0 | 62 | 275 | 634 | 1047 | 4874 | 5276 | 5276 | 5276 | 5276 | Ventes de riz |
| 1420 Sorghum sales | 0 | 11 | 26 | 109 | 243 | 268 | 475 | 475 | 475 | 475 | Ventes de sorgho |
| 1430 Maize sales | 0 | 15 | 30 | 107 | 230 | 244 | 462 | 462 | 462 | 462 | Ventes de mais |
| 1440 Cattle revenue | 0 | 4 | 38 | 101 | 189 | 632 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 0 | 31 | 135 | 311 | 515 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 0 | 2 | 4 | 24 | 60 | 127 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers) |
| 1475 Farmers grain storage | 0 | 0 | 1 | 5 | 13 | 27 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1479 Complex grain handling | 0 | 19 | 69 | 180 | 325 | 1109 | 1292 | 1292 | 1292 | 1292 | Commission manutention (complexe) |
| 1479 Complex grain storage | 0 | 4 | 14 | 37 | 66 | 222 | 261 | 261 | 261 | 261 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 0 | 1 | 1 | 7 | 16 | 33 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 0 | 1 | 1 | 2 | 4 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 0 | 150 | 594 | 1517 | 2708 | 9143 | 10607 | 10607 | 10607 | 10607 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 7 | 36 | 78 | 124 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 0 | 12 | 37 | 76 | 129 | 1020 | 1106 | 1106 | 1106 | 1106 | Riz irrigue |
| 1630 Sorghum | 0 | 4 | 7 | 25 | 51 | 52 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 Maize | 0 | 4 | 8 | 25 | 50 | 51 | 92 | 92 | 92 | 92 | Mais |
| 1660 Cattle costs | 0 | 9 | 35 | 80 | 197 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 0 | 2 | 4 | 13 | 28 | 63 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 0 | 1 | 6 | 8 | 22 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 0 | 5 | 17 | 41 | 75 | 255 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 0 | 3 | 10 | 17 | 44 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 0 | 187 | 385 | 590 | 868 | 1750 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 0 | 234 | 545 | 953 | 1588 | 3841 | 4100 | 4100 | 4100 | 4100 | TOTAL PARTIEL, COUTS VARIABLES |
| 1712 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 0 | 16 | 21 | 34 | 50 | 61 | 71 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 0 | 141 | 288 | 452 | 710 | 826 | 882 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 0 | 31 | 35 | 40 | 48 | 52 | 55 | 43 | 43 | 43 | Frais generaux du complexe |
| 1750 Research and development | 0 | 18 | 18 | 18 | 18 | 18 | 18 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 0 | 44 | 91 | 150 | 241 | 480 | 513 | 503 | 503 | 503 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 0 | 250 | 453 | 694 | 1067 | 1437 | 1539 | 1437 | 1437 | 1437 | TOTAL PARTIEL, COUTS FIXES |
| 1790 TOTAL OPERATING COSTS | 0 | 484 | 998 | 1647 | 2655 | 5278 | 5639 | 5537 | 5537 | 5537 | COUTS TOTAUX D'OPERATION |
| 1700 GROSS CASHFLOW | 0 | -334 | -404 | -130 | 53 | 3865 | 4968 | 5070 | 5070 | 5070 | CASHFLOW BRUT |
| 1940 Investment, ag. development | 1285 | 2369 | 6418 | 7125 | 5169 | 4374 | 0 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1950 Investment, facilities | 1520 | 500 | 1400 | 3285 | 400 | 0 | 0 | 243 | 243 | 243 | Investissement, installations |
| 1955 Training programs | 28 | 36 | 19 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1961 Working capital | 0 | 167 | 202 | 65 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1970 TOTAL CAPITAL INVESTMENT | 2833 | 3072 | 8039 | 10495 | 5569 | 4374 | 0 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1980 PROJECT CASHFLOW | -2833 | -3406 | -8443 | -10625 | -5516 | -509 | 4968 | 4059 | 4059 | 4059 | CASHFLOW DU PROJET |
| 1991 CUMULATIVE CASHFLOW | -2833 | -6239 | -14682 | -25307 | -30823 | -31332 | -26364 | -22305 | -18246 | -14187 | CASHFLOW CUMULATIF |
| 1993 CUMULATIVE CASHFLOW DOLLARS 000 | -11332 | -24956 | -58728 | -101228 | -123292 | -125328 | -105456 | -89220 | -72984 | -56748 | CASHFLOW CUMULATIF DOLLARS 000 |

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

TABLE 6, PART 2

CASE 3

CAS 3

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 5276 | 5276 | 5276 | 5276 | 5276 | 5276 | 5276 | 5276 | 5276 | 5276 | Ventes de riz |
| 1420 Sorghum sales | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | Ventes de sorgho |
| 1440 Maize sales | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | Ventes de mais |
| 1450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (farmiers) |
| 1474 Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 1292 | 1292 | 1292 | 1292 | 1292 | 1292 | 1292 | 1292 | 1292 | 1292 | Commission manutention (complexe) |
| 1479 Complex grain storage | 261 | 261 | 261 | 261 | 261 | 261 | 261 | 261 | 261 | 261 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 10607 | 10607 | 10607 | 10607 | 10607 | 10607 | 10607 | 10607 | 10607 | 10607 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 1106 | 1106 | 1106 | 1106 | 1106 | 1106 | 1106 | 1106 | 1106 | 1106 | Riz irrigue |
| 1630 Sorghum | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 Maize | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | Mais |
| 1660 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 4100 | 4100 | 4100 | 4100 | 4100 | 4100 | 4100 | 4100 | 4100 | 4100 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 503 | 503 | 503 | 503 | 503 | 503 | 503 | 503 | 503 | 503 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1437 | 1437 | 1437 | 1437 | 1437 | 1437 | 1437 | 1437 | 1437 | 1437 | TOTAL PARTIEL, COUTS FIXES |
| 1780 TOTAL OPERATING COSTS | 5537 | 5537 | 5537 | 5537 | 5537 | 5537 | 5537 | 5537 | 5537 | 5537 | COUTS TOTAUX D'OPERATION |
| 1790 GROSS CASHFLOW | 5070 | 5070 | 5070 | 5070 | 5070 | 5070 | 5070 | 5070 | 5070 | 5070 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | 4059 | 4059 | 4059 | 4059 | 4059 | 4059 | 4059 | 4059 | 4059 | 4059 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | -10128 | -6069 | -2010 | 2049 | 6108 | 10167 | 14226 | 18285 | 22344 | 26403 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | -40512 | -24276 | -8040 | 8196 | 24432 | 40668 | 56904 | 73140 | 89376 | 105612 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE PART 3

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 3

CAS 3

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 | ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 | Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 | Rice sales | 5276 | 5276 | 5276 | 5276 | 5276 | 5276 | 5276 | 5276 | 5276 | 5417 | Ventes de riz |
| 1420 | Sorghum sales | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 476 | Ventes de sorgho |
| 1440 | Maize sales | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 464 | Ventes de mais |
| 1450 | Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 | Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 | Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers) |
| 1474 | Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 | Complex grain handling | 1292 | 1292 | 1292 | 1292 | 1292 | 1292 | 1292 | 1292 | 1292 | 1322 | Commission manutention (complexe) |
| 1479 | Complex grain storage | 261 | 261 | 261 | 261 | 261 | 261 | 261 | 261 | 261 | 266 | Commission stockage (complexe) |
| 1480 | Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 | Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 | TOTAL REVENUE | 10607 | 10607 | 10607 | 10607 | 10607 | 10607 | 10607 | 10607 | 10607 | 10786 | REVENUE TOTAL |
| 1600 | COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 | Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 | Irrigated rice | 1106 | 1106 | 1106 | 1106 | 1106 | 1106 | 1106 | 1106 | 1106 | 1106 | Riz irrigue |
| 1630 | Sorghum | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 | Maize | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | Mais |
| 1660 | Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 | Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 | Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 | Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 | Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 | Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 | SUBTOTAL, VARIABLE COSTS | 4100 | 4100 | 4100 | 4100 | 4100 | 4100 | 4100 | 4100 | 4100 | 4100 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 | COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 | Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 | Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 | Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 | Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 | Contingency | 503 | 503 | 503 | 503 | 503 | 503 | 503 | 503 | 503 | 503 | Imprevus |
| 1775 | SUBTOTAL, FIXED COSTS | 1437 | 1437 | 1437 | 1437 | 1437 | 1437 | 1437 | 1437 | 1437 | 1437 | TOTAL PARTIEL, COUTS FIXES |
| 1790 | TOTAL OPERATING COSTS | 5537 | 5537 | 5537 | 5537 | 5537 | 5537 | 5537 | 5537 | 5537 | 5537 | COUTS TOTAUX D'OPERATION |
| 1799 | GROSS CASHFLOW | 5070 | 5070 | 5070 | 5070 | 5070 | 5070 | 5070 | 5070 | 5070 | 5249 | CASHFLOW BRUT |
| 1840 | Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 | Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1855 | Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 | Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 | TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 | PROJECT CASHFLOW | 4059 | 4059 | 4059 | 4059 | 4059 | 4059 | 4059 | 4059 | 4059 | 4238 | CASHFLOW DU PROJET |
| 1881 | CUMULATIVE CASHFLOW | 30462 | 34521 | 38580 | 42639 | 46698 | 50757 | 54816 | 58875 | 62934 | 67172 | CASHFLOW CUMULATIF |
| 1883 | CUMULATIVE CASHFLOW DOLLARS 000 | 121848 | 138084 | 154320 | 170556 | 186792 | 203028 | 219264 | 235500 | 251736 | 268688 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 7

CASE 4

CAS 4

PROJECT SENERIZ PRODUCTION REPORT
(In units and tons)

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1010 COMPLEX PRODUCTION | | | | | | | | | | |
| 1201 Rainfed rice net production | 0 | 385 | 2608 | 6155 | 10971 | 0 | 0 | 0 | 0 | 0 |
| 1211 Irrigated rice net production | 0 | 798 | 2730 | 6188 | 9110 | 95477 | 103394 | 103394 | 103394 | 103394 |
| 1221 Sorghum net production | 0 | 317 | 743 | 3101 | 6941 | 7648 | 13568 | 13568 | 13568 | 13568 |
| 1241 Maize net production | 0 | 434 | 856 | 3043 | 6563 | 6974 | 13194 | 13194 | 13194 | 13194 |
| 1250 Calves purchased | 0 | 300 | 800 | 1500 | 5000 | 10000 | 10000 | 10000 | 10000 | 10000 |
| 1251 Calves sold | 0 | 0 | 300 | 800 | 1500 | 5000 | 10000 | 10000 | 10000 | 10000 |
| 1255 Feeder cattle | 0 | 50 | 300 | 800 | 1500 | 5000 | 5000 | 5000 | 5000 | 5000 |
| 1300 FARMERS PRODUCTION | | | | | | | | | | |
| 1300 Rainfed rice net production | 0 | 33 | 98 | 261 | 526 | 1069 | 2283 | 2283 | 2283 | 2283 |
| 1305 Sorghum net production | 0 | 119 | -177 | 1118 | 2971 | 6526 | 13201 | 13201 | 13201 | 13201 |
| 1310 Millet net production | 0 | 20 | 42 | 171 | 469 | 1022 | 2197 | 2197 | 2197 | 2197 |
| 1315 Maize net production | 0 | 70 | 480 | 1344 | 3168 | 6537 | 12714 | 12714 | 12714 | 12714 |
| 1320 Total cereals production | 0 | 242 | 443 | 2894 | 7134 | 15154 | 30395 | 30395 | 30395 | 30395 |
| 1350 Farmers cattle raised | 0 | 113 | 150 | 697 | 1640 | 3419 | 6743 | 6743 | 6743 | 6743 |

NOTES: 1) Production data for years 1988-2007 are identical to those of 1987.

2) Production data for most other cases are identical to the Base cases.

RAPPORT PRODUCTION DU PROJECT SENERIZ
(En unites et tonnes)

| | |
|---|---|
| | PRODUCTION DU COMPLEXE |
| Production Nette de Riz Pluvial | |
| Production Nette de Riz Irrigue | |
| Production Nette de Sorgho | |
| Production Nette de Mais | |
| Veaux achetes | |
| Veaux vendus | |
| Betail d'engraissement | |
| | PRODUCTION DES FERMIERS |
| Production Nette de Riz Pluvial | |
| Production Nette de Sorgho | |
| Production Nette de Mil | |
| Production Nette de Mais | |
| Production Totale de Cereales | |
| Betail eleve par les fermiers | |

N.B.: 1) Donnees de production pour les annees 1988-2007 sont identiques a ceux de 1987.

2) Donees de production pour la plupart des cas son identique au cas de base.

TABLE [illegible], PART 1

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 4

CAS 4

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 0 | 49 | 222 | 512 | 833 | 3962 | 4291 | 4291 | 4291 | 4291 | Ventes de riz |
| 1420 Sorghum sales | 0 | 11 | 26 | 109 | 243 | 268 | 475 | 475 | 475 | 475 | Ventes de sorgho |
| 1440 Maize sales | 0 | 15 | 30 | 107 | 230 | 244 | 462 | 462 | 462 | 462 | Ventes de mais |
| 1450 Cattle revenue | 0 | 4 | 38 | 101 | 189 | 632 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 0 | 24 | 109 | 252 | 412 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 0 | 2 | 4 | 24 | 60 | 127 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers) |
| 1474 Farmers grain storage | 0 | 0 | 1 | 5 | 13 | 27 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 0 | 16 | 58 | 155 | 282 | 925 | 1093 | 1093 | 1093 | 1093 | Commission manutention (complexe) |
| 1479 Complex grain storage | 0 | 3 | 12 | 32 | 58 | 186 | 221 | 221 | 221 | 221 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 0 | 1 | 1 | 7 | 16 | 33 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1530 Seed center sales | 0 | 1 | 1 | 2 | 4 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 0 | 126 | 502 | 1306 | 2340 | 8011 | 9383 | 9383 | 9383 | 9383 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 6 | 34 | 74 | 118 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 0 | 12 | 36 | 73 | 124 | 976 | 1059 | 1059 | 1059 | 1059 | Riz irrigue |
| 1630 Sorghum | 0 | 4 | 7 | 25 | 51 | 52 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 Maize | 0 | 4 | 8 | 25 | 50 | 51 | 92 | 92 | 92 | 92 | Mais |
| 1660 Cattle costs | 0 | 9 | 35 | 80 | 197 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 0 | 2 | 4 | 13 | 28 | 63 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 0 | 1 | 6 | 8 | 22 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 0 | 5 | 17 | 41 | 75 | 255 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 0 | 3 | 10 | 17 | 44 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 0 | 187 | 385 | 590 | 868 | 1750 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 0 | 233 | 542 | 946 | 1577 | 3797 | 4053 | 4053 | 4053 | 4053 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 0 | 16 | 21 | 34 | 50 | 61 | 71 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 0 | 141 | 288 | 452 | 710 | 826 | 882 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 0 | 31 | 35 | 40 | 48 | 52 | 55 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 0 | 18 | 18 | 18 | 18 | 18 | 18 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 0 | 44 | 90 | 149 | 240 | 475 | 508 | 499 | 499 | 499 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 0 | 250 | 452 | 693 | 1066 | 1432 | 1534 | 1433 | 1433 | 1433 | TOTAL PARTIEL, COUTS FIXES |
| 1780 TOTAL OPERATING COSTS | 0 | 483 | 994 | 1639 | 2643 | 5229 | 5587 | 5486 | 5486 | 5486 | COUTS TOTAUX D'OPERATION |
| 1790 GROSS CASHFLOW | 0 | -357 | -492 | -333 | -303 | 2782 | 3796 | 3897 | 3897 | 3897 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 1285 | 2369 | 6418 | 7125 | 5169 | 4374 | 0 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 Investment, facilities | 1520 | 500 | 1400 | 3285 | 400 | 0 | 0 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 28 | 36 | 19 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 179 | 246 | 167 | 152 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 2833 | 3084 | 8083 | 10597 | 5721 | 4374 | 0 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | -2833 | -3441 | -8575 | -10930 | -6024 | -1592 | 3796 | 2886 | 2886 | 2886 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | -2833 | -6274 | -14849 | -25779 | -31803 | -33395 | -29599 | -26713 | -23827 | -20941 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | -11332 | -25096 | -59396 | -103116 | -127212 | -133580 | -118396 | -106852 | -95308 | -83764 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 8, PART 2

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 4

CAS 4

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 | ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 | Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 | Rice sales | 4291 | 4291 | 4291 | 4291 | 4291 | 4291 | 4291 | 4291 | 4291 | 4291 | Ventes de riz |
| 1420 | Sorghum sales | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | Ventes de sorgho |
| 1440 | Maize sales | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | Ventes de mais |
| 1450 | Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 | Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 | Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers |
| 1474 | Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 | Complex grain handling | 1093 | 1093 | 1093 | 1093 | 1093 | 1093 | 1093 | 1093 | 1093 | 1093 | Commission manutention (complexe) |
| 1479 | Complex grain storage | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | Commission stockage (complexe) |
| 1480 | Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 | Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 | TOTAL REVENUE | 9383 | 9383 | 9383 | 9383 | 9383 | 9383 | 9383 | 9383 | 9383 | 9383 | REVENUE TOTAL |
| 1600 | COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 | Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 | Irrigated rice | 1059 | 1059 | 1059 | 1059 | 1059 | 1059 | 1059 | 1059 | 1059 | 1059 | Riz irrigue |
| 1630 | Sorghum | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 | Maize | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | Mais |
| 1660 | Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 | Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 | Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 | Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 | Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 | Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 | SUBTOTAL, VARIABLE COSTS | 4053 | 4053 | 4053 | 4053 | 4053 | 4053 | 4053 | 4053 | 4053 | 4053 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 | COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 | Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 | Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 | Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 | Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 | Contingency | 499 | 499 | 499 | 499 | 499 | 499 | 499 | 499 | 499 | 499 | Imprevus |
| 1775 | SUBTOTAL, FIXED COSTS | 1433 | 1433 | 1433 | 1433 | 1433 | 1433 | 1433 | 1433 | 1433 | 1433 | TOTAL PARTIEL, COUTS FIXES |
| 1780 | TOTAL OPERATING COSTS | 5486 | 5486 | 5486 | 5486 | 5486 | 5486 | 5486 | 5486 | 5486 | 5486 | COUTS TOTAUX D'OPERATION |
| 1790 | GROSS CASHFLOW | 3897 | 3897 | 3897 | 3897 | 3897 | 3897 | 3897 | 3897 | 3897 | 3897 | CASHFLOW BRUT |
| 1840 | Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 | Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1855 | Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 | Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 | TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 | PROJECT CASHFLOW | 2886 | 2886 | 2886 | 2886 | 2886 | 2886 | 2886 | 2886 | 2886 | 2886 | CASHFLOW DU PROJET |
| 1881 | CUMULATIVE CASHFLOW | -18055 | -15169 | -12283 | -9397 | -6511 | -3625 | -739 | 2147 | 5033 | 7919 | CASHFLOW CUMULATIF |
| 1883 | CUMULATIVE CASHFLOW DOLLARS 000 | -72220 | -60676 | -49132 | -37588 | -26044 | -14500 | -2956 | 8588 | 20132 | 31676 | CASHFLOW CUMULATIF DOLLARS 000 |

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 4

CAS 4

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 4291 | 4291 | 4291 | 4291 | 4291 | 4291 | 4291 | 4291 | 4291 | 4432 | Ventes de riz |
| 1420 Sorghum sales | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 476 | Ventes de sorgho |
| 1440 Maize sales | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 464 | Ventes de mais |
| 1450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fermier |
| 1474 Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 1093 | 1093 | 1093 | 1093 | 1093 | 1093 | 1093 | 1093 | 1093 | 1122 | Commission manutention (complexe) |
| 1479 Complex grain storage | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 227 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 9383 | 9383 | 9383 | 9383 | 9383 | 9383 | 9383 | 9383 | 9383 | 9562 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 1059 | 1059 | 1059 | 1059 | 1059 | 1059 | 1059 | 1059 | 1059 | 1059 | Riz irrigue |
| 1630 Sorghum | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 Maize | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | Mais |
| 1660 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 4053 | 4053 | 4053 | 4053 | 4053 | 4053 | 4053 | 4053 | 4053 | 4053 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 499 | 499 | 499 | 499 | 499 | 499 | 499 | 499 | 499 | 499 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1433 | 1433 | 1433 | 1433 | 1433 | 1433 | 1433 | 1433 | 1433 | 1433 | TOTAL PARTIEL, COUTS FIXES |
| 1780 TOTAL OPERATING COSTS | 5486 | 5486 | 5486 | 5486 | 5486 | 5486 | 5486 | 5486 | 5486 | 5486 | COUTS TOTAUX D'OPERATION |
| 1790 GROSS CASHFLOW | 3897 | 3897 | 3897 | 3897 | 3897 | 3897 | 3897 | 3897 | 3897 | 4076 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | 2886 | 2886 | 2886 | 2886 | 2886 | 2886 | 2886 | 2886 | 2886 | 3065 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | 10805 | 13691 | 16577 | 19463 | 22349 | 25235 | 28121 | 31007 | 33893 | 36958 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | 43220 | 54764 | 66308 | 77852 | 89396 | 100940 | 112484 | 124028 | 135572 | 147832 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 9

CASE 5

CAS 5

PROJECT SENERIZ PRODUCTION REPORT
(In units and tons)

RAPPORT PRODUCTION DU PROJECT SENERIZ
(En unites et tonnes)

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1010 COMPLEX PRODUCTION | | | | | | | | | | | PRODUCTION DU COMPLEXE |
| 1201 Rainfed rice net production | 0 | 499 | 3248 | 7617 | 13409 | 0 | 0 | 0 | 0 | 0 | Production Nette de Riz Pluvial |
| 1211 Irrigated rice net production | 0 | 1002 | 3390 | 7652 | 11830 | 117449 | 127126 | 127126 | 127126 | 127126 | Production Nette de Riz Irrigue |
| 1221 Sorghum net production | 0 | 349 | 818 | 3413 | 7637 | 8416 | 14928 | 14928 | 14928 | 14928 | Production Nette de Sorgho |
| 1241 Maize net production | 0 | 478 | 944 | 3351 | 7223 | 7678 | 14520 | 14520 | 14520 | 14520 | Production Nette de Mais |
| 1250 Calves purchased | 0 | 300 | 800 | 1500 | 5000 | 10000 | 10000 | 10000 | 10000 | 10000 | Veaux achetes |
| 1251 Calves sold | 0 | 0 | 300 | 800 | 1500 | 5000 | 10000 | 10000 | 10000 | 10000 | Veaux vendus |
| 1255 Feeder cattle | 0 | 50 | 300 | 800 | 1500 | 5000 | 5000 | 5000 | 5000 | 5000 | Betail d'engraissement |
| 1300 FARMERS PRODUCTION | | | | | | | | | | | PRODUCTION DES FERMIERS |
| 1300 Rainfed rice net production | 0 | 33 | 98 | 261 | 526 | 1069 | 2283 | 2283 | 2283 | 2283 | Production Nette de Riz Pluvial |
| 1305 Sorghum net production | 0 | 119 | -177 | 1118 | 2971 | 6526 | 13201 | 13201 | 13201 | 13201 | Production Nette de Sorgho |
| 1310 Millet net production | 0 | 20 | 42 | 171 | 469 | 1022 | 2197 | 2197 | 2197 | 2197 | Production Nette de Mil |
| 1315 Maize net production | 0 | 70 | 480 | 1344 | 3168 | 6537 | 12714 | 12714 | 12714 | 12714 | Production Nette de Mais |
| 1320 Total cereals production | 0 | 242 | 443 | 2894 | 7134 | 15154 | 30395 | 30395 | 30395 | 30395 | Production Totale de Cereales |
| 1360 Farmers cattle raised | 0 | 113 | 150 | 697 | 1640 | 3419 | 6743 | 6743 | 6743 | 6743 | Betail eleve par les fermiers |

NOTES: 1) Production data for years 1988-2007 are identical to those of 1987.

2) Production data for most other cases are identical to the Base cases.

N.B.: 1) Donnees de production pour les annees 1988-2007 sont identiques a ceux de 1987.

2) Donees de production pour la plupart des cas son identique au cas de base.

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

TABLE 10, PART 1

CASE 5

CAS 5

RAPPORT FINANCIER DU PROJECT SENERI
(En millions de CFA francs)

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 0 | 62 | 275 | 634 | 1047 | 4874 | 5276 | 5276 | 5276 | 5276 | Ventes de riz |
| 1420 Sorghum sales | 0 | 12 | 29 | 119 | 267 | 295 | 522 | 522 | 522 | 522 | Ventes de sorgho |
| 1440 Maize sales | 0 | 17 | 33 | 117 | 253 | 269 | 508 | 508 | 508 | 508 | Ventes de mais |
| 1450 Cattle revenue | 0 | 4 | 38 | 101 | 189 | 632 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 0 | 31 | 135 | 511 | 515 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 0 | 2 | 4 | 24 | 60 | 127 | 255 | 255 | 255 | 255 | Commission manutention grain (fermi |
| 1474 Farmers grain storage | 0 | 0 | 1 | 5 | 13 | 27 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 0 | 20 | 71 | 185 | 337 | 1122 | 1315 | 1315 | 1315 | 1315 | Commission manutention (complexe) |
| 1479 Complex grain storage | 0 | 4 | 14 | 38 | 69 | 225 | 266 | 266 | 266 | 266 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 0 | 1 | 1 | 7 | 16 | 33 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1520 Seed center sales | 0 | 1 | 1 | 2 | 4 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 0 | 154 | 602 | 1543 | 2770 | 9211 | 10728 | 10728 | 10728 | 10728 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 7 | 36 | 78 | 124 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 0 | 12 | 37 | 76 | 129 | 1020 | 1106 | 1106 | 1106 | 1106 | Riz irrigue |
| 1630 Sorghum | 0 | 4 | 7 | 25 | 52 | 54 | 91 | 91 | 91 | 91 | Sorgho |
| 1650 Maize | 0 | 4 | 8 | 25 | 52 | 53 | 95 | 95 | 95 | 95 | Mais |
| 1660 Cattle costs | 0 | 9 | 35 | 80 | 197 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 0 | 2 | 4 | 13 | 28 | 63 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 0 | 1 | 6 | 8 | 22 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 0 | 5 | 17 | 41 | 75 | 255 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 0 | 3 | 10 | 17 | 44 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semen |
| 1710 Service units | 0 | 187 | 385 | 590 | 868 | 1750 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de servi |
| 1715 SUBTOTAL, VARIABLE COSTS | 0 | 234 | 545 | 953 | 1591 | 3845 | 4106 | 4106 | 4106 | 4106 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 0 | 16 | 21 | 34 | 50 | 61 | 71 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 0 | 141 | 288 | 452 | 710 | 826 | 882 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 0 | 31 | 35 | 40 | 48 | 52 | 55 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 0 | 18 | 18 | 18 | 18 | 18 | 18 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 0 | 44 | 91 | 150 | 242 | 480 | 513 | 504 | 504 | 504 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 0 | 250 | 453 | 694 | 1068 | 1437 | 1539 | 1438 | 1438 | 1438 | TOTAL PARTIEL, COUTS FIXES |
| 1790 TOTAL OPERATING COSTS | 0 | 484 | 998 | 1647 | 2659 | 5282 | 5645 | 5544 | 5544 | 5544 | COUTS TOTAUX D'OPERATION |
| 1799 GROSS CASHFLOW | 0 | -330 | -396 | -104 | 111 | 3929 | 5083 | 5184 | 5184 | 5184 | CASHFLOW BRUT |
| 1940 Investment, ag. development | 1285 | 2369 | 6418 | 7125 | 5169 | 4374 | 0 | 768 | 768 | 768 | Investissement, developpement agric |
| 1950 Investment, facilities | 1520 | 500 | 1400 | 3285 | 400 | 0 | 0 | 243 | 243 | 243 | Investissement, installations |
| 1955 Training programs | 28 | 36 | 19 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1961 Working capital | 0 | 165 | 198 | 52 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulemen |
| 1970 TOTAL CAPITAL INVESTMENT | 2833 | 3070 | 8035 | 10482 | 5569 | 4374 | 0 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1980 PROJECT CASHFLOW | -2833 | -3400 | -8431 | -10586 | -5458 | -445 | 5083 | 4173 | 4173 | 4173 | CASHFLOW DU PROJET |
| 1991 CUMULATIVE CASHFLOW | -2833 | -6233 | -14664 | -25250 | -30708 | -31153 | -26070 | -21897 | -17724 | -13551 | CASHFLOW CUMULATIF |
| 1993 CUMULATIVE CASHFLOW DOLLARS 000 | -11332 | -24932 | -58656 | -101000 | -122832 | -124612 | -104280 | -87588 | -70896 | -54204 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 10, PART 2

PROJECT SEMERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 5

CAS 5

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 5276 | 5276 | 5276 | 5276 | 5276 | 5276 | 5276 | 5276 | 5276 | 5276 | Ventes de riz |
| 1420 Sorghum sales | 522 | 522 | 522 | 522 | 522 | 522 | 522 | 522 | 522 | 522 | Ventes de sorgho |
| 1440 Maize sales | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | Ventes de mais |
| 1450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fermier |
| 1474 Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 1315 | 1315 | 1315 | 1315 | 1315 | 1315 | 1315 | 1315 | 1315 | 1315 | Commission manutention (complexe) |
| 1479 Complex grain storage | 266 | 266 | 266 | 266 | 266 | 266 | 266 | 266 | 266 | 266 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 10728 | 10728 | 10728 | 10728 | 10728 | 10728 | 10728 | 10728 | 10728 | 10728 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 1106 | 1106 | 1106 | 1106 | 1106 | 1106 | 1106 | 1106 | 1106 | 1106 | Riz irrigue |
| 1630 Sorghum | 91 | 91 | 91 | 91 | 91 | 91 | 91 | 91 | 91 | 91 | Sorgho |
| 1650 Maize | 95 | 95 | 95 | 95 | 95 | 95 | 95 | 95 | 95 | 95 | Mais |
| 1660 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 4106 | 4106 | 4106 | 4106 | 4106 | 4106 | 4106 | 4106 | 4106 | 4106 | TOTAL PARTIEL, COUTS VARIABLES |
| 1717 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 504 | 504 | 504 | 504 | 504 | 504 | 504 | 504 | 504 | 504 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1438 | 1438 | 1438 | 1438 | 1438 | 1438 | 1438 | 1438 | 1438 | 1438 | TOTAL PARTIEL, COUTS FIXES |
| 1780 TOTAL OPERATING COSTS | 5544 | 5544 | 5544 | 5544 | 5544 | 5544 | 5544 | 5544 | 5544 | 5544 | COUTS TOTAUX D'OPERATION |
| 1790 GROSS CASHFLOW | 5184 | 5184 | 5184 | 5184 | 5184 | 5184 | 5184 | 5184 | 5184 | 5184 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | 4173 | 4173 | 4173 | 4173 | 4173 | 4173 | 4173 | 4173 | 4173 | 4173 | CASHFLOW DU PROJET |
| 1891 CUMULATIVE CASHFLOW | -9378 | -5205 | -1032 | 3141 | 7314 | 11487 | 15660 | 19833 | 24006 | 28179 | CASHFLOW CUMULATIF |
| 1893 CUMULATIVE CASHFLOW DOLLARS 000 | -37512 | -20820 | -4128 | 12564 | 29256 | 45948 | 62640 | 79332 | 96024 | 112716 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 10, PART 3

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 5

CAS 5

RAPPORT FINANCIER DU PROJECT SENER
(En millions de CFA francs)

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1390 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | | | | | | | | | | | Ventes de riz |
| 1420 Sorghum sales | 5276 | 5276 | 5276 | 5276 | 5276 | 5276 | 5276 | 5276 | 5276 | 5417 | Ventes de sorgho |
| 1440 Maize sales | 522 | 522 | 522 | 522 | 522 | 522 | 522 | 522 | 522 | 524 | Ventes de mais |
| 1450 Cattle revenue | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 511 | Revenu du betail |
| 1461 Rice mill fees | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Commission rizerie |
| 1470 Farmers grain handling | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission manutention grain (fermi |
| 1474 Farmers grain storage | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission manutention (complexe) |
| 1479 Complex grain storage | 1315 | 1315 | 1315 | 1315 | 1315 | 1315 | 1315 | 1315 | 1315 | 1344 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 266 | 266 | 266 | 266 | 266 | 266 | 266 | 266 | 266 | 271 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes du Centre de Semences |
| | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | |
| 1550 TOTAL REVENUE | 10728 | 10728 | 10728 | 10728 | 10728 | 10728 | 10728 | 10728 | 10728 | 10908 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 1106 | 1106 | 1106 | 1106 | 1106 | 1106 | 1106 | 1106 | 1106 | 1106 | Riz irrigue |
| 1630 Sorghum | 91 | 91 | 91 | 91 | 91 | 91 | 91 | 91 | 91 | 91 | Sorgho |
| 1650 Maize | 95 | 95 | 95 | 95 | 95 | 95 | 95 | 95 | 95 | 95 | Mais |
| 1660 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semen |
| 1710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de servi |
| 1715 SUBTOTAL, VARIABLE COSTS | 4106 | 4106 | 4106 | 4106 | 4106 | 4106 | 4106 | 4106 | 4106 | 4106 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 504 | 504 | 504 | 504 | 504 | 504 | 504 | 504 | 504 | 504 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1438 | 1438 | 1438 | 1438 | 1438 | 1438 | 1438 | 1438 | 1438 | 1438 | TOTAL PARTIEL, COUTS FIXES |
| 1790 TOTAL OPERATING COSTS | 5544 | 5544 | 5544 | 5544 | 5544 | 5544 | 5544 | 5544 | 5544 | 5544 | COUTS TOTAUX D'OPERATION |
| 1799 GROSS CASHFLOW | 5184 | 5184 | 5184 | 5184 | 5184 | 5184 | 5184 | 5184 | 5184 | 5364 | CASHFLOW BRUT |
| 1940 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agrico |
| 1950 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1955 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1961 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulemen |
| 1970 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | 4173 | 4173 | 4173 | 4173 | 4173 | 4173 | 4173 | 4173 | 4173 | 4353 | CASHFLOW DU PROJET |
| 1891 CUMULATIVE CASHFLOW | 32352 | 36525 | 40698 | 44871 | 49044 | 53217 | 57390 | 61563 | 65736 | 70089 | CASHFLOW CUMULATIF |
| 1893 CUMULATIVE CASHFLOW DOLLARS 000 | 129408 | 146100 | 162792 | 179484 | 196176 | 212868 | 229560 | 246252 | 262944 | 280356 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 11

CASE 6

CAS 6

PROJECT SENERIZ PRODUCTION REPORT
(In units and tons)

RAPPORT PRODUCTION DU PROJECT SENERIZ
(En unites et tonnes)

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1010 COMPLEX PRODUCTION | | | | | | | | | | |
| 1201 Rainfed rice net production | 0 | 385 | 2608 | 6155 | 10971 | 0 | 0 | 0 | 0 | 0 |
| 1211 Irrigated rice net production | 0 | 798 | 2730 | 6188 | 9110 | 95477 | 103394 | 103394 | 103394 | 103394 |
| 1221 Sorghum net production | 0 | 285 | 668 | 2789 | 6245 | 6880 | 12208 | 12208 | 12208 | 12208 |
| 1241 Maize net production | 0 | 390 | 769 | 2735 | 5903 | 6270 | 11868 | 11868 | 11868 | 11868 |
| 1250 Calves purchased | 0 | 300 | 800 | 1500 | 5000 | 10000 | 10000 | 10000 | 10000 | 10000 |
| 1251 Calves sold | 0 | 0 | 300 | 800 | 1500 | 5000 | 10000 | 10000 | 10000 | 10000 |
| 1255 Feeder cattle | 0 | 50 | 300 | 800 | 1500 | 5000 | 5000 | 5000 | 5000 | 5000 |
| 1299 FARMERS PRODUCTION | | | | | | | | | | |
| 1300 Rainfed rice net production | 0 | 33 | 98 | 261 | 526 | 1069 | 2283 | 2283 | 2283 | 2283 |
| 1305 Sorghum net production | 0 | 119 | -177 | 1118 | 2971 | 6526 | 13201 | 13201 | 13201 | 13201 |
| 1310 Millet net production | 0 | 20 | 42 | 171 | 469 | 1022 | 2197 | 2197 | 2197 | 2197 |
| 1315 Maize net production | 0 | 70 | 480 | 1344 | 3168 | 6537 | 12714 | 12714 | 12714 | 12714 |
| 1320 Total cereals production | 0 | 242 | 443 | 2894 | 7134 | 15154 | 30395 | 30395 | 30395 | 30395 |
| 1360 Farmers cattle raised | 0 | 113 | 150 | 697 | 1640 | 3419 | 6743 | 6743 | 6743 | 6743 |

| | |
|---|---|
| PRODUCTION DU COMPLEXE | |
| Production Nette de Riz Pluvial | |
| Production Nette de Riz Irrigue | |
| Production Nette de Sorgho | |
| Production Nette de Mais | |
| Veaux achetes | |
| Veaux vendus | |
| Betail d'engraissement | |
| PRODUCTION DES FERMIERS | |
| Production Nette de Riz Pluvial | |
| Production Nette de Sorgho | |
| Production Nette de Mil | |
| Production Nette de Mais | |
| Production Totale de Cereales | |
| Betail eleve par les fermiers | |

NOTES: 1) Production data for years 1988-2007 are identical to those of 1987.

2) Production data for most other cases are identical to the Base cases.

N.B.: 1) Donnees de production pour les annees 1988-2007 sont identiques a ceux de 1987

2) Donees de production pour la plupart des cas son identique

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

TABLE 12, PART 1

CASE 6

CAS 6

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 0 | 49 | 222 | 512 | 833 | 3962 | 4291 | 4291 | 4291 | 4291 | Ventes de riz |
| 1420 Sorghum sales | 0 | 10 | 23 | 98 | 219 | 241 | 427 | 427 | 427 | 427 | Ventes de sorgho |
| 1440 Maize sales | 0 | 14 | 27 | 96 | 207 | 219 | 415 | 415 | 415 | 415 | Ventes de mais |
| 1450 Cattle revenue | 0 | 4 | 38 | 101 | 189 | 632 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 0 | 24 | 109 | 252 | 412 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 0 | 2 | 4 | 24 | 60 | 127 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers) |
| 1474 Farmers grain storage | 0 | 0 | 1 | 5 | 13 | 27 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 0 | 16 | 57 | 150 | 271 | 912 | 1071 | 1071 | 1071 | 1071 | Commission manutention (complexe) |
| 1479 Complex grain storage | 0 | 3 | 12 | 31 | 56 | 184 | 216 | 216 | 216 | 216 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 0 | 1 | 1 | 7 | 16 | 33 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 0 | 1 | 1 | 2 | 4 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 0 | 124 | 495 | 1278 | 2280 | 7944 | 9261 | 9261 | 9261 | 9261 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 34 | 74 | 118 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 0 | 12 | 36 | 73 | 124 | 976 | 1059 | 1059 | 1059 | 1059 | Riz irrigue |
| 1630 Sorghum | 0 | 4 | 7 | 24 | 49 | 51 | 86 | 86 | 86 | 86 | Sorgho |
| 1650 Maize | 0 | 4 | 7 | 24 | 49 | 50 | 89 | 89 | 89 | 89 | Mais |
| 1660 Cattle costs | 0 | 9 | 35 | 80 | 197 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 0 | 2 | 4 | 13 | 28 | 63 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 0 | 1 | 6 | 8 | 22 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 0 | 5 | 17 | 41 | 75 | 255 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 0 | 3 | 10 | 17 | 44 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 0 | 187 | 385 | 590 | 868 | 1750 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 0 | 233 | 541 | 944 | 1574 | 3795 | 4048 | 4048 | 4048 | 4048 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 0 | 16 | 21 | 34 | 50 | 61 | 71 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 0 | 141 | 288 | 452 | 710 | 826 | 882 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 0 | 31 | 35 | 40 | 48 | 52 | 55 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 0 | 18 | 18 | 18 | 18 | 18 | 18 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 0 | 44 | 90 | 149 | 240 | 475 | 507 | 498 | 498 | 498 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 0 | 250 | 452 | 693 | 1066 | 1432 | 1533 | 1432 | 1432 | 1432 | TOTAL PARTIEL, COUTS FIXES |
| 1790 TOTAL OPERATING COSTS | 0 | 483 | 993 | 1637 | 2640 | 5227 | 5581 | 5480 | 5480 | 5480 | COUTS TOTAUX D'OPERATION |
| 1799 GROSS CASHFLOW | 0 | -359 | -498 | -359 | -360 | 2717 | 3680 | 3781 | 3781 | 3781 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 1285 | 2369 | 6418 | 7125 | 5169 | 4374 | 0 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 Investment, facilities | 1520 | 500 | 1400 | 3285 | 400 | 0 | 0 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 28 | 36 | 19 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 180 | 249 | 180 | 180 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 2833 | 3085 | 8086 | 10610 | 5749 | 4374 | 0 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | -2833 | -3444 | -8584 | -10969 | -6109 | -1657 | 3680 | 2770 | 2770 | 2770 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | -2833 | -6277 | -14861 | -25830 | -31939 | -33596 | -29916 | -27146 | -24376 | -21606 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | -11332 | -25108 | -59444 | -103320 | -127756 | -134384 | -119664 | -108584 | -97504 | -86424 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 12, PART 2

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 5

CAS 5

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 4291 | 4291 | 4291 | 4291 | 4291 | 4291 | 4291 | 4291 | 4291 | 4291 | Ventes de riz |
| 1420 Sorghum sales | 427 | 427 | 427 | 427 | 427 | 427 | 427 | 427 | 427 | 427 | Ventes de sorgho |
| 1440 Maize sales | 415 | 415 | 415 | 415 | 415 | 415 | 415 | 415 | 415 | 415 | Ventes de mais |
| 1450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1451 Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fermie |
| 1474 Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 1071 | 1071 | 1071 | 1071 | 1071 | 1071 | 1071 | 1071 | 1071 | 1071 | Commission manutention (complexe) |
| 1479 Complex grain storage | 216 | 216 | 216 | 216 | 216 | 216 | 216 | 216 | 216 | 216 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betai |
| 1500 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 9261 | 9261 | 9261 | 9261 | 9261 | 9261 | 9261 | 9261 | 9261 | 9261 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 1059 | 1059 | 1059 | 1059 | 1059 | 1059 | 1059 | 1059 | 1059 | 1059 | Riz irrigue |
| 1630 Sorghum | 86 | 86 | 86 | 86 | 86 | 86 | 86 | 86 | 86 | 86 | Sorgho |
| 1650 Maize | 89 | 89 | 89 | 89 | 89 | 89 | 89 | 89 | 89 | 89 | Mais |
| 1660 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semenc |
| 1710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de servic |
| 1715 SUBTOTAL, VARIABLE COSTS | 4048 | 4048 | 4048 | 4048 | 4048 | 4048 | 4048 | 4048 | 4048 | 4048 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 498 | 498 | 498 | 498 | 498 | 498 | 498 | 498 | 498 | 498 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | TOTAL PARTIEL, COUTS FIXES |
| 1780 TOTAL OPERATING COSTS | 5480 | 5480 | 5480 | 5480 | 5480 | 5480 | 5480 | 5480 | 5480 | 5480 | COUTS TOTAUX D'OPERATION |
| 1790 GROSS CASHFLOW | 3781 | 3781 | 3781 | 3781 | 3781 | 3781 | 3781 | 3781 | 3781 | 3781 | CASHFLOW BRUT |
| 1940 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricol |
| 1950 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1955 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1961 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulemen |
| 1970 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | 2770 | 2770 | 2770 | 2770 | 2770 | 2770 | 2770 | 2770 | 2770 | 2770 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | 18836 | -16066 | -13296 | -10526 | -7756 | -4986 | -2216 | 554 | 3324 | 6094 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | 75344 | -64264 | -53184 | -42104 | -31024 | -19944 | -8864 | 2216 | 13296 | 24376 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 12, PART 3

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 5

CAS 5

RAPPORT FINANCIER DU PROJECT SENER
(En millions de CFA francs)

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 4291 | 4291 | 4291 | 4291 | 4291 | 4291 | 4291 | 4291 | 4291 | 4432 | Ventes de riz |
| 1420 Sorghum sales | 427 | 427 | 427 | 427 | 427 | 427 | 427 | 427 | 427 | 428 | Ventes de sorgho |
| 1440 Maize sales | 415 | 415 | 415 | 415 | 415 | 415 | 415 | 415 | 415 | 418 | Ventes de mais |
| 1450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (ferm |
| 1474 Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 1071 | 1071 | 1071 | 1071 | 1071 | 1071 | 1071 | 1071 | 1071 | 1100 | Commission manutention (complexe) |
| 1479 Complex grain storage | 216 | 216 | 216 | 216 | 216 | 216 | 216 | 216 | 216 | 222 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betai |
| 1500 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 9261 | 9261 | 9261 | 9261 | 9261 | 9261 | 9261 | 9261 | 9261 | 9441 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 1059 | 1059 | 1059 | 1059 | 1059 | 1059 | 1059 | 1059 | 1059 | 1059 | Riz irrigue |
| 1630 Sorghum | 86 | 86 | 86 | 86 | 86 | 86 | 86 | 86 | 86 | 86 | Sorgho |
| 1650 Maize | 89 | 89 | 89 | 89 | 89 | 89 | 89 | 89 | 89 | 89 | Mais |
| 1660 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grain. |
| 1700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de seme |
| 1710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de serv |
| 1715 SUBTOTAL, VARIABLE COSTS | 4048 | 4048 | 4048 | 4048 | 4048 | 4048 | 4048 | 4048 | 4048 | 4048 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 498 | 498 | 498 | 498 | 498 | 498 | 498 | 498 | 498 | 498 | imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | TOTAL PARTIEL, COUTS FIXES |
| 1780 TOTAL OPERATING COSTS | 5480 | 5480 | 5480 | 5480 | 5480 | 5480 | 5480 | 5480 | 5480 | 5480 | COUTS TOTAUX D'OPERATION |
| 1790 GROSS CASHFLOW | 3781 | 3781 | 3781 | 3781 | 3781 | 3781 | 3781 | 3781 | 3781 | 3961 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agri |
| 1850 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulem |
| 1870 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | 2770 | 2770 | 2770 | 2770 | 2770 | 2770 | 2770 | 2770 | 2770 | 2950 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | 8864 | 11634 | 14404 | 17174 | 19944 | 22714 | 25484 | 28254 | 31024 | 33974 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | 35456 | 46536 | 57616 | 68696 | 79776 | 90856 | 101936 | 113016 | 124096 | 135896 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 13, PART 1

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 7

CAS 7

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 0 | 56 | 249 | 573 | 940 | 4418 | 4783 | 4783 | 4783 | 4783 | Ventes de riz |
| 1420 Sorghum sales | 0 | 11 | 26 | 109 | 243 | 268 | 475 | 475 | 475 | 475 | Ventes de sorgho |
| 1440 Maize sales | 0 | 15 | 30 | 107 | 230 | 244 | 462 | 462 | 462 | 462 | Ventes de mais |
| 1450 Cattle revenue | 0 | 4 | 38 | 101 | 189 | 632 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 0 | 14 | 61 | 141 | 232 | 1075 | 1175 | 1175 | 1175 | 1175 | Commission rizerie |
| 1470 Farmers grain handling | 0 | 2 | 4 | 24 | 60 | 127 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers) |
| 1474 Farmers grain storage | 0 | 0 | 1 | 5 | 13 | 27 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 0 | 18 | 64 | 168 | 304 | 1017 | 1193 | 1193 | 1193 | 1193 | Commission manutention (complexe) |
| 1479 Complex grain storage | 0 | 3 | 13 | 34 | 62 | 204 | 241 | 241 | 241 | 241 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 0 | 1 | 1 | 7 | 16 | 33 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 0 | 1 | 1 | 2 | 4 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 0 | 125 | 488 | 1271 | 2293 | 8052 | 9570 | 9570 | 9570 | 9570 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 7 | 35 | 76 | 121 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 0 | 12 | 36 | 74 | 127 | 998 | 1082 | 1082 | 1082 | 1082 | Riz irrigue |
| 1630 Sorghum | 0 | 4 | 7 | 25 | 51 | 52 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 Maize | 0 | 4 | 8 | 25 | 50 | 51 | 92 | 92 | 92 | 92 | Mais |
| 1660 Cattle costs | 0 | 9 | 35 | 80 | 197 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 0 | 2 | 4 | 13 | 28 | 63 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 0 | 1 | 6 | 8 | 22 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 0 | 5 | 17 | 41 | 75 | 255 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 0 | 3 | 10 | 17 | 44 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 0 | 167 | 385 | 590 | 866 | 1750 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 0 | 234 | 545 | 949 | 1583 | 3819 | 4076 | 4076 | 4076 | 4076 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 0 | 16 | 21 | 34 | 50 | 61 | 71 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 0 | 141 | 288 | 452 | 710 | 826 | 882 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 0 | 31 | 35 | 40 | 48 | 52 | 55 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 0 | 18 | 18 | 18 | 18 | 18 | 18 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 0 | 44 | 91 | 149 | 241 | 478 | 510 | 501 | 501 | 501 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 0 | 250 | 453 | 693 | 1067 | 1435 | 1536 | 1435 | 1435 | 1435 | TOTAL PARTIEL, COUTS FIXES |
| 1780 TOTAL OPERATING COSTS | 0 | 484 | 996 | 1642 | 2650 | 5254 | 5612 | 5511 | 5511 | 5511 | COUTS TOTAUX D'OPERATION |
| 1790 GROSS CASHFLOW | 0 | -359 | -508 | -371 | -357 | 2798 | 3958 | 4059 | 4059 | 4059 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 1285 | 2369 | 6418 | 7125 | 5169 | 4374 | 0 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 Investment, facilities | 1520 | 500 | 1400 | 3285 | 400 | 0 | 0 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 28 | 36 | 19 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 180 | 254 | 186 | 179 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 2833 | 3085 | 8091 | 10616 | 5748 | 4374 | 0 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | -2833 | -3444 | -8599 | -10987 | -6105 | -1576 | 3958 | 3048 | 3048 | 3048 | CASHFLOW DU PROJET |
| 1891 CUMULATIVE CASHFLOW | -2833 | -6277 | -14876 | -25863 | -31968 | -33544 | -29586 | -26538 | -23490 | -20442 | CASHFLOW CUMULATIF |
| 93 CUMULATIVE CASHFLOW DOLLARS 000 | -11332 | -25108 | -59504 | -103452 | -127872 | -134176 | -118344 | -106152 | -93960 | -81768 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 13, PART 2

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

CASE 7

CAS 7

| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | Ventes de riz |
| 1420 Sorghum sales | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | Ventes de sorgho |
| 1440 Maize sales | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | Ventes de mais |
| 1450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 1175 | 1175 | 1175 | 1175 | 1175 | 1175 | 1175 | 1175 | 1175 | 1175 | Commission rizerie |
| 1470 Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers) |
| 1474 Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | Commission manutention (complexe) |
| 1479 Complex grain storage | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 9570 | 9570 | 9570 | 9570 | 9570 | 9570 | 9570 | 9570 | 9570 | 9570 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | Riz irrigue |
| 1630 Sorghum | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 Maize | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | Mais |
| 1660 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | TOTAL PARTIEL, COUTS FIXES |
| 1790 TOTAL OPERATING COSTS | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | COUTS TOTAUX D'OPERATION |
| 1799 GROSS CASHFLOW | 4059 | 4059 | 4059 | 4059 | 4059 | 4059 | 4059 | 4059 | 4059 | 4059 | CASHFLOW BRUT |
| 1940 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1950 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1955 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1961 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1970 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1820 PROJECT CASHFLOW | 3048 | 3048 | 3048 | 3048 | 3048 | 3048 | 3048 | 3048 | 3048 | 3048 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | -17394 | -14346 | -11298 | -8250 | -5202 | -2154 | 894 | 3942 | 6990 | 10038 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | -69576 | -57384 | -45192 | -33000 | -20808 | -8616 | 3576 | 15768 | 27960 | 40152 | CASHFLOW CUMULATIF DOLLARS 000 |

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

TABLE 13, PART 3

CASE 7

CAS 7

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 | ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 | Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 | Rice sales | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4924 | Ventes de riz |
| 1420 | Sorghum sales | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 476 | Ventes de sorgho |
| 1440 | Maize sales | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 464 | Ventes de mais |
| 1450 | Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1451 | Rice mill fees | 1175 | 1175 | 1175 | 1175 | 1175 | 1175 | 1175 | 1175 | 1175 | 1209 | Commission rizerie |
| 1470 | Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers) |
| 1474 | Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 | Complex grain handling | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1222 | Commission manutention (complexe) |
| 1479 | Complex grain storage | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 246 | Commission stockage (complexe) |
| 1480 | Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 | Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 | TOTAL REVENUE | 9570 | 9570 | 9570 | 9570 | 9570 | 9570 | 9570 | 9570 | 9570 | 9782 | REVENUE TOTAL |
| 1600 | COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 | Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 | Irrigated rice | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | Riz irrigue |
| 1630 | Sorghum | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 | Maize | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | Mais |
| 1660 | Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 | Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 | Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 | Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 | Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 | Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 | SUBTOTAL, VARIABLE COSTS | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 | COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 | Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 | Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 | Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 | Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 | Contingency | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | Imprevus |
| 1775 | SUBTOTAL, FIXED COSTS | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | TOTAL PARTIEL, COUTS FIXES |
| 1780 | TOTAL OPERATING COSTS | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | COUTS TOTAUX D'OPERATION |
| 1790 | GROSS CASHFLOW | 4059 | 4059 | 4059 | 4059 | 4059 | 4059 | 4059 | 4059 | 4059 | 4271 | CASHFLOW BRUT |
| 1840 | Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 | Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1855 | Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 | Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 | TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 | PROJECT CASHFLOW | 3048 | 3048 | 3048 | 3048 | 3048 | 3048 | 3048 | 3048 | 3048 | 3260 | CASHFLOW DU PROJET |
| 1881 | CUMULATIVE CASHFLOW | 13086 | 16134 | 19182 | 22230 | 25278 | 28326 | 31374 | 34422 | 37470 | 40730 | CASHFLOW CUMULATIF |
| 1883 | CUMULATIVE CASHFLOW DOLLARS 000 | 52344 | 64536 | 76728 | 88920 | 101112 | 113304 | 125496 | 137688 | 149880 | 162920 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 14, PART 1

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 8

CAS 8

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1420 Rice sales | 0 | 56 | 249 | 573 | 940 | 4418 | 4783 | 4783 | 4783 | 4783 | Ventes de riz |
| 1430 Sorghum sales | 0 | 11 | 26 | 109 | 243 | 268 | 475 | 475 | 475 | 475 | Ventes de sorgho |
| 1440 Maize sales | 0 | 15 | 30 | 107 | 230 | 244 | 462 | 462 | 462 | 462 | Ventes de mais |
| 1450 Cattle revenue | 0 | 4 | 38 | 101 | 189 | 632 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 0 | 27 | 122 | 281 | 464 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Commission manutention grain (fermiers) |
| 1474 Farmers grain storage | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Commission manutention (complexe) |
| 1479 Complex grain storage | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 0 | 1 | 1 | 7 | 16 | 33 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1490 Seed center sales | 0 | 1 | 1 | 2 | 4 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 0 | 115 | 467 | 1180 | 2086 | 7202 | 8252 | 8252 | 8252 | 8252 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 7 | 35 | 76 | 121 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 0 | 12 | 36 | 74 | 127 | 998 | 1082 | 1082 | 1082 | 1082 | Riz irrigue |
| 1630 Sorghum | 0 | 4 | 7 | 25 | 51 | 52 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 Maize | 0 | 4 | 8 | 25 | 50 | 51 | 92 | 92 | 92 | 92 | Mais |
| 1660 Cattle costs | 0 | 9 | 35 | 80 | 197 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 0 | 2 | 4 | 13 | 28 | 63 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 0 | 1 | 6 | 8 | 22 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 0 | 5 | 17 | 41 | 75 | 255 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 0 | 3 | 10 | 17 | 44 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 0 | 187 | 385 | 590 | 868 | 1750 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 0 | 234 | 543 | 949 | 1583 | 3819 | 4076 | 4076 | 4076 | 4076 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 0 | 16 | 21 | 34 | 50 | 61 | 71 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 0 | 141 | 288 | 452 | 710 | 826 | 882 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 0 | 31 | 35 | 40 | 48 | 52 | 55 | 43 | 43 | 43 | Frais generaux du complexe. |
| 1740 Research and development | 0 | 18 | 18 | 18 | 18 | 18 | 18 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 0 | 44 | 91 | 149 | 241 | 478 | 510 | 501 | 501 | 501 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 0 | 250 | 453 | 693 | 1067 | 1435 | 1536 | 1435 | 1435 | 1435 | TOTAL PARTIEL, COUTS FIXES |
| 1790 TOTAL OPERATING COSTS | 0 | 484 | 996 | 1642 | 2650 | 5254 | 5612 | 5511 | 5511 | 5511 | COUTS TOTAUX D'OPERATION |
| 1799 GROSS CASHFLOW | 0 | -369 | -529 | -462 | -564 | 1948 | 2640 | 2741 | 2741 | 2741 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 1285 | 2369 | 6418 | 7125 | 5169 | 4374 | 0 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 Investment, facilities | 1520 | 500 | 1400 | 3285 | 400 | 0 | 0 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 28 | 36 | 19 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 185 | 265 | 231 | 282 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 2833 | 3090 | 8102 | 10661 | 5851 | 4374 | 0 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | -2833 | -3459 | -8631 | -11123 | -6415 | -2426 | 2640 | 1730 | 1730 | 1730 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | -2833 | -6292 | -14923 | -26046 | -32461 | -34887 | -32247 | -30517 | -28787 | -27057 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | -11332 | -25168 | -59692 | -104184 | -129844 | -139548 | -128988 | -122068 | -115148 | -108228 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 14, PART 2

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 8

CAS 8

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | Ventes de riz |
| 1420 Sorghum sales | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | Ventes de sorgho |
| 1440 Maize sales | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | Ventes de mais |
| 1450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Commission manutention grain (fermiers) |
| 1474 Farmers grain storage | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Commission manutention (complexe) |
| 1479 Complex grain storage | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 8252 | 8252 | 8252 | 8252 | 8252 | 8252 | 8252 | 8252 | 8252 | 8252 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | Riz irrigue |
| 1630 Sorghum | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 Maize | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | Mais |
| 1660 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | TOTAL PARTIEL, COUTS FIXES |
| 1780 TOTAL OPERATING COSTS | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | COUTS TOTAUX D'OPERATION |
| 1790 GROSS CASHFLOW | 2741 | 2741 | 2741 | 2741 | 2741 | 2741 | 2741 | 2741 | 2741 | 2741 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | 1730 | 1730 | 1730 | 1730 | 1730 | 1730 | 1730 | 1730 | 1730 | 1730 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | -25327 | -23597 | -21867 | -20137 | -18407 | -16677 | -14947 | -13217 | -11487 | -9757 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | -101308 | -94386 | -87468 | -80548 | -73628 | -66708 | -59788 | -52868 | -45948 | -39028 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 14, PART 3

CASE 8

CAS 8

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4924 | Ventes de riz |
| 1420 Sorghum sales | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 476 | Ventes de sorgho |
| 1440 Maize sales | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 464 | Ventes de mais |
| 1450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Commission manutention grain (fermiers) |
| 1476 Farmers grain storage | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Commission manutention (complexe) |
| 1479 Complex grain storage | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 8252 | 8252 | 8252 | 8252 | 8252 | 8252 | 8252 | 8252 | 8252 | 8396 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | Riz irrigue |
| 1630 Sorghum | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 Maize | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | Mais |
| 1660 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | TOTAL PARTIEL, COUTS FIXES |
| 1780 TOTAL OPERATING COSTS | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | COUTS TOTAUX D'OPERATION |
| 1790 GROSS CASHFLOW | 2741 | 2741 | 2741 | 2741 | 2741 | 2741 | 2741 | 2741 | 2741 | 2885 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricoll |
| 1850 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, Installations |
| 1855 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | 1730 | 1730 | 1730 | 1730 | 1730 | 1730 | 1730 | 1730 | 1730 | 1874 | CASHFLOW DU PROJET |
| 1891 CUMULATIVE CASHFLOW | -8027 | -6297 | -4567 | -2837 | -1107 | 623 | 2353 | 4083 | 5813 | 7687 | CASHFLOW CUMULATIF |
| 1893 CUMULATIVE CASHFLOW DOLLARS 000 | -32108 | -25188 | -18268 | -11348 | -4428 | 2492 | 9412 | 16332 | 23252 | 30749 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 15, PART 1

PROJECT SEMERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 9

CAS 9

RAPPORT FINANCIER DU PROJECT SEN
(En millions de CFA francs)

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 0 | 56 | 249 | 573 | 940 | 4418 | 4783 | 4783 | 4783 | 4783 | Ventes de riz |
| 1420 Sorghum sales | 0 | 11 | 26 | 109 | 243 | 268 | 475 | 475 | 475 | 475 | Ventes de sorgho |
| 1440 Maize sales | 0 | 15 | 30 | 107 | 230 | 244 | 462 | 462 | 462 | 462 | Ventes de mais |
| 1450 Cattle revenue | 0 | 4 | 38 | 101 | 189 | 632 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 0 | 14 | 61 | 141 | 232 | 1075 | 1175 | 1175 | 1175 | 1175 | Commission rizerie |
| 1470 Farmers grain handling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Commission manutention grain (fer |
| 1476 Farmers grain storage | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Commission manutention (complexe) |
| 1479 Complex grain storage | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 0 | 1 | 1 | 7 | 16 | 33 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le beta |
| 1500 Seed center sales | 0 | 1 | 1 | 2 | 4 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 0 | 102 | 406 | 1040 | 1854 | 6677 | 7827 | 7827 | 7827 | 7827 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 7 | 35 | 76 | 121 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 0 | 12 | 36 | 74 | 127 | 998 | 1082 | 1082 | 1082 | 1082 | Riz irrigue |
| 1630 Sorghum | 0 | 4 | 7 | 25 | 51 | 52 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 Maize | 0 | 4 | 8 | 25 | 50 | 51 | 92 | 92 | 92 | 92 | Mais |
| 1660 Cattle costs | 0 | 9 | 35 | 80 | 197 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 0 | 2 | 4 | 13 | 28 | 63 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 0 | 1 | 6 | 8 | 22 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 0 | 5 | 17 | 41 | 75 | 255 | 302 | 302 | 302 | 302 | Couts variables du centre de grai |
| 1700 Seed plant | 0 | 3 | 10 | 17 | 44 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de sem |
| 1710 Service units | 0 | 187 | 385 | 590 | 868 | 1750 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de ser |
| 1715 SUBTOTAL, VARIABLE COSTS | 0 | 234 | 543 | 949 | 1583 | 3819 | 4076 | 4076 | 4076 | 4076 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 0 | 16 | 21 | 34 | 50 | 61 | 71 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 0 | 141 | 288 | 452 | 710 | 826 | 882 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 0 | 31 | 35 | 40 | 48 | 52 | 55 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 0 | 18 | 18 | 18 | 18 | 18 | 18 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 0 | 44 | 91 | 149 | 241 | 478 | 510 | 501 | 501 | 501 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 0 | 250 | 453 | 693 | 1067 | 1435 | 1536 | 1435 | 1435 | 1435 | TOTAL PARTIEL, COUTS FIXES |
| 1790 TOTAL OPERATING COSTS | 0 | 484 | 996 | 1642 | 2650 | 5254 | 5612 | 5511 | 5511 | 5511 | COUTS TOTAUX D'OPERATION |
| 1799 GROSS CASHFLOW | 0 | -382 | -590 | -602 | -796 | 1423 | 2215 | 2316 | 2316 | 2316 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 1285 | 2369 | 6418 | 7125 | 5169 | 4374 | 0 | 768 | 768 | 768 | Investissement, developpement agri |
| 1850 Investment, facilities | 1520 | 500 | 1400 | 3285 | 400 | 0 | 0 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 28 | 36 | 19 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 191 | 295 | 301 | 398 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulem |
| 1870 TOTAL CAPITAL INVESTMENT | 2833 | 3096 | 8132 | 10731 | 5967 | 4374 | 0 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | -2833 | -3478 | -8722 | -11333 | -6763 | -2951 | 2215 | 1305 | 1305 | 1305 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | -2833 | -6311 | -15033 | -26366 | -33129 | -36080 | -33865 | -32560 | -31255 | -29950 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | -11332 | -25244 | -60132 | -105464 | -132516 | -144320 | -135460 | -130240 | -125020 | -119800 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 15, PART 2

CASE 9

CASE 9

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|---|---|
| STRUCTURE ECONOMIQUE | | | | | | | | | | |
| Recettes de ventes | | | | | | | | | | |
| Ventes de riz | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 |
| Ventes de sorgho | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 |
| Ventes de mais | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 |
| Revenu du betail | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 |
| Commission rizerie | 1175 | 1175 | 1175 | 1175 | 1175 | 1175 | 1175 | 1175 | 1175 | 1175 |
| Commission manutention grain (fermiers) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Commission stockage (fermiers) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Commission manutention (complexe) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Commission stockage (complexe) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ventes de nourriture pour le betail | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 |
| Ventes du Centre de Semences | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| REVENUE TOTAL | 7827 | 7827 | 7827 | 7827 | 7827 | 7827 | 7827 | 7827 | 7827 | 7827 |
| COUTS VARIABLES DU COMPLEXE | | | | | | | | | | |
| Riz pluvial | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Riz irrigue | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 |
| Sorgho | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 |
| Mais | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 |
| Cout du betail | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 |
| Usine d'alimentation | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 |
| Couts variables de la rizerie | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 |
| Couts variables du centre de grains | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 |
| Couts variables de l'usine de semences | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 |
| Couts variables des unites de service | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 |
| TOTAL PARTIEL, COUTS VARIABLES | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 |
| COUT FIXE DU COMPLEXE | | | | | | | | | | |
| Assistance aux fermiers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 |
| Depenses fixes du complexe | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 |
| Frais generaux du complexe | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| Recherche et developpement | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 |
| Imprevus | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 |
| TOTAL PARTIEL, COUTS FIXES | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 |
| COUTS TOTAUX D'OPERATION | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 |
| CASHFLOW BRUT | 2316 | 2316 | 2316 | 2316 | 2316 | 2316 | 2316 | 2316 | 2316 | 2316 |
| Investissement, developpement agricole | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 |
| Investissement, installations | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 |
| Programmes de formation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Investissement des fonds de roulement | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| INVESTISSEMENT TOTAL DES FONDS | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 |
| CASHFLOW DU PROJET | 1305 | 1305 | 1305 | 1305 | 1305 | 1305 | 1305 | 1305 | 1305 | 1305 |
| CASHFLOW CUMULATIF | -28645 | -27340 | -26035 | -24730 | -23425 | -22120 | -20815 | -19510 | -18205 | -16900 |
| CASHFLOW CUMULATIF DOLLARS 000 | -114580 | -109360 | -104160 | -98920 | -93700 | -88480 | -83260 | -78040 | -72820 | -67600 |

RAPPORT FINANCIER DU PROJECT SENER-
(En millions de CFA francs)

STRUCTURE ECONOMIQUE
Recettes de ventes
Ventes de riz
Ventes de sorgho
Ventes de mais
Revenu du betail
Commission rizerie
Commission manutention grain (fermi
Commission stockage (fermiers)
Commission manutention (complexe)
Commission stockage (complexe)
Ventes de nourriture pour le betail
Ventes du Centre de Semences
REVENUE TOTAL
COUTS VARIABLES DU COMPLEXE
Riz pluvial
Riz irrigue
Sorgho
Mais
Cout du betail
Usine d'alimentation
Couts variables de la rizerie
Couts variables du centre de grains
Couts variables de l'usine de semen
Couts variables des unites de servi
TOTAL PARTIEL, COUTS VARIABLES
COUT FIXE DU COMPLEXE
Assistance aux fermiers
Depenses fixes du complexe
Frais generaux du complexe
Recherche et developpement
Imprevus
TOTAL PARTIEL, COUTS FIXES
COUTS TOTAUX D'OPERATION
CASHFLOW BRUT
Investissement, developpement agric
Investissement, installations
Programmes de formation
Investissement des fonds de roulem
INVESTISSEMENT TOTAL DES FONDS
CASHFLOW DU PROJET
CASHFLOW CUMULATIF
CASHFLOW CUMULATIF DOLLARS 000

PROJECT SEMERIZ FINANCIAL REPORT
(In millions of CFA francs)

5, PART 3

CASE 9

CAS 9

RAPPORT FINANCIER DU PROJECT SENERI
(En millions de CFA francs)

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4924 | Ventes de riz |
| 1420 Sorghum sales | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 476 | Ventes de sorgho |
| 1440 Maize sales | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 464 | Ventes de mais |
| 1450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 1175 | 1175 | 1175 | 1175 | 1175 | 1175 | 1175 | 1175 | 1175 | 1209 | Commission rizerie |
| 1470 Farmers grain handling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Commission manutention grain (fermie |
| 1474 Farmers grain storage | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Commission manutention (complexe) |
| 1479 Complex grain storage | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 7827 | 7827 | 7827 | 7827 | 7827 | 7827 | 7827 | 7827 | 7827 | 8005 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | Riz irrigue |
| 1630 Sorghum | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 Maize | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | Mais |
| 1660 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semenc |
| 1710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de servic |
| 1715 SUBTOTAL, VARIABLE COSTS | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | TOTAL PARTIEL, COUTS FIXES |
| 1790 TOTAL OPERATING COSTS | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | COUTS TOTAUX D'OPERATION |
| 1799 GROSS CASHFLOW | 2316 | 2316 | 2316 | 2316 | 2316 | 2316 | 2316 | 2316 | 2316 | 2494 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agrico |
| 1850 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulemen |
| 1870 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | 1305 | 1305 | 1305 | 1305 | 1305 | 1305 | 1305 | 1305 | 1305 | 1483 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | -15595 | -14290 | -12985 | -11680 | -10375 | -9070 | -7765 | -6460 | -5155 | -3672 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | -62380 | -57160 | -51940 | -46720 | -41500 | -36280 | -31060 | -25840 | -20620 | -14688 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 16, PART 1

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 10

CAS 10

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 0 | 61 | 273 | 630 | 1034 | 4860 | 5262 | 5262 | 5262 | 5262 | Ventes de riz |
| 1420 Sorghum sales | 0 | 12 | 29 | 119 | 267 | 294 | 522 | 522 | 522 | 522 | Ventes de sorgho |
| 1440 Maize sales | 0 | 17 | 33 | 117 | 253 | 268 | 508 | 508 | 508 | 508 | Ventes de mais |
| 1450 Cattle revenue | 0 | 4 | 38 | 101 | 189 | 632 | 861 | 861 | 861 | 861 | Revénu du betail |
| 1461 Rice mill fees | 0 | 27 | 122 | 281 | 464 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 0 | 2 | 4 | 24 | 60 | 127 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers) |
| 1474 Farmers grain storage | 0 | 0 | 1 | 5 | 13 | 27 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 0 | 18 | 64 | 168 | 304 | 1017 | 1193 | 1193 | 1193 | 1193 | Commission manutention (complexe) |
| 1479 Complex grain storage | 0 | 3 | 13 | 34 | 62 | 204 | 241 | 241 | 241 | 241 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 0 | 1 | 1 | 7 | 16 | 33 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 0 | 1 | 1 | 2 | 4 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 0 | 146 | 579 | 1488 | 2666 | 9069 | 10567 | 10567 | 10567 | 10567 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 7 | 35 | 76 | 121 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 0 | 12 | 36 | 74 | 127 | 998 | 1082 | 1082 | 1082 | 1082 | Riz irrigue |
| 1630 Sorghum | 0 | 4 | 7 | 25 | 51 | 52 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 Maize | 0 | 4 | 8 | 25 | 50 | 51 | 92 | 92 | 92 | 92 | Mais |
| 1660 Cattle costs | 0 | 9 | 35 | 80 | 197 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 0 | 2 | 4 | 13 | 28 | 63 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 0 | 1 | 6 | 8 | 22 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 0 | 5 | 17 | 41 | 75 | 255 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 0 | 3 | 10 | 17 | 44 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 0 | 187 | 385 | 590 | 868 | 1750 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 0 | 234 | 543 | 949 | 1583 | 3819 | 4076 | 4076 | 4076 | 4076 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 0 | 16 | 21 | 34 | 50 | 61 | 71 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 0 | 141 | 288 | 452 | 710 | 826 | 882 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 0 | 31 | 35 | 40 | 48 | 52 | 55 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 0 | 18 | 18 | 18 | 18 | 18 | 18 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 0 | 44 | 91 | 149 | 241 | 478 | 510 | 501 | 501 | 501 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 0 | 250 | 453 | 693 | 1067 | 1435 | 1536 | 1435 | 1435 | 1435 | TOTAL PARTIEL, COUTS FIXES |
| 1790 TOTAL OPERATING COSTS | 0 | 484 | 996 | 1642 | 2650 | 5254 | 5612 | 5511 | 5511 | 5511 | COUTS TOTAUX D'OPERATION |
| 1799 GROSS CASHFLOW | 0 | -338 | -417 | -154 | 16 | 3815 | 4955 | 5056 | 5056 | 5056 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 1285 | 2569 | 6418 | 7125 | 5169 | 4374 | 0 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 Investment, facilities | 1520 | 500 | 1400 | 3285 | 400 | 0 | 0 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 28 | 36 | 19 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 169 | 209 | 77 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 2833 | 3074 | 8046 | 10507 | 5569 | 4374 | 0 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | -2833 | -3412 | -8463 | -10661 | -5553 | -559 | 4955 | 4045 | 4045 | 4045 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | -2833 | -6245 | -14708 | -25369 | -30922 | -31481 | -26526 | -22481 | -18436 | -14391 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | -11332 | -24980 | -58832 | -101476 | -123688 | -125924 | -106104 | -89924 | -73744 | -57564 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 16, PART 2

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 10

CAS 10

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 5262 | 5262 | 5262 | 5262 | 5262 | 5262 | 5262 | 5262 | 5262 | 5262 | Ventes de riz |
| 1420 Sorghum sales | 522 | 522 | 522 | 522 | 522 | 522 | 522 | 522 | 522 | 522 | Ventes de sorgho |
| 1440 Maize sales | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | Ventes de mais |
| 1450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers |
| 1474 Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | Commission manutention (complexe) |
| 1479 Complex grain storage | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | Commission stockage (complexe) |
| 1500 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1520 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 10567 | 10567 | 10567 | 10567 | 10567 | 10567 | 10567 | 10567 | 10567 | 10567 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | Riz irrigue |
| 1630 Sorghum | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 Maize | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | Mais |
| 1660 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | TOTAL PARTIEL, COUTS FIXES |
| 1790 TOTAL OPERATING COSTS | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | COUTS TOTAUX D'OPERATION |
| 1799 GROSS CASHFLOW | 5056 | 5056 | 5056 | 5056 | 5056 | 5056 | 5056 | 5056 | 5056 | 5056 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | 4045 | 4045 | 4045 | 4045 | 4045 | 4045 | 4045 | 4045 | 4045 | 4045 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | -10346 | -6301 | -2256 | 1789 | 5834 | 9879 | 13924 | 17969 | 22014 | 26059 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | -41384 | -25204 | -9024 | 7156 | 23336 | 39516 | 55696 | 71876 | 88056 | 104236 | CASHFLOW CUMULATIF DOLLARS 000 |

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 10

CAS 10

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 5262 | 5262 | 5262 | 5262 | 5262 | 5262 | 5262 | 5262 | 5262 | 5417 | Ventes de riz |
| 1420 Sorghum sales | 522 | 522 | 522 | 522 | 522 | 522 | 522 | 522 | 522 | 524 | Ventes de sorgho |
| 1440 Maize sales | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 511 | Ventes de mais |
| 1450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers |
| 1474 Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1222 | Commission manutention (complexe) |
| 1479 Complex grain storage | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 246 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 10567 | 10567 | 10567 | 10567 | 10567 | 10567 | 10567 | 10567 | 10567 | 10761 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | Riz irrigue . |
| 1630 Sorghum | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 Maize | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | Mais |
| 1660 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | TOTAL PARTIEL, COUTS FIXES |
| 1780 TOTAL OPERATING COSTS | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | COUTS TOTAUX D'OPERATION |
| 1790 GROSS CASHFLOW | 5056 | 5056 | 5056 | 5056 | 5056 | 5056 | 5056 | 5056 | 5056 | 5250 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | 4045 | 4045 | 4045 | 4045 | 4045 | 4045 | 4045 | 4045 | 4045 | 4239 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | 30104 | 34149 | 38194 | 42239 | 46284 | 50329 | 54374 | 58419 | 62464 | 66703 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | 120416 | 136596 | 152776 | 168956 | 185136 | 201316 | 217496 | 233676 | 249856 | 266812 | CASHFLOW CUMULATIF DOLLARS 000 |

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PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

TABLE 17, PART 1

CASE 11

CAS 11

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 | ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 | Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 | Rice sales | 0 | 56 | 249 | 573 | 940 | 4418 | 4783 | 4783 | 4783 | 4783 | Ventes de riz |
| 1420 | Sorghum sales | 0 | 11 | 26 | 109 | 243 | 268 | 475 | 475 | 475 | 475 | Ventes de sorgho |
| 1440 | Maize sales | 0 | 15 | 30 | 107 | 230 | 244 | 462 | 462 | 462 | 462 | Ventes de mais |
| 1450 | Cattle revenue | 0 | 4 | 38 | 101 | 189 | 632 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 | Rice mill fees | 0 | 27 | 122 | 281 | 464 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 | Farmers grain handling | 0 | 2 | 4 | 24 | 60 | 127 | 255 | 255 | 255 | 255 | Commission manutention grain (fermie |
| 1474 | Farmers grain storage | 0 | 0 | 1 | 5 | 13 | 27 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 | Complex grain handling | 0 | 18 | 64 | 168 | 304 | 1017 | 1193 | 1193 | 1193 | 1193 | Commission manutention (complexe) |
| 1479 | Complex grain storage | 0 | 3 | 13 | 34 | 62 | 204 | 241 | 241 | 241 | 241 | Commission stockage (complexe) |
| 1480 | Cattle feed sales | 0 | 1 | 1 | 7 | 16 | 33 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 | Seed center sales | 0 | 1 | 1 | 2 | 4 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 | TOTAL REVENUE | 0 | 138 | 549 | 1411 | 2525 | 8577 | 9995 | 9995 | 9995 | 9995 | REVENUE TOTAL |
| 1600 | COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 | Rainfed rice | 0 | 7 | 35 | 76 | 121 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 | Irrigated rice | 0 | 12 | 36 | 74 | 127 | 998 | 1082 | 1082 | 1082 | 1082 | Riz irrigue |
| 1630 | Sorghum | 0 | 4 | 7 | 25 | 51 | 52 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 | Maize | 0 | 4 | 8 | 25 | 50 | 51 | 92 | 92 | 92 | 92 | Mais |
| 1660 | Cattle costs | 0 | 9 | 35 | 80 | 197 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 | Feed mill | 0 | 2 | 4 | 13 | 28 | 63 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 | Rice mill | 0 | 1 | 6 | 8 | 22 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 | Grain center | 0 | 5 | 17 | 41 | 75 | 255 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 | Seed plant | 0 | 3 | 10 | 17 | 44 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semenc |
| 1710 | Service units | 0 | 187 | 385 | 590 | 868 | 1750 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de servic |
| 1715 | SUBTOTAL, VARIABLE COSTS | 0 | 234 | 543 | 949 | 1583 | 3819 | 4076 | 4076 | 4076 | 4076 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 | COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 | Aid program for farmers | 0 | 16 | 21 | 34 | 50 | 61 | 71 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 | Complex fixed expenses | 0 | 141 | 288 | 452 | 710 | 826 | 882 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 | Complex fixed overhead | 0 | 31 | 35 | 40 | 48 | 52 | 55 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 | Research and development | 0 | 18 | 18 | 18 | 18 | 18 | 18 | 11 | 11 | 11 | Recherche et developpement |
| 1765 | Contingency | 0 | 44 | 91 | 149 | 241 | 478 | 510 | 501 | 501 | 501 | Imprevus |
| 1775 | SUBTOTAL, FIXED COSTS | 0 | 250 | 453 | 693 | 1067 | 1435 | 1536 | 1435 | 1435 | 1435 | TOTAL PARTIEL, COUTS FIXES |
| 1780 | TOTAL OPERATING COSTS | 0 | 484 | 996 | 1642 | 2650 | 5254 | 5612 | 5511 | 5511 | 5511 | COUTS TOTAUX D'OPERATION |
| 1790 | GROSS CASHFLOW | 0 | -346 | -447 | -231 | -125 | 3323 | 4383 | 4484 | 4484 | 4484 | CASHFLOW BRUT |
| 1840 | Investment, ag. development | 1285 | 2982 | 7618 | 8625 | 7269 | 6174 | 0 | 768 | 768 | 768 | Investissement, developpement agricol |
| 1850 | Investment, facilities | 1520 | 500 | 1400 | 3285 | 400 | 0 | 0 | 243 | 243 | 243 | Investissement, installations |
| 1855 | Training programs | 28 | 36 | 19 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 | Working capital | 0 | 173 | 224 | 116 | 63 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 | TOTAL CAPITAL INVESTMENT | 2833 | 3691 | 9261 | 12046 | 7732 | 6174 | 0 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 | PROJECT CASHFLOW | -2833 | -4037 | -9708 | -12277 | -7857 | -2851 | 4383 | 3473 | 3473 | 3473 | CASHFLOW DU PROJET |
| 1881 | CUMULATIVE CASHFLOW | -2833 | -6870 | -16578 | -28855 | -36712 | -39563 | -35180 | -31707 | -28234 | -24761 | CASHFLOW CUMULATIF |
| 1883 | CUMULATIVE CASHFLOW DOLLARS 000 | -11332 | -27480 | -66312 | -115420 | -146848 | -158252 | -140720 | -126828 | -112936 | -99044 | CASHFLOW CUMULATIF DOLLARS 000 |

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 11

CAS 11

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | Ventes de riz |
| 1420 Sorghum sales | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | Ventes de sorgho |
| 1440 Maize sales | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | Ventes de mais |
| 1450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fermier |
| 1474 Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | Commission manutention (complexe) |
| 1479 Complex grain storage | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | Riz irrigue |
| 1630 Sorghum | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 Maize | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | Mais |
| 1660 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semence |
| 1710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | TOTAL PARTIEL, COUTS FIXES |
| 1780 TOTAL OPERATING COSTS | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | COUTS TOTAUX D'OPERATION |
| 1790 GROSS CASHFLOW | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricol |
| 1850 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | CASHFLOW DU PROJET |
| 1891 CUMULATIVE CASHFLOW | -21288 | -17815 | -14342 | -10869 | -7396 | -3923 | -450 | 3023 | 6496 | 9969 | CASHFLOW CUMULATIF |
| 1893 CUMULATIVE CASHFLOW DOLLARS 000 | -85152 | -71260 | -57368 | -43476 | -29584 | -15692 | -1800 | 12092 | 25984 | 39876 | CASHFLOW CUMULATIF DOLLARS 000 |

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 11

CAS 11

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 410 Rice sales | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4924 | Ventes de riz |
| 420 Sorghum sales | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 476 | Ventes de sorgho |
| 440 Maize sales | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 464 | Ventes de mais |
| 450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 461 Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 470 Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers) |
| 474 Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 475 Complex grain handling | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1222 | Commission manutention (complexe) |
| 479 Complex grain storage | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 246 | Commission stockage (complexe) |
| 480 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 500 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 550 TOTAL REVENUE | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 10173 | REVENUE TOTAL |
| 600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 620 Irrigated rice | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | Riz irrigue |
| 630 Sorghum | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | Sorgho |
| 650 Maize | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | Mais |
| 660 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 715 SUBTOTAL, VARIABLE COSTS | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | TOTAL PARTIEL, COUTS VARIABLES |
| 718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 765 Contingency | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | Imprevus |
| 775 SUBTOTAL, FIXED COSTS | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | TOTAL PARTIEL, COUTS FIXES |
| 780 TOTAL OPERATING COSTS | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | COUTS TOTAUX D'OPERATION |
| 790 GROSS CASHFLOW | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4662 | CASHFLOW BRUT |
| 840 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricole |
| 850 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 855 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 861 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 870 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 880 PROJECT CASHFLOW | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3651 | CASHFLOW DU PROJET |
| 881 CUMULATIVE CASHFLOW | 13442 | 16915 | 20388 | 23861 | 27334 | 30807 | 34280 | 37753 | 41226 | 44877 | CASHFLOW CUMULATIF |
| 883 CUMULATIVE CASHFLOW DOLLARS 000 | 53768 | 67660 | 81552 | 95444 | 109336 | 123228 | 137120 | 151012 | 164904 | 179508 | CASHFLOW CUMULATIF DOLLARS 000 |

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

TABLE 18, PART 1

CASE 12

CAS 12

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1380 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 0 | 56 | 249 | 573 | 940 | 4418 | 4783 | 4783 | 4783 | 4783 | Ventes de riz |
| 1420 Sorghum sales | 0 | 11 | 26 | 109 | 243 | 268 | 475 | 475 | 475 | 475 | Ventes de sorgho |
| 1440 Maize sales | 0 | 15 | 30 | 107 | 230 | 244 | 462 | 462 | 462 | 462 | Ventes de mais |
| 1450 Cattle revenue | 0 | 4 | 38 | 101 | 189 | 632 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 0 | 27 | 122 | 281 | 464 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 0 | 2 | 4 | 24 | 60 | 127 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers) |
| 1474 Farmers grain storage | 0 | 0 | 1 | 5 | 13 | 27 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 0 | 18 | 64 | 168 | 304 | 1017 | 1193 | 1193 | 1193 | 1193 | Commission manutention (complexe) |
| 1479 Complex grain storage | 0 | 3 | 13 | 34 | 62 | 204 | 241 | 241 | 241 | 241 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 0 | 1 | 1 | 7 | 16 | 33 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 0 | 1 | 1 | 2 | 4 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 0 | 138 | 549 | 1411 | 2525 | 8577 | 9995 | 9995 | 9995 | 9995 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 7 | 35 | 76 | 121 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 0 | 12 | 36 | 74 | 127 | 998 | 1082 | 1082 | 1082 | 1082 | Riz irrigue |
| 1630 Sorghum | 0 | 4 | 7 | 25 | 51 | 52 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 Maize | 0 | 4 | 8 | 25 | 50 | 51 | 92 | 92 | 92 | 92 | Mais |
| 1660 Cattle costs | 0 | 9 | 35 | 80 | 197 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 0 | 2 | 4 | 13 | 28 | 63 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 0 | 1 | 6 | 8 | 22 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 0 | 5 | 17 | 41 | 75 | 255 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 0 | 3 | 10 | 17 | 44 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 0 | 187 | 385 | 590 | 868 | 1750 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 0 | 234 | 543 | 949 | 1583 | 3819 | 4076 | 4076 | 4076 | 4076 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 0 | 16 | 21 | 34 | 50 | 61 | 71 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 0 | 141 | 288 | 452 | 710 | 826 | 882 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 0 | 31 | 35 | 40 | 48 | 52 | 55 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 0 | 18 | 18 | 18 | 18 | 18 | 18 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 0 | 44 | 91 | 149 | 241 | 478 | 510 | 501 | 501 | 501 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 0 | 250 | 453 | 693 | 1067 | 1435 | 1536 | 1435 | 1435 | 1435 | TOTAL PARTIEL, COUTS FIXES |
| 1780 TOTAL OPERATING COSTS | 0 | 484 | 996 | 1642 | 2650 | 5254 | 5612 | 5511 | 5511 | 5511 | COUTS TOTAUX D'OPERATION |
| 1790 GROSS CASHFLOW | 0 | -346 | -447 | -231 | -125 | 3323 | 4383 | 4484 | 4484 | 4484 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 1285 | 1757 | 5218 | 5425 | 3069 | 2574 | 0 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 Investment, facilities | 1520 | 500 | 1400 | 3285 | 400 | 0 | 0 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 28 | 36 | 19 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 173 | 224 | 116 | 63 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 2833 | 2466 | 6861 | 9046 | 3532 | 2574 | 0 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | -2833 | -2812 | -7308 | -9277 | -3657 | 749 | 4383 | 3473 | 3473 | 3473 | CASHFLOW DU PROJET |
| 1891 CUMULATIVE CASHFLOW | -2833 | -5645 | -12953 | -22230 | -25887 | -25138 | -20755 | -17282 | -13809 | -10336 | CASHFLOW CUMULATIF |
| 1893 CUMULATIVE CASHFLOW DOLLARS 000 | -11332 | -22580 | -51812 | -88920 | -103548 | -100552 | -83020 | -69128 | -55236 | -41344 | CASHFLOW CUMULATIF DOLLARS 000 |

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

TABLE 18, PART 2

CASE 12

CAS 12

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | Ventes de riz |
| 1420 Sorghum sales | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | Ventes de sorgho |
| 1440 Maize sales | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | Ventes de mais |
| 1450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers) |
| 1476 Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | Commission manutention (complexe) |
| 1479 Complex grain storage | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | Riz irrigue |
| 1630 Sorghum | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 Maize | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | Mais |
| 1660 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1745 Contingency | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | TOTAL PARTIEL, COUTS FIXES |
| 1790 TOTAL OPERATING COSTS | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | COUTS TOTAUX D'OPERATION |
| 1799 GROSS CASHFLOW | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | CASHFLOW BRUT |
| 1940 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1950 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1955 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1961 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1970 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1980 PROJECT CASHFLOW | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | CASHFLOW DU PROJET |
| 1991 CUMULATIVE CASHFLOW | -6863 | -3390 | 83 | 3556 | 7029 | 10502 | 13975 | 17448 | 20921 | 24394 | CASHFLOW CUMULATIF |
| 1995 CUMULATIVE CASHFLOW DOLLARS 000 | -27452 | -13560 | 332 | 14224 | 28116 | 42008 | 55900 | 69792 | 83684 | 97576 | CASHFLOW CUMULATIF DOLLARS 000 |

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 12

CAS 12

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4924 | Ventes de riz |
| 1420 Sorghum sales | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 476 | Ventes de sorgho |
| 1440 Maize sales | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 464 | Ventes de mais |
| 1450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers |
| 1474 Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1222 | Commission manutention (complexe) |
| 1479 Complex grain storage | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 246 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 10173 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | Riz irrigue |
| 1630 Sorghum | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 Maize | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | Mais |
| 1660 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | TOTAL PARTIEL, COUTS FIXES |
| 1780 TOTAL OPERATING COSTS | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | COUTS TOTAUX D'OPERATION |
| 1790 GROSS CASHFLOW | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4662 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3651 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | 27867 | 31340 | 34813 | 38286 | 41759 | 45232 | 48705 | 52178 | 55651 | 59302 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | 111468 | 125360 | 139252 | 153144 | 167036 | 180928 | 194820 | 208712 | 222604 | 237208 | CASHFLOW CUMULATIF DOLLARS 000 |

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 13

CAS 13

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1420 Rice sales | 0 | 56 | 249 | 573 | 940 | 4418 | 4783 | 4783 | 4783 | 4783 | Ventes de riz |
| 1430 Sorghum sales | 0 | 11 | 26 | 109 | 243 | 268 | 475 | 475 | 475 | 475 | Ventes de sorgho |
| 1440 Maize sales | 0 | 15 | 30 | 107 | 230 | 244 | 462 | 462 | 462 | 462 | Ventes de mais |
| 1450 Cattle revenue | 0 | 4 | 38 | 101 | 189 | 632 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 0 | 27 | 122 | 281 | 464 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 0 | 2 | 4 | 24 | 60 | 127 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers) |
| 1476 Farmers grain storage | 0 | 0 | 1 | 5 | 13 | 27 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 0 | 18 | 64 | 168 | 304 | 1017 | 1193 | 1193 | 1193 | 1193 | Commission manutention (complexe) |
| 1479 Complex grain storage | 0 | 3 | 13 | 34 | 62 | 204 | 241 | 241 | 241 | 241 | Commission stockage (complexe) |
| [illegible] Cattle feed sales | 0 | 1 | 1 | 7 | 16 | 33 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1590 Seed center sales | 0 | 1 | 1 | 2 | 4 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 0 | 138 | 549 | 1411 | 2525 | 8577 | 9995 | 9995 | 9995 | 9995 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 7 | 35 | 76 | 121 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 0 | 12 | 36 | 74 | 127 | 998 | 1082 | 1082 | 1082 | 1082 | Riz irrigue |
| 1630 Sorghum | 0 | 4 | 7 | 25 | 51 | 52 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 Maize | 0 | 4 | 8 | 25 | 50 | 51 | 92 | 92 | 92 | 92 | Mais |
| 1660 Cattle costs | 0 | 9 | 35 | 80 | 197 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 0 | 2 | 4 | 13 | 28 | 63 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 0 | 1 | 6 | 8 | 22 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 0 | 5 | 17 | 41 | 75 | 255 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 0 | 3 | 10 | 17 | 44 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 0 | 187 | 385 | 590 | 868 | 1750 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 0 | 234 | 543 | 949 | 1583 | 3819 | 4076 | 4076 | 4076 | 4076 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 0 | 16 | 21 | 34 | 50 | 61 | 71 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 0 | 141 | 288 | 452 | 710 | 826 | 882 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 0 | 31 | 35 | 40 | 48 | 52 | 55 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 0 | 18 | 18 | 18 | 18 | 18 | 18 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 0 | 44 | 91 | 149 | 241 | 478 | 510 | 501 | 501 | 501 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 0 | 250 | 453 | 693 | 1067 | 1435 | 1536 | 1435 | 1435 | 1435 | TOTAL PARTIEL, COUTS FIXES |
| 1790 TOTAL OPERATING COSTS | 0 | 484 | 996 | 1642 | 2650 | 5254 | 5612 | 5511 | 5511 | 5511 | COUTS TOTAUX D'OPERATION |
| 700 GROSS CASHFLOW | 0 | -346 | -447 | -231 | -125 | 3323 | 4383 | 4484 | 4484 | 4484 | CASHFLOW BRUT |
| 1940 Investment, ag. development | 1285 | 2369 | 4543 | 5250 | 5169 | 4374 | 0 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1950 Investment, facilities | 1520 | 500 | 1400 | 3285 | 400 | 0 | 0 | 243 | 243 | 243 | Investissement, installations |
| 1955 Training programs | 28 | 36 | 19 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1961 Working capital | 0 | 173 | 224 | 116 | 63 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1970 TOTAL CAPITAL INVESTMENT | 2833 | 3078 | 6186 | 8671 | 5632 | 4374 | 0 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1980 PROJECT CASHFLOW | -2833 | -3424 | -6633 | -8902 | -5757 | -1051 | 4383 | 3473 | 3473 | 3473 | CASHFLOW DU PROJET |
| 1991 CUMULATIVE CASHFLOW | -2833 | -6257 | -12890 | -21792 | -27549 | -28600 | -24217 | -20744 | -17271 | -13798 | CASHFLOW CUMULATIF |
| 1993 CUMULATIVE CASHFLOW DOLLARS | -11332 | -25028 | -51560 | -87168 | -110196 | -114400 | -96868 | -82978 | -69084 | -55192 | CASHFLOW CUMULATIF DOLLARS 000 |

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

TABLE 19, PART 2

CASE 13

CAS 13

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | | | | | | | | | | | |
| 1420 Sorghum sales | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | Ventes de riz |
| 1440 Maize sales | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | Ventes de sorgho |
| 1450 Cattle revenue | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | Ventes de mais |
| 1461 Rice mill fees | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1470 Farmers grain handling | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1474 Farmers grain storage | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers) |
| 1475 Complex grain handling | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1479 Complex grain storage | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | Commission manutention (complexe) |
| 1480 Cattle feed sales | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | Commission stockage (complexe) |
| 1500 Seed center sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | Riz irrigue |
| 1630 Sorghum | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 Maize | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | Mais |
| 1660 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | TOTAL PARTIEL, COUTS VARIABLES |
| 1719 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1760 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | TOTAL PARTIEL, COUTS FIXES |
| 1780 TOTAL OPERATING COSTS | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | COUTS TOTAUX D'OPERATION |
| 1790 GROSS CASHFLOW | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | CASHFLOW BRUT |
| 1940 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1950 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1955 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1961 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1970 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1830 PROJECT CASHFLOW | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | -10325 | -6852 | -3379 | 94 | 3567 | 7040 | 10513 | 13986 | 17459 | 20932 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | -41300 | -27408 | -13516 | 376 | 14268 | 28160 | 42052 | 55944 | 69836 | 83728 | CASHFLOW CUMULATIF DOLLARS 000 |

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

TABLE 19, PART 3

CASE 13

CAS 13

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4783 | 4924 | Ventes de riz |
| 1420 Sorghum sales | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 476 | Ventes de sorgho |
| 1440 Maize sales | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 464 | Ventes de mais |
| 1450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers) |
| 1474 Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1193 | 1222 | Commission manutention (complexe) |
| 1479 Complex grain storage | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 246 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 9995 | 10173 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | Riz irrigue |
| 1630 Sorghum | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 Maize | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | Mais |
| 1660 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | 4076 | TOTAL PARTIEL, COUTS VARIABLES |
| 1719 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | 1435 | TOTAL PARTIEL, COUTS FIXES |
| 1790 TOTAL OPERATING COSTS | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | 5511 | COUTS TOTAUX D'OPERATION |
| 1799 GROSS CASHFLOW | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4484 | 4662 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3473 | 3651 | CASHFLOW DU PROJET |
| 1891 CUMULATIVE CASHFLOW | 24405 | 27878 | 31351 | 34824 | 38297 | 41770 | 45243 | 48716 | 52189 | 55840 | CASHFLOW CUMULATIF |
| 1893 CUMULATIVE CASHFLOW DOLLARS 000 | 97620 | 111512 | 125404 | 139296 | 153188 | 167080 | 180972 | 194864 | 208756 | 223360 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 20

CASE 14

CAS 14

PROJECT SENERIZ PRODUCTION REPORT
(In units and tons)

RAPPORT PRODUCTION DU PROJECT SENERIZ
(En unites et tonnes)

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1010 COMPLEX PRODUCTION | | | | | | | | | | | PRODUCTION DU COMPLEXE |
| 1201 Rainfed rice net production | 0 | 0 | 412 | 2768 | 6376 | 11130 | 0 | 0 | 0 | 0 | Production Nette de Riz Pluvial |
| 1211 Irrigated rice net production | 0 | 0 | 860 | 2940 | 6440 | 8870 | 93943 | 102000 | 102000 | 102000 | Production Nette de Riz Irrigue |
| 1221 Sorghum net production | 0 | 0 | 277 | 655 | 2741 | 6221 | 6688 | 11968 | 11968 | 11968 | Production Nette de Sorgho |
| 1241 Maize net production | 0 | 0 | 394 | 751 | 2603 | 5683 | 6094 | 11634 | 11634 | 11634 | Production Nette de Mais |
| 1250 Calves purchased | 0 | 300 | 800 | 1500 | 5000 | 10000 | 10000 | 10000 | 10000 | 10000 | Veaux achetes |
| 1251 Calves sold | 0 | 0 | 300 | 800 | 1500 | 5000 | 10000 | 10000 | 10000 | 10000 | Veaux vendus |
| 1255 Feeder cattle | 0 | 50 | 300 | 800 | 1500 | 5000 | 5000 | 5000 | 5000 | 5000 | Betail d'engraissement |
| 1299 FARMERS PRODUCTION | | | | | | | | | | | PRODUCTION DES FERMIERS |
| 1300 Rainfed rice net production | 0 | 33 | 98 | 261 | 526 | 1069 | 2283 | 2283 | 2283 | 2283 | Production Nette de Riz Pluvial |
| 1305 Sorghum net production | 0 | 119 | -177 | 1118 | 2971 | 6526 | 13201 | 13201 | 13201 | 13201 | Production Nette de Sorgho |
| 1310 Millet net production | 0 | 20 | 42 | 171 | 469 | 1022 | 2197 | 2197 | 2197 | 2197 | Production Nette de Mil |
| 1315 Maize net production | 0 | 70 | 480 | 1344 | 3168 | 6537 | 12714 | 12714 | 12714 | 12714 | Production Nette de Mais |
| 1320 Total cereals production | 0 | 242 | 443 | 2894 | 7134 | 15154 | 30395 | 30395 | 30395 | 30395 | Production Totale de Cereales |
| 1360 Farmers cattle raised | 0 | 113 | 150 | 697 | 1640 | 3419 | 6743 | 6743 | 6743 | 6743 | Betail aleve par les fermiers |

NOTES: 1) Production data for years 1988-2007 are identical to those of 1987.

2) Production data for most other cases are identical to the Base cases.

N.B.: 1) Donnees de production pour les annees 1988-2007 sont identiques a ceux de 1987.

2) Donees de production pour la plupart des cas son identique au cas de base.

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

TABLE 21, PART 1

CASE 14

CAS 14

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 0 | 0 | 53 | 237 | 532 | 830 | 3899 | 4233 | 4233 | 4233 | Ventes de riz |
| 1420 Sorghum sales | 0 | 0 | 10 | 23 | 96 | 218 | 234 | 419 | 419 | 419 | Ventes de sorgho |
| 1440 Maize sales | 0 | 0 | 14 | 26 | 91 | 199 | 213 | 407 | 407 | 407 | Ventes de mais |
| 1450 Cattle revenue | 0 | 4 | 38 | 101 | 189 | 632 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 0 | 1 | 27 | 119 | 267 | 421 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 0 | 2 | 4 | 24 | 60 | 127 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers) |
| 1474 Farmers grain storage | 0 | 0 | 1 | 5 | 13 | 27 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 0 | 0 | 16 | 60 | 153 | 268 | 896 | 1055 | 1055 | 1055 | Commission manutention (complexe) |
| 1479 Complex grain storage | 0 | 0 | 3 | 13 | 31 | 54 | 180 | 213 | 213 | 213 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 0 | 1 | 1 | 7 | 16 | 33 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 0 | 1 | 1 | 2 | 4 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 0 | 9 | 168 | 617 | 1452 | 2816 | 8263 | 9168 | 9168 | 9168 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 6 | 35 | 75 | 118 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 0 | 0 | 12 | 36 | 73 | 123 | 973 | 1056 | 1056 | 1056 | Riz irrigue |
| 1630 Sorghum | 0 | 0 | 4 | 7 | 24 | 49 | 50 | 85 | 85 | 85 | Sorgho |
| 1650 Maize | 0 | 0 | 4 | 7 | 24 | 48 | 49 | 89 | 89 | 89 | Mais |
| 1660 Cattle costs | 0 | 9 | 35 | 80 | 197 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 0 | 2 | 4 | 13 | 28 | 63 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 0 | 1 | 6 | 8 | 22 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 0 | 5 | 17 | 41 | 75 | 255 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 0 | 3 | 10 | 17 | 44 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 0 | 187 | 385 | 590 | 868 | 1750 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 0 | 207 | 483 | 834 | 1430 | 3056 | 3886 | 4044 | 4044 | 4044 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 0 | 16 | 21 | 34 | 50 | 61 | 71 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 0 | 141 | 288 | 452 | 710 | 826 | 882 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 0 | 31 | 35 | 40 | 48 | 52 | 55 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 0 | 18 | 18 | 18 | 18 | 18 | 18 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 0 | 41 | 85 | 138 | 226 | 401 | 491 | 498 | 498 | 498 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 0 | 247 | 447 | 682 | 1052 | 1358 | 1517 | 1432 | 1432 | 1432 | TOTAL PARTIEL, COUTS FIXES |
| 1780 TOTAL OPERATING COSTS | 0 | 454 | 930 | 1516 | 2482 | 4414 | 5403 | 5476 | 5476 | 5476 | COUTS TOTAUX D'OPERATION |
| 1790 GROSS CASHFLOW | 0 | -445 | -762 | -899 | -1030 | -1598 | 2860 | 3692 | 3692 | 3692 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 1285 | 2369 | 6418 | 7125 | 5169 | 4374 | 0 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 Investment, facilities | 1520 | 500 | 1400 | 3285 | 400 | 0 | 0 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 28 | 36 | 19 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 223 | 381 | 450 | 515 | 799 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 2833 | 3128 | 8218 | 10880 | 6084 | 5173 | 0 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | -2833 | -3573 | -8980 | -11779 | -7114 | -6771 | 2860 | 2681 | 2681 | 2681 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | -2833 | -6406 | -15386 | -27165 | -34279 | -41050 | -38190 | -35509 | -32828 | -30147 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | -11332 | -25624 | -61544 | -108660 | -137116 | -164200 | -152760 | -142036 | -131312 | -120588 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 21, PART 2

PROJECT SEMERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 14

CAS 14

RAPPORT FINANCIER DU PROJECT SENERI
(En millions de CFA francs)

| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 410 Rice sales | | | | | | | | | | | Ventes de riz |
| 420 Sorghum sales | 4233 | 4233 | 4233 | 4233 | 4233 | 4233 | 4233 | 4233 | 4233 | 4233 | Ventes de sorgho |
| 440 Maize sales | 419 | 419 | 419 | 419 | 419 | 419 | 419 | 419 | 419 | 419 | Ventes de mais |
| 450 Cattle revenue | 407 | 407 | 407 | 407 | 407 | 407 | 407 | 407 | 407 | 407 | Revenu du betail |
| 461 Rice mill fees | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Commission rizerie |
| 470 Farmers grain handling | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission manutention grain (fermi |
| 474 Farmers grain storage | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission stockage (fermiers) |
| 475 Complex grain handling | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission manutention (complexe) |
| 479 Complex grain storage | 1055 | 1055 | 1055 | 1055 | 1055 | 1055 | 1055 | 1055 | 1055 | 1055 | Commission stockage (complexe) |
| 480 Cattle feed sales | 213 | 213 | 213 | 213 | 213 | 213 | 213 | 213 | 213 | 213 | Ventes de nourriture pour le betail |
| 500 Seed center sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes du Centre de Semences |
| | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | |
| 550 TOTAL REVENUE | 9168 | 9168 | 9168 | 9168 | 9168 | 9168 | 9168 | 9168 | 9168 | 9168 | REVENUE TOTAL |
| 600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 620 Irrigated rice | 1056 | 1056 | 1056 | 1056 | 1056 | 1056 | 1056 | 1056 | 1056 | 1056 | Riz irrigue |
| 630 Sorghum | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | Sorgho |
| 650 Maize | 89 | 89 | 89 | 89 | 89 | 89 | 89 | 89 | 89 | 89 | Mais |
| 660 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semen |
| 710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de servi |
| 715 SUBTOTAL, VARIABLE COSTS | 4044 | 4044 | 4044 | 4044 | 4044 | 4044 | 4044 | 4044 | 4044 | 4044 | TOTAL PARTIEL, COUTS VARIABLES |
| 719 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 765 Contingency | 498 | 498 | 498 | 498 | 498 | 498 | 498 | 498 | 498 | 498 | Imprevus |
| 775 SUBTOTAL, FIXED COSTS | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | TOTAL PARTIEL, COUTS FIXES |
| 780 TOTAL OPERATING COSTS | 5476 | 5476 | 5476 | 5476 | 5476 | 5476 | 5476 | 5476 | 5476 | 5476 | COUTS TOTAUX D'OPERATION |
| 790 GROSS CASHFLOW | 3692 | 3692 | 3692 | 3692 | 3692 | 3692 | 3692 | 3692 | 3692 | 3692 | CASHFLOW BRUT |
| 840 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agric |
| 850 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 855 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 861 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulemen |
| 870 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 880 PROJECT CASHFLOW | 2681 | 2681 | 2681 | 2681 | 2681 | 2681 | 2681 | 2681 | 2681 | 2681 | CASHFLOW DU PROJET |
| 881 CUMULATIVE CASHFLOW | -27466 | -24785 | -22104 | -19423 | -16742 | -14061 | -11380 | -8699 | -6018 | -3337 | CASHFLOW CUMULATIF |
| 883 CUMULATIVE CASHFLOW DOLLARS 000 | -109864 | -99140 | -88416 | -77692 | -66968 | -56244 | -45520 | -34796 | -24072 | -13348 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 21, PART 3

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 14

CAS 14

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 4233 | 4233 | 4233 | 4233 | 4233 | 4233 | 4233 | 4233 | 4233 | 4374 | Ventes de riz |
| 1420 Sorghum sales | 419 | 419 | 419 | 419 | 419 | 419 | 419 | 419 | 419 | 420 | Ventes de sorgho |
| 1440 Maize sales | 407 | 407 | 407 | 407 | 407 | 407 | 407 | 407 | 407 | 410 | Ventes de mais |
| 1450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers) |
| 1474 Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 1055 | 1055 | 1055 | 1055 | 1055 | 1055 | 1055 | 1055 | 1055 | 1084 | Commission manutention (complexe) |
| 1479 Complex grain storage | 213 | 213 | 213 | 213 | 213 | 213 | 213 | 213 | 213 | 218 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 9168 | 9168 | 9168 | 9168 | 9168 | 9168 | 9168 | 9168 | 9168 | 9347 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 1056 | 1056 | 1056 | 1056 | 1056 | 1056 | 1056 | 1056 | 1056 | 1056 | Riz irrigue |
| 1630 Sorghum | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | Sorgho |
| 1650 Maize | 89 | 89 | 89 | 89 | 89 | 89 | 89 | 89 | 89 | 89 | Mais |
| 1660 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 4044 | 4044 | 4044 | 4044 | 4044 | 4044 | 4044 | 4044 | 4044 | 4044 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX-FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 498 | 498 | 498 | 498 | 498 | 498 | 498 | 498 | 498 | 498 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | TOTAL PARTIEL, COUTS FIXES |
| 1780 TOTAL OPERATING COSTS | 5476 | 5476 | 5476 | 5476 | 5476 | 5476 | 5476 | 5476 | 5476 | 5476 | COUTS TOTAUX D'OPERATION |
| 1790 GROSS CASHFLOW | 3692 | 3692 | 3692 | 3692 | 3692 | 3692 | 3692 | 3692 | 3692 | 3871 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | 2681 | 2681 | 2681 | 2681 | 2681 | 2681 | 2681 | 2681 | 2681 | 2860 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | -656 | 2025 | 4706 | 7387 | 10068 | 12749 | 15430 | 18111 | 20792 | 23652 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | -2624 | 8100 | 18824 | 29548 | 40272 | 50996 | 61720 | 72444 | 83168 | 94608 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 22

CASE 18

CAS 18

PROJECT SENERIZ PRODUCTION REPORT
(In units and tons)

RAPPORT PRODUCTION DU PROJECT SENERIZ
(En unites et tonnes)

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1010 COMPLEX PRODUCTION | | | | | | | | | | | PRODUCTION DU COMPLEXE |
| 1201 Rainfed rice net production | 0 | 2768 | 6376 | 11395 | 0 | 0 | 0 | 0 | 0 | 0 | Production Nette de Riz Pluvial |
| 1211 Irrigated rice net production | 0 | 2700 | 5960 | 8270 | 89874 | 102000 | 102000 | 102000 | 102000 | 102000 | Production Nette de Riz Irrigue |
| 1221 Sorghum net production | 0 | 550 | 2561 | 6221 | 6928 | 12768 | 13568 | 13568 | 13568 | 13568 | Production Nette de Sorgho |
| 1241 Maize net production | 0 | 751 | 2713 | 6123 | 6534 | 12414 | 13194 | 13194 | 13194 | 13194 | Production Nette de Mais |
| 1250 Calves purchased | 0 | 300 | 800 | 1500 | 5000 | 10000 | 10000 | 10000 | 10000 | 10000 | Veaux achetes |
| 1251 Calves sold | 0 | 0 | 300 | 800 | 1500 | 5000 | 10000 | 10000 | 10000 | 10000 | Veaux vendus |
| 1255 Feeder cattle | 0 | 50 | 300 | 800 | 1500 | 5000 | 5000 | 5000 | 5000 | 5000 | Betail d'engraissement |
| 1299 FARMERS PRODUCTION | | | | | | | | | | | PRODUCTION DES FERMIERS |
| 1300 Rainfed rice net production | 0 | 33 | 98 | 261 | 526 | 1069 | 2283 | 2283 | 2283 | 2283 | Production Nette de Riz Pluvial |
| 1305 Sorghum net production | 0 | 119 | -177 | 1118 | 2971 | 6526 | 13201 | 13201 | 13201 | 13201 | Production Nette de Sorgho |
| 1310 Millet net production | 0 | 20 | 42 | 171 | 469 | 1022 | 2197 | 2197 | 2197 | 2197 | Production Nette de Mil |
| 1315 Maize net production | 0 | 70 | 480 | 1344 | 3168 | 6537 | 12714 | 12714 | 12714 | 12714 | Production Nette de Mais |
| 1320 Total cereals production | 0 | 242 | 443 | 2894 | 7134 | 15154 | 30395 | 30395 | 30395 | 30395 | Production Totale de Cereales |
| 1350 Farmers cattle raised | 0 | 113 | 150 | 697 | 1640 | 3419 | 6743 | 6743 | 6743 | 6743 | Betail eleve par les fermiers |

NOTES:- 1) Production data for years 1988-2007 are identical to those of 1987.

2) Production data for most other cases are identical to the Base cases.

N.B.: 1) Donnees de production pour les annees 1988-2007 sont identiques a ceux de 1987.

2) Donees de production pour la plupart des cas son identique au cas de base.

560

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

TABLE 23, PART 1

CASE 15

CAS 15

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 0 | 227 | 512 | 816 | 3730 | 4233 | 4233 | 4233 | 4233 | 4233 | Ventes de riz |
| 1420 Sorghum sales | 0 | 19 | 90 | 218 | 242 | 447 | 475 | 475 | 475 | 475 | Ventes de sorgho |
| 1440 Maize sales | 0 | 26 | 95 | 214 | 229 | 434 | 462 | 462 | 462 | 462 | Ventes de mais |
| 1450 Cattle revenue | 0 | 4 | 38 | 101 | 189 | 632 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 0 | 110 | 249 | 399 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 0 | 2 | 4 | 24 | 60 | 127 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers) |
| 1476 Farmers grain storage | 0 | 0 | 1 | 5 | 13 | 27 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 0 | 57 | 148 | 269 | 868 | 1068 | 1081 | 1081 | 1081 | 1081 | Commission manutention (complexe) |
| 1479 Complex grain storage | 0 | 11 | 30 | 55 | 174 | 216 | 219 | 219 | 219 | 219 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 0 | 1 | 1 | 7 | 16 | 33 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 0 | 1 | 1 | 2 | 4 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 0 | 458 | 1169 | 2110 | 7125 | 8824 | 9311 | 9311 | 9311 | 9311 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 35 | 75 | 119 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 0 | 36 | 72 | 122 | 965 | 1056 | 1056 | 1056 | 1056 | 1056 | Riz irrigue |
| 1630 Sorghum | 0 | 6 | 23 | 49 | 51 | 87 | 88 | 88 | 88 | 88 | Sorgho |
| 1640 Maize | 0 | 7 | 24 | 49 | 50 | 91 | 92 | 92 | 92 | 92 | Mais |
| 1650 Cattle costs | 0 | 9 | 35 | 80 | 197 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 0 | 2 | 4 | 13 | 28 | 63 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 0 | 1 | 6 | 8 | 22 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 0 | 5 | 17 | 41 | 75 | 255 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 0 | 3 | 10 | 17 | 44 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 0 | 187 | 385 | 590 | 868 | 1750 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 0 | 291 | 651 | 1088 | 2300 | 3952 | 4050 | 4050 | 4050 | 4050 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 0 | 16 | 21 | 34 | 50 | 61 | 71 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 0 | 141 | 288 | 452 | 710 | 826 | 882 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 0 | 31 | 35 | 40 | 48 | 52 | 55 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 0 | 18 | 18 | 18 | 18 | 18 | 18 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 0 | 50 | 101 | 163 | 313 | 491 | 508 | 498 | 498 | 498 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 0 | 256 | 463 | 707 | 1139 | 1448 | 1534 | 1432 | 1432 | 1432 | TOTAL PARTIEL, COUTS FIXES |
| 1780 TOTAL OPERATING COSTS | 0 | 547 | 1114 | 1795 | 3439 | 5400 | 5584 | 5482 | 5482 | 5482 | COUTS TOTAUX D'OPERATION |
| 1790 GROSS CASHFLOW | 0 | -89 | 55 | 315 | 3686 | 3424 | 3727 | 3829 | 3829 | 3829 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 3685 | 5144 | 9018 | 11125 | 6969 | 774 | 0 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 Investment, facilities | 1520 | 500 | 1400 | 3285 | 400 | 0 | 0 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 28 | 36 | 19 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 5233 | 5725 | 10437 | 14430 | 7369 | 774 | 0 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | -5233 | -5814 | -10382 | -14115 | -3683 | 2650 | 3727 | 2818 | 2818 | 2818 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | -5233 | -11047 | -21429 | -35544 | -39227 | -36577 | -32850 | -30032 | -27214 | -24396 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | -20932 | -44188 | -85716 | -142176 | -156908 | -146308 | -131400 | -120128 | -108856 | -97584 | CASHFLOW CUMULATIF DOLLARS 000 |

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

TABLE 23, PART 2

CASE 15

CAS 15

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 410 Rice sales | 4233 | 4233 | 4233 | 4233 | 4233 | 4233 | 4233 | 4233 | 4233 | 4233 | Ventes de riz |
| 420 Sorghum sales | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | Ventes de sorgho |
| 440 Maize sales | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | Ventes de mais |
| 450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 461 Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 470 Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers) |
| 476 Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 475 Complex grain handling | 1081 | 1081 | 1081 | 1081 | 1081 | 1081 | 1081 | 1081 | 1081 | 1081 | Commission manutention (complexe) |
| 479 Complex grain storage | 219 | 219 | 219 | 219 | 219 | 219 | 219 | 219 | 219 | 219 | Commission stockage (complexe) |
| 480 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 500 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 550 TOTAL REVENUE | 9311 | 9311 | 9311 | 9311 | 9311 | 9311 | 9311 | 9311 | 9311 | 9311 | REVENUE TOTAL |
| 600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 620 Irrigated rice | 1056 | 1056 | 1056 | 1056 | 1056 | 1056 | 1056 | 1056 | 1056 | 1056 | Riz irrigue |
| 630 Sorghum | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | Sorgho |
| 650 Maize | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | Mais |
| 660 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 715 SUBTOTAL, VARIABLE COSTS | 4050 | 4050 | 4050 | 4050 | 4050 | 4050 | 4050 | 4050 | 4050 | 4050 | TOTAL PARTIEL, COUTS VARIABLES |
| 719 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 750 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 755 Contingency | 498 | 498 | 498 | 498 | 498 | 498 | 498 | 498 | 498 | 498 | Imprevus |
| 775 SUBTOTAL, FIXED COSTS | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | TOTAL PARTIEL, COUTS FIXES |
| 790 TOTAL OPERATING COSTS | 5482 | 5482 | 5482 | 5482 | 5482 | 5482 | 5482 | 5482 | 5482 | 5482 | COUTS TOTAUX D'OPERATION |
| 800 GROSS CASHFLOW | 3829 | 3829 | 3829 | 3829 | 3829 | 3829 | 3829 | 3829 | 3829 | 3829 | CASHFLOW BRUT |
| 840 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricole |
| 850 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 855 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 861 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 870 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 890 PROJECT CASHFLOW | 2818 | 2818 | 2818 | 2818 | 2818 | 2818 | 2818 | 2818 | 2818 | 2818 | CASHFLOW DU PROJET |
| 891 CUMULATIVE CASHFLOW | -21578 | -18760 | -15942 | -13124 | -10306 | -7488 | -4670 | -1852 | 966 | 3784 | CASHFLOW CUMULATIF |
| 893 CUMULATIVE CASHFLOW DOLLARS 000 | -86312 | -75040 | -63768 | -52496 | -41224 | -29952 | -18680 | -7408 | 3864 | 15136 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 23, PART 3

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 15

CAS 15

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 4233 | 4233 | 4233 | 4233 | 4233 | 4233 | 4233 | 4233 | 4233 | 4374 | Ventes de riz |
| 1420 Sorghum sales | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 476 | Ventes de sorgho |
| 1440 Maize sales | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 464 | Ventes de mais |
| 1450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers) |
| 1474 Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 1081 | 1081 | 1081 | 1081 | 1081 | 1081 | 1081 | 1081 | 1081 | 1111 | Commission manutention (complexe) |
| 1479 Complex grain storage | 219 | 219 | 219 | 219 | 219 | 219 | 219 | 219 | 219 | 224 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| 1500 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 9311 | 9311 | 9311 | 9311 | 9311 | 9311 | 9311 | 9311 | 9311 | 9490 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Riz pluvial |
| 1620 Irrigated rice | 1056 | 1056 | 1056 | 1056 | 1056 | 1056 | 1056 | 1056 | 1056 | 1056 | Riz irrigue |
| 1630 Sorghum | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | Sorgho |
| 1650 Maize | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | Mais |
| 1660 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 4050 | 4050 | 4050 | 4050 | 4050 | 4050 | 4050 | 4050 | 4050 | 4050 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 498 | 498 | 498 | 498 | 498 | 498 | 498 | 498 | 498 | 498 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | 1432 | TOTAL PARTIEL, COUTS FIXES |
| 1780 TOTAL OPERATING COSTS | 5482 | 5482 | 5482 | 5482 | 5482 | 5482 | 5482 | 5482 | 5482 | 5482 | COUTS TOTAUX D'OPERATION |
| 1790 GROSS CASHFLOW | 3829 | 3829 | 3829 | 3829 | 3829 | 3829 | 3829 | 3829 | 3829 | 4008 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 | Investissement, developpement agricole |
| 1850 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | 1011 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | 2818 | 2818 | 2818 | 2818 | 2818 | 2818 | 2818 | 2818 | 2818 | 2997 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | 6602 | 9420 | 12238 | 15056 | 17874 | 20692 | 23510 | 26328 | 29146 | 32143 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | 26408 | 37680 | 40952 | 60224 | 71496 | 82768 | 94040 | 105312 | 116584 | 128572 | CASHFLOW CUMULATIF DOLLARS 000 |

TABLE 26

CASE 16

CAS 16

PROJECT SENERIZ PRODUCTION REPORT
(In units and tons)

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1010 COMPLEX PRODUCTION | | | | | | | | | | |
| 1201 Rainfed rice net production | 0 | 988 | 3504 | 7507 | 12856 | 695 | 726 | 726 | 726 | 726 |
| 1211 Irrigated rice net production | 0 | 704 | 2388 | 5192 | 6520 | 103020 | 103020 | 103020 | 103020 | 103020 |
| 1221 Sorghum net production | 0 | 950 | 2667 | 6729 | 11278 | 12744 | 23744 | 23744 | 23744 | 23744 |
| 1241 Maize net production | 0 | 1080 | 2834 | 6657 | 11035 | 12044 | 23004 | 23004 | 23004 | 23004 |
| 1250 Calves purchased | 0 | 300 | 800 | 1500 | 1000 | 10000 | 10000 | 10000 | 10000 | 10000 |
| 1251 Calves sold | 0 | 0 | 300 | 800 | 1500 | 5000 | 10000 | 10000 | 10000 | 10000 |
| 1255 Feeder cattle | 0 | 50 | 300 | 800 | 1500 | 5000 | 5000 | 5000 | 5000 | 5000 |
| 1299 FARMERS PRODUCTION | | | | | | | | | | |
| 1300 Rainfed rice net production | 0 | 33 | 98 | 261 | 526 | 1069 | 2283 | 2283 | 2283 | 2283 |
| 1305 Sorghum net production | 0 | 119 | -177 | 1118 | 2971 | 6526 | 13201 | 13201 | 13201 | 13201 |
| 1310 Millet net production | 0 | 20 | 42 | 171 | 469 | 1022 | 2197 | 2197 | 2197 | 2197 |
| 1315 Maize net production | 0 | 70 | 480 | 1344 | 3168 | 6537 | 12714 | 12714 | 12714 | 12714 |
| 1320 Total cereals production | 0 | 242 | 443 | 2894 | 7134 | 15154 | 30395 | 30395 | 30395 | 30395 |
| 1360 Farmers cattle raised | 0 | 113 | 150 | 697 | 1640 | 3419 | 6743 | 6743 | 6743 | 6743 |

NOTES: 1). Production data for years 1988-2007 are identical to those of 1987.

2) Production data for most other cases are identical to the Base cases.

RAPPORT PRODUCTION DU PROJECT SENERIZ
(En unites et tonnes)

| | |
|---|---|
| | PRODUCTION DU COMPLEXE |
| Production Nette de Riz Pluvial | |
| Production Nette de Riz Irrigue | |
| Production Nette de Sorgho | |
| Production Nette de Mais | |
| Veaux achetes | |
| Veaux vendus | |
| Retail d'engraissement | |
| | PRODUCTION DES FERMIERS |
| Production Nette de Riz Pluvial | |
| Production Nette de Sorgho | |
| Production Nette de Mil | |
| Production Nette de Mais | |
| Production Totale de Cereales | |
| Retail eleve par les fermiers | |

N.B.: 1) Donnees de production pour les annees 1988-2007 sont identiques a ceux de 1987.

2). Donnees de production pour la plupart des cas son identique au cas de base.

PROJECT SEMERIZ FINANCIAL REPORT
(In millions of CFA francs)

CASE 16

CAS 16

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | | | | | | | | | | | |
| 1420 Sorghum sales | 0 | 70 | 245 | 527 | 804 | 4304 | 4305 | 4305 | 4305 | 4305 | Ventes de riz |
| 1440 Maize sales | 0 | 33 | 93 | 236 | 395 | 446 | 831 | 831 | 831 | 831 | Ventes de sorgho |
| 1450 Cattle revenue | 0 | 38 | 99 | 233 | 386 | 422 | 805 | 805 | 805 | 805 | Ventes de mais |
| 1451 Rice mill fees | 0 | 4 | 38 | 101 | 189 | 632 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1470 Farmers grain handling | 0 | 34 | 120 | 259 | 398 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1474 Farmers grain storage | 0 | 2 | 4 | 24 | 60 | 127 | 255 | 255 | 255 | 255 | Commission manutention grain (fermiers) |
| 1475 Complex grain handling | 0 | 0 | 1 | 5 | 13 | 27 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1479 Complex grain storage | 0 | 31 | 96 | 219 | 350 | 1079 | 1264 | 1264 | 1264 | 1264 | Commission manutention (complexe) |
| 1480 Cattle feed sales | 0 | 7 | 20 | 45 | 72 | 217 | 257 | 257 | 257 | 257 | Commission stockage (complexe) |
| 1500 Seed center sales | 0 | 1 | 1 | 7 | 16 | 33 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betail |
| | 0 | 1 | 1 | 2 | 4 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 0 | 221 | 718 | 1658 | 2687 | 8894 | 10303 | 10303 | 10303 | 10303 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 0 | 13 | 42 | 82 | 128 | 7 | 7 | 7 | 7 | 7 | Riz pluvial |
| 1620 Irrigated rice | 0 | 12 | 35 | 71 | 119 | 1058 | 1058 | 1058 | 1058 | 1058 | Riz irrigue |
| 1630 Sorghum | 0 | 11 | 24 | 53 | 82 | 87 | 155 | 155 | 155 | 155 | Sorgho |
| 1650 Maize | 0 | 11 | 25 | 54 | 84 | 88 | 161 | 161 | 161 | 161 | Mais |
| 1660 Cattle costs | 0 | 9 | 35 | 80 | 197 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 0 | 2 | 4 | 13 | 28 | 63 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 0 | 1 | 6 | 8 | 22 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 0 | 5 | 17 | 41 | 75 | 255 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 0 | 3 | 10 | 17 | 44 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 0 | 187 | 385 | 590 | 868 | 1750 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 0 | 254 | 583 | 1010 | 1647 | 3958 | 4195 | 4195 | 4195 | 4195 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 0 | 16 | 21 | 34 | 50 | 61 | 71 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 0 | 141 | 288 | 452 | 710 | 826 | 882 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 0 | 31 | 35 | 40 | 48 | 52 | 55 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 0 | 18 | 18 | 18 | 18 | 18 | 18 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 0 | 46 | 95 | 155 | 247 | 492 | 522 | 513 | 513 | 513 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 0 | 252 | 457 | 699 | 1073 | 1449 | 1548 | 1447 | 1447 | 1447 | TOTAL PARTIEL, COUTS FIXES |
| 1780 TOTAL OPERATING COSTS | 0 | 506 | 1040 | 1709 | 2720 | 5407 | 5743 | 5642 | 5642 | 5642 | COUTS TOTAUX D'OPERATION |
| 1790 GROSS CASHFLOW | 0 | -285 | -322 | -51 | -33 | 3487 | 4560 | 4661 | 4661 | 4661 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 2045 | 3129 | 7178 | 7355 | 7379 | 4374 | 0 | 968 | 968 | 968 | Investissement, developpement agricole |
| 1850 Investment, facilities | 1520 | 500 | 1400 | 3285 | 400 | 0 | 0 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs. | 28 | 34 | 19 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 143 | 161 | 26 | 17 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 3593 | 3806 | 8758 | 10686 | 7796 | 4374 | 0 | 1211 | 1211 | 1211 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | -3593 | -4093 | -9080 | -10737 | -7829 | -887 | 4560 | 3450 | 3450 | 3450 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | -3593 | -7686 | -16766 | -27503 | -35332 | -36219 | -31659 | -28209 | -24759 | -21309 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | -14372 | -30744 | -67064 | -110012 | -141328 | -144876 | -126636 | -112836 | -99036 | -85236 | CASHFLOW CUMULATIF DOLLARS 000 |

PROJECT SENERIZ FINANCIAL REPORT
(In millions of CFA francs)

25, PART 2

CASE 16

CAS 16

RAPPORT FINANCIER DU PROJECT SENERIZ
(En millions de CFA francs)

| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1300 ECONOMIC STRUCTURE | | | | | | | | | | | STRUCTURE ECONOMIQUE |
| 1400 Sales receipts | | | | | | | | | | | Recettes de ventes |
| 1410 Rice sales | 4305 | 4305 | 4305 | 4305 | 4305 | 4305 | 4305 | 4305 | 4305 | 4305 | Ventes de riz |
| 1420 Sorghum sales | 831 | 831 | 831 | 831 | 831 | 831 | 831 | 831 | 831 | 831 | Ventes de sorgho |
| 1440 Maize sales | 805 | 805 | 805 | 805 | 805 | 805 | 805 | 805 | 805 | 805 | Ventes de mais |
| 1450 Cattle revenue | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | 861 | Revenu du betail |
| 1461 Rice mill fees | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | Commission rizerie |
| 1470 Farmers grain handling | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | 255 | Commission manutention grain (fermier |
| 1474 Farmers grain storage | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | Commission stockage (fermiers) |
| 1475 Complex grain handling | 1264 | 1264 | 1264 | 1264 | 1264 | 1264 | 1264 | 1264 | 1264 | 1264 | Commission manutention (complexe) |
| 1479 Complex grain storage | 257 | 257 | 257 | 257 | 257 | 257 | 257 | 257 | 257 | 257 | Commission stockage (complexe) |
| 1480 Cattle feed sales | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | Ventes de nourriture pour le betal |
| 1500 Seed center sales | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Ventes du Centre de Semences |
| 1550 TOTAL REVENUE | 10303 | 10303 | 10303 | 10303 | 10303 | 10303 | 10303 | 10303 | 10303 | 10303 | REVENUE TOTAL |
| 1600 COMPLEX VARIABLE COSTS | | | | | | | | | | | COUTS VARIABLES DU COMPLEXE |
| 1610 Rainfed rice | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | Riz pluvial |
| 1620 Irrigated rice | 1058 | 1058 | 1058 | 1058 | 1058 | 1058 | 1058 | 1058 | 1058 | 1058 | Riz irrigue |
| 1630 Sorghum | 155 | 155 | 155 | 155 | 155 | 155 | 155 | 155 | 155 | 155 | Sorgho |
| 1650 Maize | 161 | 161 | 161 | 161 | 161 | 161 | 161 | 161 | 161 | 161 | Mais |
| 1660 Cattle costs | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | 511 | Cout du betail |
| 1670 Feed mill | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | Usine d'alimentation |
| 1680 Rice mill | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | Couts variables de la rizerie |
| 1690 Grain center | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | 302 | Couts variables du centre de grains |
| 1700 Seed plant | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | Couts variables de l'usine de semences |
| 1710 Service units | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | 1761 | Couts variables des unites de service |
| 1715 SUBTOTAL, VARIABLE COSTS | 4195 | 4195 | 4195 | 4195 | 4195 | 4195 | 4195 | 4195 | 4195 | 4195 | TOTAL PARTIEL, COUTS VARIABLES |
| 1718 COMPLEX FIXED COSTS | | | | | | | | | | | COUT FIXE DU COMPLEXE |
| 1720 Aid program for farmers | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | Assistance aux fermiers |
| 1725 Complex fixed expenses | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | Depenses fixes du complexe |
| 1730 Complex fixed overhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | Frais generaux du complexe |
| 1740 Research and development | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | Recherche et developpement |
| 1765 Contingency | 513 | 513 | 513 | 513 | 513 | 513 | 513 | 513 | 513 | 513 | Imprevus |
| 1775 SUBTOTAL, FIXED COSTS | 1447 | 1447 | 1447 | 1447 | 1447 | 1447 | 1447 | 1447 | 1447 | 1447 | TOTAL PARTIEL, COUTS FIXES |
| 1790 TOTAL OPERATING COSTS | 5642 | 5642 | 5642 | 5642 | 5642 | 5642 | 5642 | 5642 | 5642 | 5642 | COUTS TOTAUX D'OPERATION |
| 1799 GROSS CASHFLOW | 4661 | 4661 | 4661 | 4661 | 4661 | 4661 | 4661 | 4661 | 4661 | 4661 | CASHFLOW BRUT |
| 1840 Investment, ag. development | 968 | 968 | 968 | 968 | 968 | 968 | 968 | 968 | 968 | 968 | Investissement, developpement agricole |
| 1850 Investment, facilities | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | 243 | Investissement, installations |
| 1855 Training programs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Programmes de formation |
| 1861 Working capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Investissement des fonds de roulement |
| 1870 TOTAL CAPITAL INVESTMENT | 1211 | 1211 | 1211 | 1211 | 1211 | 1211 | 1211 | 1211 | 1211 | 1211 | INVESTISSEMENT TOTAL DES FONDS |
| 1880 PROJECT CASHFLOW | 3450 | 3450 | 3450 | 3450 | 3450 | 3450 | 3450 | 3450 | 3450 | 3450 | CASHFLOW DU PROJET |
| 1881 CUMULATIVE CASHFLOW | -17859 | -14409 | -10959 | -7509 | -4059 | -609 | 2841 | 6291 | 9741 | 13191 | CASHFLOW CUMULATIF |
| 1883 CUMULATIVE CASHFLOW DOLLARS 000 | -71436 | -57636 | -43836 | -30036 | -16236 | -2436 | 11364 | 25164 | 38964 | 52764 | CASHFLOW CUMULATIF DOLLARS 000 |

# CHAPTER 13 : FINANCIAL STRUCTURE

13.1. INTRODUCTION

13.2. NOTES ON THE CONTEXT OF PROJECT FINANCING

13.3. AMORTIZATION AND DEPRECIATION

# CHAPTER 13 : FINANCIAL STRUCTURE

## 13.1. INTRODUCTION

The sources and amounts of financing for Project SENERIZ are still uncertain at the time of preparation of this report. Much progress has been made; a number of interested sources have been identified and contacted, and encouragement and promises received. However, no firm commitments have been made, pending the availability of the report of the pre-investment study.

In the absence of data on terms and conditions of loans, it is not possible to draw up either a profit and loss statement or a statement of sources and uses of funds. However, a schedule of yearly depreciation charges on capital equipment, one of the elements necessary for a profit and loss statement, has been prepared and is presented as Table 13.3.

## 13.2. NOTES ON THE CONTEXT OF PROJECT FINANCING

Despite the fact that no absolute commitments have been made regarding the funding of Project SENERIZ, a number of relevant statements can be made concerning the need, possible sources and general guidelines for project financing :

The size and scope of the project both creates and solves financing problems. The amount of funds required, in relation to the total Senegalese budget, dictates that the project be funded from one or more loans, rather than out of current operating funds. On the other hand, the very magnitude of the project, and its considerable

impact on the rice deficit, as well as on the economy of the Upper Casamance and all of Senegal, guarantee that a significant opportunity is made available to the lender or lenders to benefit a desrving nation, and to participate in a project that will have real impact.

In view of planned implementation of project SENERIZ by a Senegalese society, of which majority ownership and control belong to the government, a Government guarantee of repayment of borrowed funds is likely to be available. In view of the nature of the collateral (security) which the project could offer for the borrowed funds, a Government guarantee is almost certain to be required.

The private capital market in Senegal is almost certainly not capable of supplying the necessary funds. However, it is not unreasonable to expect that local banks might participate in the project, particularly for the financing of some of the local costs.

The rate of return calculated for the project cashflow before financing, at 7.53% for the base case and a maximum of 9.74% for the best of the modified versions studied in the sensitivity analysis, is insufficient to attract loans on purely commercial terms.

The most probable sources of foreign funds in the amounts required would seem to be international lending agencies specializing in loans at concessional rates, and foreign governments that have concessional lending programs. Examples of the former are the International Development Association and the African Development Bank. Examples of the latter are the Saudi Fund for Development, the Development Loan Fund of the European Economic Community, and the "soft" loan programs of the United States Agency for International Development and the Canadian International Development Agency.

Whatever "soft" loans or grants are obtained for funding the project will facilitate the remaining financing. To illustrate the arithmetic of this concept, suppose that half the funds required were made

available as a zero-cost loan or grant. The rate of return of 7.53% calculated for total project investment would be approximately doubled if the returns could be allocated to paying off only half as much borrowed money. Conceivably, the project, if it received concessional rates or grants for a substanital portion of its needs, could cope with commercial terms for the remainder of the funds needed.

## 13.3. AMORTIZATION AND DEPRECIATION

Table 13.3. exhibits the annual depreciation charges on capital equipment. The buildings housing the processing units are assumed for the most part to have a 20-year life, while the transportation equipment, including farm tractors, automobiles, busses, and trucks, are assumed to have a five-year life.

In addition to depreciation of items included in the initial investment program, it is estimated that, beginning in Year 8, replacement of some part of the equipment would have to begin. Thus, an annual capital investment of CFA 1,011 million is shown beginning in the eighth year.

x

x x

TABLE 13.1. Depreciation and Amortization (in thousands of CFA francs)

| | Investment | Life (yrs) | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 |
|---|---|---|---|---|---|---|---|
| Studies | 213 150 | 15 | 10 933 | 14 210 | 14 210 | 14 210 | 14 210 |
| Pumps | 36 000 | 10 | 3 600 | 3 600 | 3 600 | 3 600 | 3 600 |
| Irrigation equipment | 150 000 | 10 | 15 000 | 15 000 | 15 000 | 15 000 | 15 000 |
| Generators | 500 000 | 10 | 20 000 | 40 000 | 50 000 | 50 000 | 50 000 |
| Shop equipment | 1 500 000 | 20 | 10 000 | 20 000 | 35 000 | 55 000 | 75 000 |
| Cereals processing center | 4 440 000 | 20 | 50 000 | 50 000 | 100 000 | 222 000 | 222 000 |
| Seed plant | 70 000 | 20 | 3 500 | 3 500 | 3 500 | 3 500 | 3 500 |
| Rice mill | 450 000 | 25 | 2 000 | 4 000 | 4 000 | 18 000 | 18 000 |
| Farm machinery | 3 000 000 | 5 | 26 000 | 80 000 | 180 000 | 300 000 | 460 000 |
| Feed plant | 145 000 | 10 | - | - | - | 14 500 | 14 500 |
| Transport equipment | 477 500 | 5 | 15 660 | 25 460 | 36 080 | 49 080 | 80 800 |
| Engineering | 642 000 | 15 | 7 800 | 42 800 | 42 800 | 42 800 | 42 800 |
| Dam and reservoir | 3 000 000 | 30 | - | | 50 000 | 100 000 | 100 000 |
| Irrigation system | 3 900 000 | 20 | - | - | 97 500 | 195 000 | 195 000 |
| Land development | 15 000 000 | 20 | 30 000 | 90 000 | 210 000 | 360 000 | 570 000 |
| Training programs | 102 500 | 15 | 1 830 | 4 207 | 5 500 | 6 833 | 6 833 |
| Road building equipment | 270 000 | 5 | - | 54000 | 54 000 | 54 000 | 54 000 |
| Totals | 33 897 000 | | 196 323 | 446 777 | 901 190 | 1 503 523 | 1 925 243 |

$ 135,600 ~ =

| | Year 7 | Years 8-16 | Year 17 | Year 18 | Year 19 | Years 20-30 |
|---|---|---|---|---|---|---|
| Studies | 14 210 | 14 210 | 3 277 | - | - | - |
| Pumps | 3 600 | 3 600 | 3 600 | 3 600 | 3 600 | 3 600 |
| Road building equipment | 54 000 | 54 000 | 54 000 | 54 000 | 54 000 | 54 000 |
| Irrigation equipment | 15 000 | 15 000 | 15 000 | 15 000 | 15 000 | 15 000 |
| Generators | 50 000 | 50 000 | 50 000 | 50 000 | 50 000 | 50 000 |
| Shop equipment | 75 000 | 75 000 | 75 000 | 75 000 | 75 000 | 75 000 |
| Cereals processing center | 222 000 | 222 000 | 222 000 | 222 000 | 222 000 | 222 000 |
| Seed plant | 3 500 | 3 500 | 3 500 | 3 500 | 3 500 | 3 500 |

(Year 7 - 30 continued next page)

TABLE 13.1. Depreciation and Amortization (conclusion)

| | Year 7 | Years 8-16 | Year 17 | Year 18 | Year 19 | Years 20-30 |
|---|---|---|---|---|---|---|
| Rice mill | 18 000 | 18 000 | 18 000 | 18 000 | 18 000 | 18 000 |
| Farm machinery | 574 000 | 574 000 | 574 000 | 574 000 | 574 000 | 574 000 |
| Feed plant | 14 500 | 14 500 | 14 500 | 14 500 | 14 500 | 14 500 |
| Transport equipment | 80 800 | 80 800 | 80 800 | 80 800 | 80 800 | 80 800 |
| Engineering | 42 800 | 42 800 | 35 000 | - | - | - |
| Dam and reservoir | 100 000 | 100 000 | 100 000 | 100 000 | 100 000 | 100 000 |
| Irrigation system | 195 000 | 195 000 | 195 000 | 195 000 | 195 000 | 195 000 |
| Land development | 750 000 | 750 000 | 750 000 | 750 000 | 750 000 | 750 000 |
| Training programs | 6 833 | 6 833 | 5 003 | 2 627 | 1 333 | - |
| Totals | 2 219 243 | 2 219 243 | 2 198 680 | 2 158 027 | 2 156 733 | 2 155 400 |