Guidimaka Integrated Rural Development Project

Selibaby, Republic Islamic of Mauritania

# FINAL REPORT OF THE AGRONOMY DIVISION

(Agricultural Seasons 1981-82 and 1982-83)

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GUIDIMAKA INTEGRATED RURAL DEVELOPMENT PROJECT

# Final Report, Agronomy Division

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## I. Introduction

1. The main objective of the Agronomy Division is to perform research and widen the use of technically appropriate, cost-efficient and socially feasible methods in order to improve the productivity of major crops in the Project's Zone d'Intervention Directe (ZID). An analysis of the results obtained over the past two years in the areas of agricultural research and extension can be used to make recommendations for future agricultural development in the Region. The results are provided in detail in the two annual reports (81 and 82) of the Agronomy Division.

2. The technical recommendations in this report are of a practical nature and are widely accepted by hundreds of small farmers who have participated in the Project in the ZID. To a great extent, the recommendations can be applied throughout the entire Region. It is only necessary to simply expand agricultural extension beyond the ZID so that every small farmer in the Region may use the improved techniques.

3. In the first phase of the project, ending in June 1983, the techniques that have been recommended are simple, inexpensive, make limited use of animal traction for farming operations (almost exclusively for plowing) and are available within the limited resources of the majority of farmers in the area. These techniques have demonstrated a marked improvement in crop yields; however, to attain the food self-sufficiency objective for the entire Region, a second phase will have to be planned, in which the methods being used must be disseminated. In addition, more advanced techniques will be tested, such as development of land parcels for farming, maintenance of soil fertility, erosion control, use of improved seeds and varieties, etc. Finally, the development of animal traction cultivation will be

supported through an agricultural credit system and through structured organizations at the village level.

4. This final report supplies all basic information required to direct future activities in the second phase of agricultural development in the Guidimaka Region.

## II. Impact of Certain Factors on Agricultural Production in the Region

5. First of all, it is essential to mention the climate factor, which all existing crops depend on. The Guidimaka Region has a Sahelian climate with three distinct seasons in a given year: the dry and cool season from November to February, a dry and hot season from March to June, and a wet and hot season from July to October. The latter is also known as the rainy season. The implications of these seasonal characteristics are as follows:

- a rainy period that lasts 3 to 4 months during the hot and wet season, mainly for grain and food crops.

- a vegetable crop production period during the dry and cool season.

- a period when no crops are grown during the dry and hot season.

It should also be noted that during the rainy season, the amount and distribution of rainfall, winds and high temperatures may have harmful consequences for these crops.

6. Rainfall, an essential factor for agriculture in the Region, has been sorely lacking in the past few years. The Region gets about 500 to 600 mm of annual rainfall during a normal year. Yet, and for several years now, the lower figure of 500 mm per year has barely been reached. Besides the low rainfall rate, the rainfall pattern is erratic: the rain falls in brief showers which gives rise to significant surface water runoff, then stops, sometimes for rather long periods of time, and crops suffer from drought.

7. The winds are usually very strong. In a region where the land has become more and more denuded, this can cause great damage to agriculture. To mention a few of the more important types of damage, the winds induce sandy soil erosion, contribute to increased evapo-transpiration and cause cereal plants to fall over.

8. The generally high temperatures during the rainy season cause intense evapo-transpiration. This brings about a significant loss in the soil's moisture content.

9. Agriculture in the Region also depends on another important factor: soil. There are three major soil types, distinguished by their nature and fertility:

- Clayey soil (Katamangué type), of which about 50% is clay and more than 1% is organic matter. This soil is able to hold a substantial amount of water and can be considered as good soil for sorghum. This type of soil, however, must be plowed intensively to enable greater infiltration of water as soon as the first rains fall.

- Sandy soil (Singha type), of which about 65% is white sand and 1/2 of one percent is organic matter. It retains only

small amounts of water and is appropriate for early sorghum, pearl millet, cowpeas and groundnuts.

- Sandy-clayey soil (Niarouwallé type), with an average of 20% clay, 30% white sand and less than 1% organic matter, is appropriate for any crop on the condition that it has been sufficiently plowed.

Furthermore, different intermediate soil types exist among these three major types.

In topographical terms, these three types of soils and the intermediate soil types are found at high altitudes, on slopes or in lowlands. In general, the lowlands are most cultivated because they provide higher yields owing to the accumulation of organic matter and moisture.

10. Cultivation is still done by traditional methods. Animal traction remains somewhat unknown and underdeveloped. The result of this is that the average sorghum yield is approximately 800 kg/ha (according to the 1981 estimate). However, this technical void will soon be filled because of the willingness and aggressive interest of the Region's small farmers.

## III. Improvement of Major Crops in the Region

### 11. Sorghum

In the food grain category, more sorghum is grown than any other crop in the Region. With regards to consumption, however, sorghum is far from being the most important staple food. Improving sorghum production is therefore the first goal to be reached in order to attain food self-sufficiency.

12. There are four main local varieties of sorghum, as follows: two early varieties (76 and 80 days), Sidi Niéléba and Samba Diénéba; a semi-early variety (105 and 115 days), Nébané; and a late variety (115 and 125 days), Fellah. The local population prefers Fellah, despite its longer growing season, because it yields more than the other varieties (as long as there is no drought) and its food value is higher (makes for more flour). The two early varieties, Sidi Niéléba and Samba Diénéba, however, are being grown more and more because of insufficient rainfall and to meet grain needs in periods of greater demand. With enough rainfall and improved cultivating methods, all local varieties can produce up to 2 tons/hectare.

13. Traditional cultivating methods are still largely practiced by the small farmers of the Region. These include:

- Clearing the land and leaving trees and stumps behind. Stubble from weeds or stalks (if the field has previously been cultivated) are gathered and burned.

- Sowing by hand in the traditional manner, i.e. scattering seed irregularly and in every direction. The number of seeds per hole often exceeds ten.

- Weeding as soon as the seeds have germinated. It should be noted that weeding by hand is an extremely cumbersome and time-consuming task. Moreover, there is often a bottleneck during the weeding period, which prevents the small farmers from engaging in other agricultural operations such as thinning and reseeding. In many cases, weeding cannot be finished early enough to keep weeds from crowding out the young plants. When weeding, the small farmers gather and stack the weeds on ridges of earth between seed holes. On slopes, if the ridges

are laid out perpendicular to the slope they can retain a large amount of water which in turn benefits the plants.

- Thinning and reseeding missed areas. Proper thinning, i.e. leaving 2 to 3 plants per seed hole, is a practice not very well known to farmers. In addition, reseeding missed areas is often done too late to yield good results.

Where traditional methods are used, the average yield for sorghum is estimated at 800 kg/ha. The demonstration plots where improved methods were used during the 1981 and 1982 cropping seasons showed an average increase in yield of 50%.

14. Improving sorghum production depends primarily on increasing the yield of this crop. Improved methods which have been tested, taught and recommended to small farmers are:

1) Clearing arable land: All stumps must be removed if the soil is to be plowed. The stubbles are either left where they are or turned under when the soil is plowed. It is better not to burn the fields, as burning can cause deterioration of the arable layer by destroying the organic matter that is already there.

2) Plowing the soil: In rainfed areas, plowing has the dual advantage of improving soil structure and allowing for significant water filtration into the ground. On slopes, plowing rows perpendicular to the slope can partially stop surface water runoff, thereby limiting soil erosion. Depending on the type of soil and the amount of traction power the small farmer has, plowing at depths of 10 to 20 cm is recommended. In a field trial on the clayey soil of Katamangué, a parcel plowed at a depth of 15 cm yielded 15% more than an unplowed parcel, even though improved methods were used on both plots. It was

also observed that plants are usually greener and are less adversely affected by drought on plowed parcels. Plowing the soil has yet another advantage with regards to weed control. On lowlands where weeds grow very quickly with the first rains, plowing destroys the weeds and makes the soil less subject to weed growth later, which obviously facilitates weeding.

3) Use of pure seeds: It is custom for farmers to select their better seed and save them for the next planting season. Generally, seed selection is based on the size of the panicle and good grain formation, with no consideration for varietal purity. The advantage in using pure seed is being able to conserve the uniformity and productivity of the variety used. Pure seed therefore contributes to increased quantity and quality of crops. High yielding varieties, recently introduced, will degenerate from year to year (when mixed with local varieties) and yield less and less if there is no system of production and distribution (or exchange) for pure seed. While awaiting the organization of such a system at the village level, small farmers should be trained and guided in producing their own pure seeds. They could either select the better panicles from their fields all the while taking into account varietal pure, or produce the seeds in a separate plot and eliminate all panicles which are not of the variety being used.

4) Planting with improved cultivation methods will differ from traditional planting in the following ways:

| | Traditional Method | Improved Techniques Recommended |
|---|---|---|
| Seeding pattern | In every direction | In rows. On slopes, rows must be perpendicular to the slope |
| Spacing | Vary, 50 to 80 cm between seed holes | 1 meter between rows 30-50 cm between plants/seeds |
| Number of seeds per hole | 10 and over | average of 5 |
| Seeding depth | Will vary according to the small farmers | 3 to 5cm |
| Seeding date | Will vary according to individual experience | As early as possible taking into account the possibility of reseeding. |

5) Thinning and reseeding: Thinning entails removing young shoots once they have attained a growth stage of 3 to 4 leaves and leaving 2 to 3 plants per seed hole. Thinning reduces evapo-transpiration since the number of plants has been scaled down, and permits the remaining plants to grow larger panicles with well formed grains, therefore making for a better yield. In traditional cultivation, the small farmers often neglect thinning, either out of ignorance or because the thinning period coincides with the weeding season and they prefer weeding to thinning. They must thus be convinced to perform both weeding and thinning simultaneously.

Reseeding those areas where the first planting failed should be done as soon as possible; young plants grow quickly and they develop better.

6) Weeding, dressing and ridging: Weeding is the most important of all upkeep tasks and occupies the better part of the work day for the small farmer and his family. The first weeding should be done as soon as possible, immediately after the sorghum has germinated. In the lowlands, weeding must be done before seeding as weeds start to grow as soon as the first rains have fallen and very often smother the young sorghum plants if carried out too late.

Plowing before planting destroys most weeds, permitting the farmer to reduce the amount of time and labor in subsequent weedings. Weeding can also be done at a later stage with animal traction, which method is both time and labor efficient.

The second weeding followed by dressing is often necessary to keep the field clean and to facilitate water filtration into the ground.

Weeding may be followed by a ridging which serves to protect plants against downpours once they have attained a certain height and to maintain a certain humidity level at the base of plants. The farmers usually gather the weeds onto a ridge between plants. This practice is useful in that it retains rainwater, on the condition that the ridges are perpendicular to the slope. It is an even better practice to place the ridges nearer or onto the plants themselves and perpendicular to the slope.

7) Ridging: A great percentage of sloped land is planted in sorghum. Yields are usually low because of insufficient water filtration into the ground due to runoff. Erosion also leaves the soil impoverished.

In demonstration trials, at the Project experimental site and on farmer fields, where sorghum plants were ridged, there was a 40% yield increase and a clear difference was noted in vegetative growth. In addition, the ridged plants are less prone to being carried away by runoff water.

In order to obtain good results, the ridges must lie perpendicular to the slope and be spaced at one meter (recommended for sorghum) or at two meters if seedbeds are made on or between them. In the case of making seedbeds, the ridges should measure 30 to 40 cm from the base and about 30 cm in height.

The ridges can be made either by hand with a 'daba', or with a plow. Weeding and earthing up planted ridges should be done simultaneously.

Fields where ridge cultivation is used are less subject to weed invasion (plowing and ridging destroys most weeds). Consequently, the farmers spend less on weeding. The number of work days ordinarily devoted to weeding non-ridged fields will cover the total number of work days for ridging and weeding where ridge cultivation is used.

Ridge cultivation is thus a simple and inexpensive method which can make for increased agricultural production by improving crop yields, and increased cultivated acreage, especially on sloped land usually left fallow.

8) Use of high yield varieties: Local varieties presently cultivated in the Region are the following:

| Variety | No. of Days (planting to harvest) | Stalk | Panicle | Grain | Average yield (with improved practices) | Grain quality | Comments |
|---|---|---|---|---|---|---|---|
| **Sidi Nieleba** | 70-80 | Thin/ slender 2m20 | Very loose | Small, white | 1,000 to 1,500 kg/ha. | Of low value (not very floury) | Cultivated for its short season and consumption before the main harvest |
| **Samba Dieneba** | -id- | -id- | -id- | -id-, with black hull | -id- | -id- | |
| **Fella** | 115-125 | Big, 2m30-2m50 | Compact, bent at base | Med. to large; white, yellow, red | 2,000 kg/ha | Floury, of high value | Grown more than any other variety for its commercial value and high yields |
| **Nebane** | 105-115 | Big, 2m20-2m30 | Looser than Fella, bent at base | White, pink, yellow red | 1,500 to 2,000 kg/ha | Of highest value after Fella | Grown for its commercial quality and shorter season as compared to Fella |

As a general rule, these varieties do not exist in pure form, but are more or less mixed (Sidi Nieleba with Samba Dieneba, Fella with Nebana). With regards to the Falla and Nebane varieties, many types exist and are differentiated by the form of the panicle, grain color and to a lesser extent, by plant height.

Varietal improvement can be accomplished by selecting the purer Fella and Nebane varieties which yield better than the mixed varieties presently cultivated by the small farmers.

In addition, the introduction of new varieties could also give a number of varieties superior to the local varieties. The objective in selecting newly introduced varieties is to find varieties with the following qualities:

- early maturation, about 100 days from seeding to harvesting
- tolerance to drought
- short to medium height and resistant to downpours
- Striga-resistant
- disease resistant, especially to blight
- average yield for large plots: more than 2 tons/hectare
- good taste (comparable to Fellah).

Field trials with new varieties, performed over a two-year period, yielded the following results:

1) Three varieties that satisfied selection criteria were selected for extension. These were E 35-1, KPV 5 and CE 151, the first of which had already proven to be successful in production plots and was already in demand by farmers. There

is a sufficient quantity of E 35-1 seed for distribution starting next year. The E 35 variety will be recommended for use in the lowlands and for ridge cultivation on sloping land.

2) About ten other varieties have been retained for continued experimentation next year, a few will surely be selected and added to the three previous ones.

3) The hybrid variety H8110 of the Asgrow Seed Company in Italy has met the selection criteria and yielded over 3 tons per hectare on a production plot. Unfortunately, this variety will not be used in extension activities because of difficulty in producing seeds locally.

4) Three varieties are promising from the standpoint of resistance to Striga and have been selected for extension activities beginning next year. These are varieties IS 2814, IS 8686 and IS 115 from ICRISAT/Upper Volta where they have been used experimentally for two years.

15. Pearl millet

Pearl millet, not to be confused with the local name "mil" which is sorghum, is the second most widely grown cereal after sorghum. In some cases, pearl millet can replace sorghum in the preparation of couscous as a basic food. However, pearl millet is not as widely grown as sorghum because of one major problem: Spanish flies attack it.

In agronomic terms, pearl millet is better adapted to semi-arid climates and soil conditions than sorghum. It resists drought, grows sufficiently early to produce under little rainfall conditions, and although it does better in sandy soil, it adapts just as well to clayey soil. If an efficient and in-

expensive method of controlling Spanish flies could be found, pearl millet acreage would increase significantly.

16. The most widely grown variety of pearl millet at present is Souna III, introduced by the project several years ago. This variety is rather well known in other Sahelian countries. It is quite productive and can yield up to 2 tons per hectare when improved methods are used. It is of good quality for couscous which constitutes the most widely consumed product at the local level.

17. The cultivating methods used for growing pearl millet are almost the same as those traditionally used for growing sorghum. Given this similarity in traditional methods, plus the Spanish fly pest problem, the small farmers barely obtain more than 500 kg per hectare.

18. Steps to improve pearl millet production can be taken both by increasing the total cultivated area and by using improved methods.

Expanding pearl millet acreage should be encouraged to reduce the risk of losing a major food crop to drought, as is the case with sorghum monoculture. However, expanding/increasing the area used for growing pearl millet is possible only if an effective method can be found to combat Spanish flies.

As for cultivation practices, improved methods recommended for growing sorghum are almost totally applicable to pearl millet, except that pearl millet requires a spacing of one meter between rows and 50 cm to one meter between plants.

19. Cowpeas

Cowpeas are leguminous food plants grown during the rainy season for seed consumption, and as vegetable crops for leaf consumption.

When grown during the rainy season, cowpeas are always cultivated in association with sorghum. The two seeds are sown together. This method of mixed planting has a few advantages; for the cowpeas, which benefit from the care given to the sorghum, and for the sorghum itself, which benefits from soil enrichment provided by the cowpeas.

During the vegetable crop season, cowpeas are grown either in gardens where watering is available, or on lowlands where the soil still contains moisture. The leaves are harvested several times while the plant is growing.

20. Techniques for improving cowpea cultivation are as follows:

- Introduce and select more productive varieties for seed production. The Agronomy Division chose several high yielding varieties in 1981; unfortunately all the stored seeds were totally destroyed by insects, so that the variety trial was unable to continue in 1982.

- When planted in association, cowpeas should be planted between the sorghum plants. Cowpeas develop better and are used as cover plants to prevent weed growth.

- Find a method to control the insects that damage stored grain.

21. Groundnuts

Groundnuts are more important than cowpeas since groundnut consumption increases as groundnut production increases. Groundnuts are used as human food whereas the chaff and shells are used for animal feed.

22. It is quite possible to increase groundnut production to meet consumption requirements due to certain conditions that favor development of this crop, such as:

- High, sandy ground, too marginal for growing other crops, can be used for growing goundnuts. The example of the Singha Region can be mentioned, where a large area of sandy soil, abandoned for several years, was used during the last rainy season by the small farmers to grow groundnuts as a result of the demonstration at the Project experimental site.

- Sloping, sandy soil, rendered poorer and poorer by erosion, and not very adequate for other crops, is conducive to groundnut cultivation.

- The groundnut plant requires little water and can adapt to the Region's semi-arid climate even when there is little rainfall.

- Contrary to cowpeas, groundnuts do not seem to attract insects that cause damage to stored plants and seeds.

23. Where traditional growing methods are used, the average groundnut yield is estimated at approximately 600 kg/ha unshelled. According to observations made in small farmers' fields and the results obtained from experimental sites, it is estimated that the average groundnut yield could exceed 1,000

kg/ha if the small farmers applied the following technical improvements:

- Soil preparation, either with a plow or by deep scraping. On sandy soil, plowing or scraping the surface down to 10 cm is recommended. On slopes, cultivation in ridges perpendicular to the slope is necessary.

- Seeding in straight rows with 60 cm spacings between rows and from 30 to 40 cm spacing between plants. Row seeding can be done either by hand, with a one-row seeder or with a large multi-seeder. Row seeding makes for easier maintenance.

- Upkeep by weeding and ridging. Weeding must be done two or three times, from the time the groundnuts sprout to flowering. Ridging, when performed early enough, i.e., before or at the time of flowering, promotes fructification. Maintenance operations must cease after flowering so that fructification is not jeopardized.

- Use of selected edible varieties through the introducing and selection of foreign varieties. Introducing and testing the behavior of edible varieties in Senegal began only with last year's rainy season. Several promising varieties were chosen for continuing the trials next year.

24. Vegetable crops

Vegetable cropping has become more and more important in the Region. In Selibaby itself, vegetable production, previously unimportant but for a few crops grown traditionally, has clearly increased since the Project began. Vegetable cropping was developed, and has rapidly expanded to several villages in the past two years. The success of vegetable cropping in Selibaby and its surroundings is largely due to a number of favorable factors, such as:

- Favorable climate during the cool and dry season.

- Local population need for fresh vegetables to improve the quality of daily meals.

- Small farmer interest in supplemental income generated by the sale of vegetable produce.

- Effective technical assistance provided to the farmers by the Project.

- Availability of manual labor and well water during the vegetable growing season.

25. The objective of the Project regarding its vegetable component is to promote production and consumption of fresh vegetables throughout the Region. This objective was reached in Selibaby and in several villages because of the following concrete activities:

- Introduction and testing of species and varieties well adapted to agricultural extension efforts. The species now being grown include several varieties of tomatoes; several varieties of lettuce; white-heart cabbage; carrots; several varieties of onions; several varieties of eggplant; leeks; turnips; red beets; peppers; turnip cabbage; radishes; watermelon; melons and potatoes.

- Planted a demonstration garden in Selibaby and set up demonstration plots on land owned by small farmers to provide assistance in cultivation methods and to extend different vegetables.

- Distributed seeds and plants for re-planting to encourage participation from a larger number of farmers. Plant distribution is intended to assist a number of farmers who are unable to make seedbeds or who have not succeeded with their seedbeds because of damage caused by insects and animals.

- Provided technical and follow-up support to all individual and collective vegetable gardens. Animation/extension agents and skilled workers either remained at the site or were sent in mobile teams to villages to ensure that the advise was in fact provided.

- Organized demonstration sessions on methods of preparing vegetables for consumption, as the small farmers are not familiar with certain vegetable garden species.

- Supplied the collective gardens with cement, rods and barbed wire for constructing watering holes and putting up fences.

26. For the vegetable growing season of 1981-1982:

- All vegetables were planted on 120 plots in the Project demonstration garden. Farmers from several villages receiving assistance visited the Project garden and learned vegetable cultivation practices.

- Project technical assistance was provided to 6 collective and 42 individual gardens in Selibaby and ten villages.

- The results of the campaign exceeded all expectations. Success in those villages not previously acquainted with growing vegetables generated much interest in the villagers, many of whom have indicated a desire to grow vegetables during the next campaign. In Selibaby, the results were mani-

fested by a striking decrease in the quantity of fresh vegetables that came in from Bakel, Senegal, and Kayes, Mali. The average price of fresh vegetables on the Selibaby market decreased from UM 70/kg to 50/kg. A head of lettuce that used to sell for UM 20 cost UM 10.

- The 1982-83 vegetable cropping season yielded better results as compared to the previous year. The number of individual and collective gardens nearly doubled in Selibaby and the villages included in the project. Six other large villages, Guémou, Chaggar, Bouli, Oulyengé, Kankossa 2 and Daffort, were added to those already participating, with 6 collective gardens and twenty or so individual gardens assisted by the Project. All of the new villages have great potential for vegetable production and are important consumption and marketing centers for vegetables.

27. The vegetable program yielded positive and concrete results in Selibaby and in several villages inside and outside the ZID. The program's success has enabled the Project to gain more confidence from the local farmers and has also enabled the farmers to improve the quality of their daily meals. Lastly, it has enabled them to earn additional income by selling vegetables.

The program could be expanded to all of the large urban centers and villages of the Guidimaka Region in the coming years if the following appropriate measures are adopted:

- The number of animation/extension agents and skilled workers must be increased and the new mobile teams must be trained to meet requirements for extension and technical assistance to future vegetable growers.

- The vegetable growers require assistance in purchasing seeds and equipment.

- Methods of processing and on-site preservation and storage of produce must be tested and training provided to avoid losses where perishables are concerned.

- Surplus produce on local markets must be exported to greater consumption centers.

## IV. Animal Traction Development

28. Animal traction plays a very important role in countries where agricultural methods are still traditionally practiced. Introducing animal traction in such countries can give rise to a virtual technical and socio-economic revolution at the small farmer level. In effect, animal traction allows farmers to produce more in less time, at lower cost and with less physical effort. In the Guidimaka Region, animal traction has the following advantages:

- Animal traction can be used to deploy improved techniques such as plowing the soil, ridge cultivation on slopes, row seeding, weeding (or weeding-dressing) and ridging, which are generally practiced on all soil types. Animal traction thus contributes to increased crop yields.

- Animal traction requires less time for cultivating activities, which enables the farmers to increase his acreage and to sow early enough to escape the drought that frequently comes at the end of the rainy season.

- Animal traction uses less manual labor and makes for increased labor efficiency which means higher yields at lower production costs.

- In addition to cultivation, animal traction power is used for pumping/hauling water for herds and for transporting water in carts. Such uses generate important income for animal traction enterprises.

- Finally, investing in cattle as part of an animal traction enterprise is always profitable because after 5 years of labor, the oxen can be sold at a higher price, in proportion to weight gain.

29. Estimates of the profitability of animal traction. These estimates are based on:

- 15 work days per year for plowing (the 15 day limit is set on the basis of the short rain period);

- 100 work days per year for transportation (if the number of work days for transportation increases, returns will be greater);

- 3 work days to plow one hectare (animal traction).

A. Profitability of The Animal Traction Enterprise:

1) 1982 investment:

| | |
|---|---|
| - 2 oxen: | UM 16,000 (can be sold in five years for UM 21,000) |
| - One 8" plow | UM 6,500 |
| - 1 oxen cart | UM 17,000 |
| Total | UM 39,500 |

2) Total yearly expenditures:

| | | |
|---|---|---|
| - Depreciation of the plow 5 years | $\frac{\text{UM } 6{,}500}{5}$ = | UM 1,300 |
| - Interest, 10% per year | | 130 |
| - Cart depreciation 5 years | $\frac{\text{UM}17{,}000}{5}$ = | 3,400 |
| - Interest, 10% per year | | 340 |
| - Feed for oxen: | | |
| 270 days, grain: UM 15x4kgx270 | | 16,200 |
| 270 days, straw: UM 2x12kgx270 | | 6,480 |
| (90 days grazing) | | |
| - Labor: | | |
| Plowing: UM 200 x 2 x 15 days | | 6,000 |
| Transportation: 200 x 100 days | | 20,000 |
| Total | | UM 53,850 |

3) Cost of One Day of Plowing:

| | | |
|---|---|---|
| - Plow depreciation and interest | $\frac{\text{UM } 1{,}300 + 130}{15}$ = | 95 |
| - Feed for oxen: | | |
| Grain (30 days): | $\frac{15 \times 4 \times 30}{15}$ = | 120 |
| - Straw (30 days): | $\frac{2 \times 12 \times 30}{15}$ = | 48 |
| - Laborers: UM 200 x 2 | | 400 |
| - Profit for the enterprise: | | 200 |
| Total | | UM 863 |

4) Cost of one day of transportation:

- Depreciation, cart and interest $\frac{\text{UM } 3{,}400 + 340}{100}$ = UM 37
- Feed for oxen:
  - Grain (240 days) $\frac{\text{UM } 15 \times 4 \times 240}{100}$ = 144
  - Straw (240 days) $\frac{\text{UM } 2 \times 12 \times 240}{100}$ = 58
- Laborer: UM 200 x 1 200
- Profit for the enterprise: 300

Total UM 739

5) Earnings per year:

- Plowing: UM 863 x 15 = UM 12,945
- Transportation: 739 x 100 = 73,900

Total UM 86,845

6) Profit per year: UM 86,845 - UM 53,850 = UM 33,000

B. Profitability of One Hectare Plowed Using Animal Traction

- Yield using traditional method: 800 kg/ha
- Yield with plowing and improved methods: 1,200 kg/ha
- Increase: Yield: 400 kg/ha
  Income: UM 15 x 400 = UM 6,000
- Cost for one hectare plowed:
  UM 863 x 3 days UM 2,590
- Profit: UM 6,000 - UM 2,590 = UM 3,410

30. Two surveys performed with two farmers in Soufi and in Selibaby provide the following examples of profitability:

1) In Soufi, Mr. Mohamed Ould Lehbib:

| | |
|---|---|
| <u>1982 Investment</u> (payable in two years, 82 and 83): | |
| -A team of trained oxen: | UM 14,000 |
| -One 8" plow | 6,800 |
| -One oxen cart: | 17,500 |
| Total | UM 38,300 |
| | |
| <u>1982 Earnings:</u> | |
| -Plowing: 14 days at UM 1,000/day | UM 14,000 |
| -Miscellaneous transportation: | 30,000 |
| -Transportation/harvest: 30 days at 1,000/day | 30,000 |
| Total: | UM 74,000 |

2) In Selibaby, Mr. Boubou Sakho:

-Animal traction: In 1981 the total area cultivated exclusively by hand, approximately 2.8 ha, with six laborers. In 1982, total area cultivated with animal traction, was 4.5 ha, with three laborers.

-Pumping water for herds: done previously by hand and loss of animals due to lack of water. For 1982, with animal traction, no losses were recorded.

31. As part of the DRIG Project, animal traction activities include the following:

- Training of trainers: About 15 trainers and assistant trainers have been trained by the Project and are now working with the Project to in turn train the farmers.

- Establishment of Farmer Training Centers in Selibaby and in the ZID villages to provide training in training animals and animal traction cultivation practices. A trainer and assistant are assigned to each center which is further equipped with a pair of oxen and agricultural implements to demonstrate and provide training in animal traction. The farmers bring their animals and necessary feed to the centers and take an active part in training. The farmers are also trained in the use and maintenance of trained animals.

- Purchase of appropriate equipment for animal traction that does not exist locally, for resale either for cash or on credit, at prices determined by the Government.

- Collaboration with the Regional Agricultural Sector and other agricultural development projects in providing training programs, seminars, demonstration workshops and equipment sales training on animal traction.

32. At the outset, the DRIG Project experienced a few difficulties, especially farmer distrust. The farmers were under the impression that animal traction would cause their animals to die and that the Project's only reason for introducing animal traction was to sell implements. Yet, after two years of sustained effort in agricultural extension training for animal traction, the Project has been able to win over the confidence of a large number of local farmers and is now on the right track. The major problem that must still be resolved, however, is finding a credit system that can effectively help a great number of farmers who need financial assistance to purchase animals and equipment for animal traction. This problem obviously exceeds the capabilities of the DRIG Project.

## V. Conclusion

33. In its first phase, which ends before the 1983 rainy season, the DRIG Project gathered base data needed for agricultural development in the Guidimaka Region, and implemented experimental and agricultural extension programs in cropping methods and animal traction. The results, obtained from the several hundred small farmers directly affected by the Project, are highly encouraging but limited to the ZID (Zoné d'Intervention Directe, a radius of 20 km around Selibaby). A second phase, lasting at least four years and beginning with the 1983 rainy season, will be absolutely necessary so that the Project can cover the entire Region and thus attain food self-sufficiency. If the Project is to continue for the second phase, further recommendations should be made to ensure for proper operation and a greater Project success.

34. The Phase II project objective must be determined as a function of the local population's most pressing needs and on the basis of the results obtained over the past few year. The people need the following food crops: sorghum and pearl millet for use as staples, and groundnuts, cowpeas and vegetables for increased consumption to improve nutrition and the quality of daily meals. The increase in food production must, therefore, be based on the development of these crops. But considering the results already obtained and given certain constraints at the present time, the development of sorghum, groundnuts and vegetables should be of priority.

35. In the past years, the introduction of new, selected varieties, the application of improved, simple and inexpensive methods, ridge cultivation perpendicular to slopes, and animal traction have led to increased yields. Future Project activi-

ties must necessarily continue along these lines. In addition, more advanced practices must be the subject of experimentation and agricultural extension efforts, e.g. improving soil fertility through locally available organic fertilizers, preparation of plots to combat soil erosion and conserve as much rainwater as possible, and production of selected seed.

36. Increasing food crop production should also be envisioned, through an increase in total cultivated acreage. Animal traction can sufficiently decrease the amount of work time in the fields, enabling the farmers to increase their total acreage. Cropping on ridges, which makes sloped land more productive whereas they are now often abandoned because of their very low yield, can also contribute to an increase in total areas under cultivation.

37. Agricultural experimentation must continue in varietal selection and implementation of methods to improve soil fertility and prepare plots for cropping.

38. Agricultural extension must be the principal element of Phase II activities. Farmers and Agricultural Extension Training Centers must increase on an average of five centers per year, so that the Project can cover all of the large villages in the Region within the next four years. Extension topics on selected varieties, improved techniques, ridge cultivation and animal traction should be continued. Other subjects will be added as the new results from the experiments become available. The number of animation/extension agents and animal trainers must be increased according to the centers' needs; they should be trained and then retrained every year, and are to be continually supervised by the centers.

39. At the village level, organizing small farmers into groups and cooperatives is essential. It is through such village organizations that the Project can affect the largest number of farmers and that farmers, in turn, can receive a maximum amount of technical assistance and more efficiently use implements and means of production.

40. Finally, close cooperation must exist between the Project, various regional and governmental departments and other rural development projects so as to coordinate and strengthen the assistance provided to small farmers. For example, in order to develop animal traction, an agricultural credit system must be organized at the village level to help the farmers procure the material they need. This type of assistance, however, exceeds the capabilities of the Project, and must necessarily emanate from the Government to round out the Project's technical assistance.

## APPENDIX

### Considerations Concerning Fruit Production in the ZID

After observing all of the socio-economic, technical and climatic problems in the ZID over the past two years, I feel it is important to raise several points in determining the feasibility of fruit production in the ZID.

I. Climatic consideration

The Guidimaka Region, in general, and the ZID, in particular, have Sahelian climates, characterized by three distinct seasons: the dry and cool season from November to February, the dry and hot season from March until June, and the wet and hot season from July until October.

Annual rainfall has been measured over the last few years and on the average amounts to less than 500 mm. The rainy season is usually from July to October, but in reality, there are often years when the rains stop rather early, in mid-September.

Another disadvantage is poor rainfall distribution. Generally, the rains fall in downpours and most water is lost due to runoff.

Given the rainfall pattern of the area, fruit trees are only able to vegetatively develop during the three rainy months of the year. They must be constantly watered during the remaining nine months so as to maintain their latent growth period. It is also noted that young trees, in the first year of growth, have difficulty surviving the dry and hot season, even when watered abundantly, because of intense evapo-transpiration and high temperatures during that time of the year.

There are several fruit species that more or less tolerate drought and high temperatures, such as mango, guava and some citrus. Thus, vegetative development may be satisfactory with abundant watering, but their fructification period, which generally occurs during the dry season, may be jeopardized by drought and high temperatures during the day. While visiting the mango orchards near Selibaby during the fructification period, I noticed that the trees had suffered from the dry spell. The young fruits were poorly developed or had fallen before reaching maturation.

It therefore seems to me that the climatic conditions in this region are not favorable to the expansion of fruit crops. There are perhaps a few rich individuals who can afford an expensive, long-term investment to plant certain fruit species; but they must still be skilled in the application of appropriate fruit tree cultivation techniques.

## II. Technical consideration

Fruit production in a given region requires studying the application of appropriate techniques for this type of cultivation, such as adaptation of fruit species to regional ecological conditions, selection of the best clones or varieties to be planted, multiplication and distribution of the plant material of selected species, cultivation practices regarding soil preparation, seeding and planting young trees, manuring, efficient and economical irrigation and watering methods, size of trees, grafting, protection against insects and diseases, and finally, fruit preservation and marketing.

All of the above-mentioned techniques are essential if orchards are to succeed, but they are totally absent from the DRIG Project and the Agricultural Sector. Agronomy Division efforts so far have been dedicated solely to the upkeep of the Niarouwallé orchard.

If the Project is to fulfill the objective related to fruit production in the ZID, technical studies and training of technicians would require a few more years. In my opinion, this is not at all feasible since the Project ends in December 1982.

Therefore, as long as the present technical constraint is not resolved, agricultural extension work in fruit production in the ZID will not yield any results.

## III. Socio-economic consideration

In tropical and sub-tropical developing countries where the climates are favorable to the development of fruit species, there are generally two forms of fruit-related operations:

1. Specialized plantations with areas ranging from a few hectares to tens of hectares; and,

2. Family orchards where a few fruit trees or even a few dozen fruit trees are planted around the farmers' houses.

The first type of operation requires a rather high level of technology and a major investment from the planters, and is feasible only in regions where arable land is not used for annual crops.

The latter form is more common since every farmer has a plot of land, regardless of size, around his home where he can maintain his kitchen garden and small orchard. In this type of operation, each family can easily take care of the fruit trees, and the supplemental income generated by this enterprise can be significant.

Both types of operations are frequently assisted by regional, governmental and private services that select the fruit species, distribute selected plant material (particularly young grafted plants), and provide the necessary technical assistance.

When analyzing the socio-economic conditions in the ZID, however, one can see that a certain number of factors limit development of fruit cultivation:

1. Specialized plantation operations could encounter several problems; such as:

a) Arable land is not always available near urban centers and village centers for establishing large plantations. Increasing soil degradation forces the farmers to go farther and farther away from their villages to grow their food crops; large fruit tree plantations would thus find themselves in keen competition with traditional annual crops.

b) There are no specialized agencies capable of providing the growers of large plantations with the needed technical assistance. Consequently, the growers would not be willing to commit large sums of investment capital to an area where production factors are not very favorable.

2. As for family fruit farming in the ZID, the major difficulty encountered is that homes are bunched together, leaving very little available space for planting trees. Were the trees planted outside the home area, it would be difficult to watch for damage caused by animals and to ensure harvests.

## IV. Conclusion and proposal for the Niarouwallé orchard

Considering the socio-economic, technical and climatic factors already mentioned, it can be said in conclusion that given present Project status, the development of fruit farming inside the ZID would come up against a number of problems unlikely to be resolved.

This being the case, would it be desirable to revise the Project objective as far as fruit production is concerned and to determine a solution for the Niarouwallé orchard?

The orchard was started during the 1980 rainy season, when a hundred or so fruit trees including guava, citrus, papaya and mango trees, were planted. Only the guava and the citrus trees managed to develop, but their vegetative growth is quite slow. Caring for the orchard requires at least 5 permanent laborers to water the trees during the entire dry season and upkeep them during the rainy season. If the trees were to succeed, results from the orchard would only be achieved with an extremely high production cost, factor which does not lend itself to agricultural extension and does not benefit the people living in the ZID.

Furthermore, funds required for the orchard could not be made available from the Region's or the Agricultural Sector's budget once the Project is over. Even if the Project goes on, there is no way to be certain that the orchard would constitute an important objective of second phase.

The solution would be to sell all of the existing trees in the Niarouwallé orchard (assuming there are buyers), or to distribute them to the people of Selibaby for planting around their houses. The trees are still at the stage where they can be transplanted. Amounts earmarked for the orchard in the future will be transferred to other more important activities within the Agronomy Division.