

PN-AAU 908

95844-161

ECONOMICS OF THE SAHEL

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Economics of the Sahel

Despite the drought which has adversely affected the Sudano-Sahelian region for several years and assumed catastrophic proportions ^{IN 1973-} ~~until~~ 1974, widespread famine in the Sahel appears to have been averted, ~~due~~ in large measure ^{due} to the massive relief effort by the international donor community. ~~The~~ ^{low} ~~exceptional~~ ~~and~~ ~~unique~~ ~~vulnerability~~ ^{level} ~~of~~ ~~the~~ ~~economics~~ ~~to~~ ~~which~~ ~~was~~ ~~added~~ ~~insufficient~~ ~~rainfall,~~ ~~with~~ ~~the~~ ~~consequent~~ ~~failure~~ ~~of~~ ~~crops~~ ~~and~~ ~~deterioration~~ ~~of~~ ~~herds,~~ ~~has~~ ~~resulted~~ ~~in~~ ~~tragic~~ ~~human~~ ~~suffering,~~ ~~massive~~ ~~economic~~ ~~and~~ ~~social~~ ~~disruption,~~ ~~and~~ ~~great~~ ~~damage~~ ~~to~~ ~~an~~ ~~already~~ ~~fragile~~ ~~ecological~~ ~~system.~~ ~~The~~ ~~problem~~ ~~which~~ ~~the~~ ~~area~~ ~~now~~ ~~faces~~ ~~and~~ ~~will~~ ~~face~~ ~~for~~ ~~many~~ ~~years~~ ~~to~~ ~~come~~ ~~presents~~ ~~the~~ ~~governments~~ ~~of~~ ~~the~~ ~~region~~ ~~and~~ ~~to~~ ~~the~~ ~~international~~ ~~community~~ ~~a~~ ~~great~~ ~~challenge.~~ ~~The~~ ~~effort~~ ~~to~~ ~~meet~~ ~~this~~ ~~challenge~~ ~~has~~ ~~already~~ ~~been~~ ~~extensive,~~ ~~but~~ ~~overcoming~~ ~~the~~ ~~emergency~~ ~~and~~ ~~achieving~~ ~~less~~ ~~precarious~~ ~~conditions~~ ~~of~~ ~~life~~ ~~for~~ ~~the~~ ~~people~~ ~~of~~ ~~the~~ ~~region~~ ~~require~~ ~~determination,~~ ~~creativity,~~ ~~and~~ ~~vast~~ ~~resources.~~ ~~The~~ ~~damage~~ ~~left~~ ~~by~~ ~~the~~ ~~drought~~ ~~remains~~ ~~and~~ ~~has~~ ~~made~~ ~~weaker~~ ~~the~~ ~~already~~ ~~fragile~~ ~~foundations~~ ~~upon~~ ~~which~~ ~~the~~ ~~governments~~ ~~and~~ ~~societies~~ ~~of~~ ~~the~~ ~~Sahel-Sudano~~ ~~countries~~ ~~are~~ ~~based.~~ ~~There~~ ~~is,~~ ~~however,~~ ~~an~~ ~~opportunity~~ ~~to~~ ~~coalesce~~ ~~worldwide~~ ~~concern~~ ~~for~~ ~~the~~ ~~area~~ ~~into~~ ~~an~~ ~~approach~~ ~~which~~ ~~will~~ ~~assure~~ ~~sufficient~~ ~~resources~~ ~~to~~ ~~bring~~ ~~about~~ ~~long~~ ~~term~~ ~~development~~ ~~in~~ ~~the~~ ~~Sahel-Sudano~~ ~~region.~~

The Dimension of the Problem

The Economies Foundations of the Region

In 1970, the population of the Sudano-Sahelian countries amounted to approximately 23.6 million, of which about one-fourth lived in the Sudano-Sahelian

zone. The annual population growth rate, ranged from 1.7 percent in Gambia to 3.3 percent in Niger, during the decade of the sixties. It is expected that by the year 2000 the population of Chad, Gambia, Mali, Mauritania, Niger, Senegal and Upper Volta will be 47.7 million.

The overriding physical constraint is the aridity of the region. The known mineral resources are scarce and tend to be located far from established population and communication centers. Above all, the region lacks any significant energy ^{Sources} in particular. For historical reasons, the transportation network is poorly endowed with ~~north-south~~ ^{east-west links}, making international communications, especially in the case of land-locked countries, difficult.

While the annual output of goods and services (GDP) of the economies of the region has shown varied growth rates during the sixties, due certainly to the presence of French settlers whose withdrawal after independence was gradual, ^{the GDP} ~~the per capita income~~ ^{low} has averaged a growth of 1.2% a year. Since the increase in population has been estimated at an average of about 2.3 percent during the same period, it may be presumed that the per capita ^{income} has declined by at least 1.1 percent. This situation occurred in spite of ^{fairly large} a volume of foreign assistance provided to the area.

^{accurate} While ^{is not} quantitative information during the drought and in the post drought period ~~are~~ not available, it is assumed actually that the per capita income has declined by 15 to 25 percent.

Since their independence in the 1960's, the Sahel-Sudano countries have been formulating comprehensive national development plans. These plans reflect ^{tend to} only patterns of theories of economic development of industrialized countries who financed some development programs. The plans consisted of projects not

related to each other or to sectors or to plan targets where those were defined. Nevertheless, certain characteristics were common to the development policy imposed, required, or adopted in the entire area. The public sector, the export sector and some kinds of industrialization were emphasized and although sponsored by some donors, have been viewed as the foundation of development where, in fact, they represented a benefit to certain donors. The public sector plan was a capital expenditure program establishing quantitative targets and priorities incorporating only a few of the financial and other policy measures needed for their implementation. In conclusion, a majority of projects implemented were ill conceived and many were only the product of requirements of policy guidelines of some donors who change their philosophy in function of their interests and economical policies.

Exports and imports in the decade of 1960's provide useful indicators as to the state of the economies of the Sahel-Sudano countries.

While exports seem to have made a substantial contribution toward GNP prior to the drought, if we consider GNP as the sole yardstick and in view of the dualism of the economy prevailing in these countries with little linkage between modern and traditional sector, growth of GNP as a measure of economic development in the area has relatively little meaning.

The increase of exports was not sufficient to eliminate ^{the} trade deficit. For 1971 the total value of exports stood at \$US332 million, as compared to imports amounting to \$US497 million. From 1968 to 1971 the growth rate of exports fell to slightly over 2 percent while imports increased at the average rate of over 10 percent. The slower increase in exports and the

increase in imports can be attributed in large part to the fact that export products of the region are subject to more price elasticity and to short-term prices on the world market manipulated in the industrialized countries. The same treatments apply to import products. The secular trend in the rate of price differentials of imports and exports has always been unfavorable to Sahel-Sudano countries in view of the susceptibilities of the area to international forces. This can be explained by the fact that most of the recorded trade of the region has been mostly with donors as shown below.

The sky rocketing price of imports, particularly, food, petroleum and machinery, combined with stagnating and insufficiently diversified exports, create an increasingly serious balance of payment disequilibrium. To remedy this situation, external capital was needed, not only for the foreign exchange gap, but to augment domestic saving and investment as well.

The inflow of foreign aid to Sahel-Sudano countries between 1965 and 1971 paid nearly 42 percent of the imports and constituted nearly 56 percent of the total gross investment as evidenced by the information below.

The net flow of loans and grants will certainly not compensate the monetary losses suffered by the drought stricken countries, and unfavorable terms of trade and their membership with the zone franc which reflects the continuation of a colonial system. Economists who thoroughly study this internal situation of which IMF and IBRD have been silent, agree that this system is biased against indigenous savings and investments which creates an overvalued currency with pro-import and anti-export biases. As a result, there has never been any implementation of an independent exchange rate policy and CFA francs have been inexorably linked to the fate of the French francs and through the

PERCENTAGE OF TOTAL RECORDED TRADE1969/1970

	Sahel-Sudan	West Africa	EEC	Others
Chad Imports	2%	17%	51%	30%
Exports	0	5	84	11
Mali Imports	9	18	48	25
Exports	7	69	18	6
Mauritania Imports	3	3	58	37
Exports	2	4	86	7
Niger Imports	5	12	64	19
Exports	2	28	68	32
Upper Volta Imports	4	21	63	12
Exports	2	53	64	21

French franc to currencies of other donors who have been plagued with successive devaluation reflecting a staggering inflation.

Under these conditions external capital was needed not only to cover the foreign exchange gap but to augment domestic savings and investments as well. Given domestic savings as percentage of GDP averaged 6.9 percent as compared to 16.2 for all developing countries.

However, due to the inflow of foreign capital, the ratio of investment to GDP for the stricken drought countries was estimated at 17 percent in 1970; the same rate as that achieved by all developing countries in that year. The dual nature of the economies of the Sahel-Sudano may help to understand the low rate per capita income for some countries of the region and negative growth for others, despite the relatively high rate of savings achieved with the help of foreign assistance. Furthermore, development funds from foreign sources have not always been invested in the most productive manner. Sometimes this has been a burden, reflecting a symptom of misery rather than a cure, especially for projects financed through multilateral aid.

From 1961 to 1971 more than a third of foreign aid was spent on so-called "technical assistance" designed to manage and operate projects and programs financed from abroad. There is reason to believe that projects and programs in various instances have been designed for purposes to suit placement of experts of UN and specialized agencies instead of assisting the countries, or as is the case of France, the technical assistance was provided to place a great number of civil servants who became jobless after independence of the African countries.

We estimate also that one-third of the foreign aid was spent on machinery

and equipment that was unfit for the region and which became obsolete for lack of parts or utilities.

Dependent as they are on external financing, both for capital and current expenditures, the drought stricken countries have incurred sizable foreign debts. By the end of 1971 the total had reached US\$717.7 million. A measure of the debt service burden is the percentage of interest and amortization charges in total government revenues according to the UN. This percentage in 1971 ranged from 4 percent for Upper Volta to 30 percent for Mali. The average of 14 percent of debt charges to government revenues for the region is very high.

As for the service payment on external public debt as percentage of export of goods and non-factors services for 1970-1972, the percentage of such payments is also prohibitive.

As of 31 December 1972, the external public debt outstanding for Sahelian-Sudano countries reached more than 750 million. And it is expected that by the end of 1975, the external public debt outstanding will reach one billion US dollars which represents more than the total amount of agricultural production in the Sahel-Sudano countries.

Aggregate Investment and Aid Targets

Conventional and simple economic projections have been used to indicate a reasonable set of conditions under which per capita incomes in the Sahel countries might double in the next fifteen to twenty years. The figures given here are not "forecasts" in the usual sense, because they are conditional on a number of environmental factors and host government policies that are not pre-determined. Furthermore there are a number of other growth paths and investment profiles that might achieve about the same goals (in terms of per income). Wise planning must then take these conditions as guideposts and working hypotheses that will need continual updating over the entire investment period as new data and new technologies become available. The working hypotheses developed in the course of study for doubling Sahel per capita incomes are as follows (all estimates in terms of 1974 prices, with no allowance for inflationary trends in the future):

15.2090
—

1. Total gross capital formation financed by all sources - local private savings, local taxation, foreign aid, and foreign private investment - should total about 36 billion dollars.

2. A substantial part of this capital formation will need to be in the form of "human capital", primarily improvements in labor force productivity via investments in education, training, health, and nutrition. However, the relative proportions invested in physical versus human capital cannot be forecast now.

3. Most of the capital formation for the planning period (about 26 billion dollars, according to the preliminary estimates) should be financed from local sources. This hypothesis implies that local governments will have good tax collection performance, that they will keep public budgets "under control" so that increasing proportions go to capital investment rather than to military and administrative expenses, and that profitability and other incentives in the private sector are sufficient to increase voluntary private savings.

4. Foreign inflows will be about eight to thirteen billion dollars. Most of these funds will be concessional aid, although donors and host countries should consider means to improve climates for private foreign investment also.

5. Technically sound development projects totaling twelve to seventeen billion dollars, with economically feasible rates of return (in the range 10% to 20% annually), can be identified for the region. The host governments will have the technical and administrative "absorptive capacity" to execute these projects successfully.

6. Average long-run weather patterns will prevail, as will historical patterns of investment, productivity, and consumption.

It will be noted that of the 12-17 billion dollar total government investment plan in hypothesis five, about two-thirds to three-fourths might be financed by foreign aid (hypothesis four). A

aid
8-13 B

desirable pattern probably will see a very low locally financed proportion in the first few years of the planning period, gradually increasing toward the last years to as much as one-half. The sectoral investment targets below could be phased in such a pattern.

Sectoral Investment Targets

These figures also should be interpreted as working hypotheses or points of departure, which need to be revised periodically. In particular it must be stressed that although every attempt has been made to use generally acceptable cost estimating norms (e.g., costs per hectare, costs per kilometer, etc.) future price shifts may change the cost profiles substantially. Furthermore, it is not realistic at this early stage to estimate the relative "payoffs" of the various sectors, so that significant changes in relative sectoral emphases may seem appropriate when further data are available.

Finally, any of these guideposts might eventually need to be abandoned if detailed technical studies and cost analyses do not support the feasibility of specific projects. Nonetheless, after taking account of these caveats, these estimates provide a reasonable initial framework for long-term sectoral planning.

SECTOR OR SUB-SECTOR	INVESTMENT TARGET (MILLIONS OF 1974 DOLLARS)	SOURCE OF ESTIMATE OR CRITICAL ASSUMPTION
Agriculture and Food Projects	1,305.0	FAO Provisional World Food Plan, 1973
Forestry	1,050.0	CBLT and CLSS studies; 1.3 million hectares at ca. \$800 per hectare
Irrigation (not including dams)	1,431.2	810,000 hectares @ \$1767 per hectare
Dams and power plants	523.5	UN, OMVS, and MIT estimates
Fisheries	83.0	UNDP Project Niger RAF/71/273; costs extrapolated to other countries
Integrated Rural Development Projects	1,836.0	IRBD and FAO studies; about 600,000 families at \$3000 per family
Elementary Education	387.9	} 848.7 ca. 1.5 million pupils at \$260 per pupil
Secondary Education	92.0	
Higher Education	368.8	
Roads - all weather	2,403.2	ca. 20,000 km. at \$120,000 per km.
Investment studies	160.2	
Telecommunications	30.3	UNDP and ITU studies
Onchocerciasis - Volta basin	120.0	IBRD studies
Health		(estimates not completed)

Macroeconomic Targets and Aid Flows for Sahel Countries

Experiments with simple macroeconomic growth models of the six Francophone Sahel countries indicate that net foreign capital inflows between eight and twelve billion dollars (measured in constant 1974 prices) might be instrumental in helping to double the region's per capita income by 1989-1990. The projections are, however, subject to a number of severe criticisms. In particular, they depend upon extremely poor macroeconomic data and incorporate an unsatisfactorily large number of untested simplifying assumptions. Therefore one should regard them strictly as preliminary and use them with extreme caution. Nonetheless, these projections are "reasonable" by conventional standards and can provide a convenient starting point for a dialogue with other donors. The methodology herein is simple enough to permit rapid recalculations of the projections for almost any new assumptions likely to arise in such a dialogue. Furthermore, the aid inflow targets are always given as ranges rather than point estimates in order to avoid a false sense of precision.

for aid
8-12B
in 1974
(net inflow)

Choice of Target Growth Rates. There are literally thousands of GNP (or GDP - gross domestic product - which is actually used here) growth paths that will double the region's per capita income within fifteen or so years. Experiments with the economic models indicate the growth path in Table 1 will both double per capita income and also eliminate net foreign capital

inflow requirements by about 1990. This growth path is optimistic, but it is not unreasonable if long-run average weather patterns prevail; if the region's governments follow sound economic policies; and if historical patterns of consumption, investment, and productivity hold approximately in the future.

Table 1

Year	'74	'75	'76	'77	'78	'79	'80	'81
GDP								
Growth Rate	5%	6%	6%	7%	7%	7%	8%	8%
Index of Per Capita GDP	100	102	106	110	114	119	125	131

Table 1 (cont.)

Year	'82	'83	'84	'85	'86	'87	'88	'89	'90
GDP									
Growth Rate	8%	8%	8%	8%	8%	8%	8%	8%	8%
Index of Per Capita GDP	138	146	154	162	171	180	189	199	210

Notes

1. The per capita income calculations assume a uniform population growth rate of 2.5% per year. This assumption is especially troublesome because there is conflicting evidence from low-income African contexts whether parents tend to respond to higher incomes by increasing or decreasing family size. Therefore the economic determinants of fertility and mortality deserve research attention in any program to develop reliable macroeconomic forecasts for the Sahel. The model used here has a serious weakness in not including feedbacks from higher income to fertility and mortality.

2. None of the projections in this paper incorporate any information or assumptions about income distribution among classes or regions within countries. However, the relative incomes among the six countries are assumed constant throughout the period.

Composition of Foreign Inflows. All figures presented are ^{net} ~~not~~ of debt repayment and interest. Therefore the actual foreign inflows to achieve the target growth rates will probably need to be larger than the net figures here. But on the other hand, there has been no attempt to project commercial loans and foreign private investment as components separate from concessional inflows. Therefore it is impossible to predict at this preliminary stage whether the net foreign capital targets projected here tend to overstate or understate concessional inflows. It seems appropriate, however, to ignore such financial composition problems for these preliminary calculations, since in large measure their resolution will depend upon donors' actions and policies rather than upon economic forces in the recipient countries.

Worldwide Inflation. The detailed projections below are all in terms of constant 1974 dollars. However for comparative purposes, assume that average dollar price levels increase by 10% in 1975, 9% in 1976, and so forth until reaching a steady 5% annual inflation rate in 1980. This assumption, combined with

profile of foreign inflows projected below, raises the total Sahel net foreign inflow target from the range 8-12 billion constant 1974 dollars to about 12-19 billion current dollars.

Recipient Countries Policies. These projections do not distinguish between two types of locally financed investment, private and public. It is commonly accepted by many observers, apparently without a reliable statistical basis, that no significant private capital formation or savings occur in the rural sectors of these economies. Should this assumption be true in the future, then most of the locally financed investment needed to achieve the models growth targets (which amounts to about 26 billion 1974 dollars over the 15 year period) must be paid for with local government revenues, chiefly taxes. The projections make a crucial assumption that the six countries governments maintain future "government consumption" expenditures (i.e., government expenditures on defense, administration, and other non-capital items) at the same average percentage of GDP as in 1964-72. If the governments cannot control their budgets to the extent of achieving these historical "consumption" levels, then the growth projections may require substantial revisions to show either lower target growth rates or higher foreign aid. Successful government policies to reduce "non-productive" government expenditures, and thereby release money either for private or public investment, could help improve future growth performance. Two caveats

are in order, however. In the first place, we should not be so mesmerized by statistics on investment, public or private, that we support policies non-conducive to unrecorded small scale private investment (as on peasant farms). In the second place, we should devote greater attention to the investment aspects of public health and education expenditures, many of which are recorded officially under statistics on administration or public consumption, but which in fact may contribute significantly to human capital formation (and thereby to higher labor productivity).

Derivation of Upper and Lower Limits. Weighting the six Sahel countries historically observed incremental capital output ratios (ICOR) by 1972 GDP's yields an average ICOR for the region of about 4.2. (Individual country's ICOR's were calculated from investment and GDP data for 1964 to 1972, but several years data were not available for some countries.) This statistic is almost the same as the ICOR calculated for the entire West African franc zone, 4.5 (see B. Maldant and M. Haubert, Croissance et Conjoncture dans l'Ouest Africain, Paris, 1973). All lower limit calculations below are based upon a Sahel-wide ICOR of 4.5. However it may be over optimistic to expect large aid financed investments to achieve such a low ICOR (which is roughly equivalent for capital projects to a 20-25% internal rate of return). Therefore the upper limit calculations assume the foreign financed investment has an ICOR of 7.0 (roughly equivalent to a 14% internal rate of return), while locally financed investment continues to have an ICOR of 4.5.

Personal Consumption. The projections below incorporate a personal consumption growth rate of 4% per year, beginning with personal consumption assumed equal to about 74% of GDP in 1974. With population assumed to increase 2.5% per year, the model then allows per capita living standards to increase 1.5% per year. In a sense, one may regard the increased personal consumption as contributing to human capital formation especially via improved nutrition.

Time and Country Profiles of Target Foreign Inflows. The target net inflows in Table 2 were derived without regard to the recipient countries "absorptive capacities". This is admittedly a serious fault, whose revision could shift the time profile drastically.

Base Year Data. National accounts data for five countries are available only to 1972. For one country (Chad) the data are available only to 1971. These projections all start with 1974, assuming that real GDP stayed constant from 1972 (or 1971) until 1974.

Table 2
 Net Foreign Capital Inflow Targets for the Six Countries
 (in millions at constant 1974 dollars)

Year	Target GDP Growth Rate	Target Inflow	
		low estimate	high estimate
1974	5%	448	697
1975	6%	614	955
1976	6%	594	924
1977	7%	764	1,188
1978	7%	727	1,131
1979	7%	688	1,070
1980	8%	869	1,352
1981	8%	804	1,251
1982	8%	684	1,064
1983	8%	638	992
1984	8%	539	838
1985	8%	424	660
1986	8%	293	456
1987	8%	144	224
1988	8%	-	-
Totals		8,230	12,802

Table 3
 Foreign Inflow Targets by Country
 (in billions of 1974 dollars)

Country	Years	Target Inflows	
		low estimate	high estimate
Senegal	1974-87	2.7	4.2
Mali	1974-87	1.8	2.8
Upper Volta	1974-89	1.3	2.1
Niger	1974-87	1.1	1.7
Chad	1974-88	1.0	1.5
Mauritania	1974-84	0.2	0.3

Table 4
 Average Consumption Propensities Used For
 Projections (based upon 1964-72 experience)

Country	Public Consumption	Private Consumption
Senegal	18.6%	70.1%
Mali	15.7%	73.6%
Upper Volta	12.2%	84.7%
Niger	10.5%	81.1%
Chad	17.0%	74.9%
Mauritania	15.8%	65.0%
Average*	15.8%	74.1%

Technical Description of the Economic Model. These projections derive from the simplest kind of growth model, in which one year's economic growth is entirely a function of investment in the previous year. This sort of model has many serious faults, which have been discussed thoroughly in the economics literature. Counterbalancing these liabilities are its ready communicability to the development community, the relatively small number of assumptions it requires, and the ease with which it may be re-calculated to allow for new information or alternative assumptions. The model allows national income to be spent three ways, for investment, for private consumption, and for government consumption. It does not differentiate, in this version, between private investment and government investment. (Government consumption is comprised of administrative and other expenses not resulting in fixed capital formation.) Total investment is equal to the sum of domestic savings plus net foreign inflows,

$$(1) \quad I = S + F$$

$$(2) \quad F = M - X$$

where M is imports and X is exports. National income, Y , is measured in these projections as gross domestic product (GDP):

$$(3) \quad Y = S + C_g + C_p,$$

$$(4) \quad C = C_g + C_p,$$

therefore,

$$(5) \quad S = Y - C$$

where S is domestic savings, C is total consumption, C_g is government

consumption, and C_p is private consumption. National income is assumed to grow each year as a result of additions to capital stock the previous year:

$$(7) \quad Y_{t+1} - Y_t = \frac{1}{\sigma} I_t,$$

where σ is the incremental capital-output ratio. The rate of growth, g_t , for year t is:

$$(8) \quad g_t = \frac{Y_{t+1} - Y_t}{Y_t},$$

and

$$(9) \quad g_t = \frac{1}{\sigma} \cdot \frac{I_t}{Y_t}.$$

Solving for I_t gives the amount of new investment "required" in year t , I'_t , to achieve growth rate g_t :

$$(10) \quad I'_t = \sigma g_t Y_t$$

or

$$(11) \quad I'_t = \sigma (Y_{t+1} - Y_t).$$

The total value of resources "required" for the economy to satisfy both its growth and consumption requirements in any year is then (without subscripts)

$$(12) \quad T' = I' + C$$

$$(13) \quad T' = S + F' + C$$

Therefore,

$$(14) \quad F' = T' - Y,$$

where F' is the net foreign capital inflow required to achieve the target growth rate.

Magnitude of external required investment for Sahel-Sudan countries.

Agriculture

Over the past ten years agricultural production has become insufficient as to the meeting of the food demand and the generating of increase cast earnings for the population but only 27 percent of the total area of 5.3 million square Km receive an annual average more than 500 cu in of rain, a figure which is general regarded as the lower limit to support a permanent system of rainfed agriculture.

Agriculture is still largely practices as a subsistence economy with a relatively small proportion of the agricultural output entering the monetized part of the economy. The sector is characterized by a low productivity in general, which is due to low incentives as far as secured market outlets and guaranteed produce prices are concerned, the absence of high yielding varieties particularly for the main grain crops millet and sorghum, an insufficient use of farm inputs, the adherence to traditional cultivation techniques, an ineffective use of water resources and a low impact of agricultural extension activities.

This situation results in low income out of agricultural activities and consequently a reduced internal capital formation, saving and a low capacity for self-financing. It also explains why the agricultural sector and the rural economy in general are still limited .

The production of cereals and in particular millet and sorghum is by far the most important output, not only because this subsector covers the largest part of the cultivated area and represents 65 percent of the total value of crop production, but also because grains constitute 70 percent of the food intake in terms of calories of the population.

A grain consumption of 120-175 kg. per capita reflects a high preference for this commodity and places these countries amongst those in the world with the highest per capita grain consumption.

In years with normal rainfall conditions grain output of millet, sorghum, maize and wheat corresponds more or less to the demand with the exception of rice, which is becoming increasingly important as an import commodity, particularly for Senegal. Mauritania's grain demand has, as a result of the particular climatic handicap of this country, outstripped the domestic production.

In order to cope with an increasing grain demand within the subsistence and the market economy, farmers expanded in the first instance the grain crop area to zones with favorable rainfall conditions but marginal soil conditions by encroaching on pasture areas which are marginal for crop production, and by shortening the rotation cycle. Certain more profitable cash crops have replaced sorghum in some areas and have forced farmers to plant sorghum under less favorable conditions or not at all.

These steps resulted in a degradation of soil fertility and soil structure and contributed to a worsening of the already delicate balance between man, plants and soil.

Crop production and livestock production are in many areas two separate sectors with hardly any common interests as far as crop cultivators and cattle raisers are concerned. This separation, which has its social and historical reasons, does not permit either of the two subsectors to benefit from the other; crop producers rarely utilize the important potential of draught animals; cattle raisers do not benefit from the possibilities for a more rapid fattening of animals.

It is estimated that 88 percent of the total labour force of the six Sahelian countries is engaged in agricultural activities both for crop and livestock production.

The annual value of agricultural production at current market prices amounts to about 900 million United States dollars or 40 percent of the Gross Domestic Product.

Crop production is an important and in certain countries the most significant source of foreign exchange earnings. The export earnings of Chad are derived 70 percent from cotton, those of Niger 60 percent from groundnut, and those of Senegal 50 percent from groundnut, too.

Grains are the major staple food of the area and will remain so as a result of their adaption to the climatic conditions and the food consumption habits of the population.

The agricultural sector is closely related with other sectors and aspects of the economy of the region. Crop production in large scale will stimulate and strengthen all the economy of the area. The

agricultural sector's productivity is a function, however, of the use of water resources for irrigation purposes, which will have a multiplier effect for transforming in long term all the region from being a food deficit area to one which is self sufficient.

Other investments needed by each country for year 2000.

- | | |
|--|--|
| <p>1) <u>National surveying and map services</u> an estimated cost for such project is based on an UNDP financing some years ago of 1.100.000 such national will cost for Sahel-Sudan countries.</p> | <p>2.500.00 for each country <u>15.000.000</u></p> |
| <p>2) <u>Development of hydrological service for ground water</u> exploitation UNDP-project 1.5 millions</p> | <p>6 x 1.500.000
<u>9.000.000</u></p> |
| <p>3) <u>Establishment of a geological survey</u> (UNDP-project 3.500.000)</p> | <p>6 x 3.500.000
<u>21.000.000</u></p> |
| <p>4) <u>Strengthen electric power service</u> (organization survey reconnaissance of the hydroelectric potential UNDP-project cost</p> | <p>6 x 1.250.000
<u>7.500.000</u></p> |
| <p>5) <u>Soil Service</u> UNDP-project cost</p> | <p>6 x 1.500.000
<u>9.000.000</u></p> |
| <p>6) Development of a project for <u>development of dry-farming areas</u> and for strengthening the service in each of these countries as model UNDP 6.100.000 for 1000 ha.</p> | <p>6 x 6.100.000
<u>36.600.000</u></p> |

Other investments needed (cont'd)

Page 2

7) Agricultural survey for each country		
UNDP 1.900.000		6 x 1.900.000
		<u>11,400,000</u>
8) Water resources survey each country		
UNDP 2.2 millions		6 x 2.200.000
		<u>13,200,000</u>
9) Mineral survey each country		
UNDP 2.183.000		6 x 2.183.000
		<u>13,098,000</u>
10) Feasibility study of the processing of millet	UNDP 560.000	
		6 x 560.000
		<u>3,360,000</u>
11) Cotton research Institute in each country	UNDP 1.500.000	
		6 x 1.500.000
		<u>9,000,000</u>
12) Integrated and studies on the development of natural resources	1.900 million	
		6 x 1.900.000
		<u>11,400,000</u>

New Plans and New Strategies

At present, Mali, Mauritania, Senegal, Gambia and Upper Volta have either formulated a medium term development program for the seventies, or enunciated a long term (ten year) development strategy. Chad and Niger also announced long term development objectives. Most of the new strategies are toward the water resource and agriculture sectors in the widest sense, with its related and supporting activities, are evident in the recently completed plans and those in preparation.

The overall picture, however, showed basically weaker economies dependent on the outside world for their finance, technology, raw materials, food imports and markets for their products. They are more vulnerable at home because of structural imbalances, lower productivity in subsistence farming which provides the means of livelihood for the mass of their populations, progressive erosion of the land, inadequate linkages between the modern and traditional sectors, increasing underemployment and unemployment, and an ever-increasing gap between the high incomes of a few and the poverty of many, with its consequences of the domestic market.

Shifts in Priorities - The New Plans

The benefits of development were disappointingly few, and governments, even before the present drought, began to re-examine the fundamental premises underlying their development orientation. In the meantime, based on their own experience, the pattern of development thinking has been changing in the donor community. The concept of a multiplicity of development

patterns, each indigenous to the physical and cultural environment in which it operates, gradually made its way.

In the countries of the Sudano-Sahelian region, the drought has made governments take a hard look at the realities of the situation, and has prompted decisions by the governments in many countries to change their development strategies radically. A shift in priorities towards the development of the agricultural sector in the widest sense, with its related and supporting activities, is evident in the recently completed plans and those in preparation.

The new national development plans make integrated agriculture (including animal husbandry, crop production, fisheries and forestry) and the primary sector the thrust of the development effort. National self-sufficiency in staple crops has become the major objective, and increased productivity of the subsistence farmer the major means to that end. In general, and with variations for specific problems of individual countries, the new development strategies have the following objectives:

1. to make the countries self-sufficient in food crops;
2. to associate farming with animal husbandry; and
3. to build industry chiefly on the produce of the agricultural sector, whenever possible.

Labor intensive projects are preferred and the establishment of small workshops and factories producing goods and for the domestic market is encouraged in order to provide new employment opportunities.

The income gap between subsistence farmers and cash crop producers is to be narrowed by offering the former subsidies, technical assistance and other incentives previously only available to producers of export crops such as cotton, groundnuts and sugar. For the first time, the new Mali plan mentions guaranteed prices and secure markets for the subsistence farmers as an inducement to increase production. This would not only provide farmers with sufficiently higher incomes which would enable them to buy the needed agricultural inputs, but would also stabilize the flows of food crops to local markets and stimulate effective demand for domestic manufacturers.

Mali, Mauritania, Senegal and Upper Volta stress integrated regional development schemes, which encompass the development of agro-industries and are combined with transportation projects centered around local marketing facilities. Although no changes in the social structure are foreseen, the plans mention farmers' producer and consumer cooperatives as the main policy making institutions in the rural development schemes.

The new Mali plan (1974/75-1979/80) emphasizes integrated regional development schemes based on the expansion of production of small scale crop or stock farmers. First priority is given to the attainment of self-sufficiency in domestic food supplies and the development of agro-industries, energy and water resources. In the longer run, the plan envisages integrated projects based on the construction of two large dams: the Selingue dam and the Manatali dam, both included in the regional projects proposed by the Permanent Inter-State Committee (CILSS).

The new Senegal plan (1973-1977) shows a striking shift in priorities towards agriculture: 41 percent of total investment is allocated to agriculture (including livestock and forestry) and water development. In recent year.

Senegal has concentrated on increasing production in light manufacturing and food industries based on cash crops with less emphasis on its agricultural subsistence base. Imports of food, rising to nearly 30 percent of total imports, were necessary to support the rapidly growing population. In order to encourage the production of food crops, the government of Senegal is considering subsidies and other incentives for subsistence farmers. As in other countries, the income differences between cash crop farmers and subsistence farmers growing food for the domestic market have become more pronounced in the last decade, and the drought has made matters worse with many subsistence farmers flocking to the urban centers in search of food and livelihood. In general, the new plan stresses the need for meeting the demands of the domestic market first, and focuses attention on the increasing problem of unemployment, which has also been aggravated in urban areas by the refugees coming from the drought stricken North. Development projects with employment creating capacities have received priority in the plan.

Other features of the plan are resettlement schemes, the improvement of local marketing facilities and the establishment of local farmers' cooperatives, all of which are intended to provide an institutional link between the modern and traditional sectors of the economy.

Mauritania is at present elaborating a longer-term development strategy which aims at the establishment of a more balanced economy within the next ten to fifteen years. The new development plan's basic objective is to achieve integrated agricultural development, with controlled livestock production and exports. Self-sufficiency in food staples, including meat, at a higher nutritional level, is one objective of the plan to be achieved in conjunction

with the parallel rehabilitation of traditional cultivation of dates (which also serve as a cash crop), cereals and vegetables. Cereal imports have reached an all time high in 1972 with the situation being further aggravated by the drought. The new development plan also includes the cultivation of rice as a possible substitute for millet and sorghum.

Upper Volta had a so called "project plan" (1967-1970), which was essentially a list of public sector investment projects. It is one of the few which has stressed agricultural development as the main ingredient of its growth. The projects in the development plan emphasize integrated rural development and a very much needed infrastructure.

With the drought severely impairing its execution, however, implementation of the plan has been much below expectations and capital outlay is estimated to have reached about 72 percent of total planned investment, and about 58 percent of investment planned for the primary sector (agriculture, livestock, water control and rural infrastructure).

The new "Plan Cadre" (1972-1976) shows no major changes in emphasis. It continues to stress the development of the primary sector which is to receive some 30 percent of planned capital expenditure. As before, the fundamental objective is the expansion and diversification of the agricultural base of the country is to produce food for the rural and urban populations so as to achieve national self-sufficiency and to provide a basis for export growth; to improve the marketing system; the road network and other services which will support and encourage agricultural production, evening out shortages and surpluses. The major institutions and instruments of this action program

are to be the Regional Development Organizations which have been established throughout the country.

In the Niger area a system of continuous planning has been adopted. Under the system, a revised four-year public investment program is being prepared annually on the basis of the financial status of ongoing projects. Depending upon prospective financing, other projects are included or deleted in a revised program after consultation with the Ministry concerned.

As was the case with the previous plan (1968-1972), the development of the rural sector has been assigned top priority in the ten year development "Perspectives" which are being elaborated at present. Investment in the agricultural sector will account for about one-third of the planned development expenditures. The thrust of the development effort will be towards the dual objective of ensuring adequate food supplies to the population and to develop exports of agro-industries (in addition to expanding exports of uranium and other minerals). In its agricultural development program in particular, the government is seeking to found its policy on the widest possible base in the rural areas through the participation and association of farmers, with the help of a country wide cooperative system, in the proposed improvements in production and marketing.

To support the objectives outlined before, various types of programs have been envisaged and are being carried out, of which the most important are:

1. specific crop development schemes for certain commodities (cotton, groundnuts, cowpeas, fresh vegetables);

2. productivity operations focused on a selected geographic area and conceived as integrated rural development schemes (irrigation projects, specific schemes for livestock improvement, processing industries); and ✓
3. "programmes de couverture" i.e., general activities designed to increase agricultural production. ✓

Niger's landlocked economy is burdened with high transport costs to sea-ports, and suffers also from an underdeveloped transport system within the country, where distances between marketing points are long. Consequently, roads bridges and other economic infrastructure related to transport and communication are expected to amount to roughly one-third in the ten year "Perspectives".

Chad's first development plan (1966-1970) allocated nearly 32 percent of the investment outlays to rural development and slightly more than one-fourth of the total to such supportive services as the development of transport, communication and of domestic trade. A characteristic of the first development plan was the high percentage of expenditure (19 percent of the total) allocated to such current expenditure as the payment of the personnel transport and maintenance needed to put the plan into operation. Broadly stated, the plan's objectives were:

1. increase of agricultural production and its diversification;
2. increase in the quality and quantity of meat production through a broad animal health campaign and the provision of permanent water and grazing facilities for livestock, as well as the establishment of processing industries; and
3. the adaptation of the educational system to better serve the manpower needs of the country.

Nearly two-thirds of the plan were financed from foreign sources, chiefly,

FAC and FED grants. However, the plan's projected investment expenditure was drastically revised downwards (by nearly 50 percent) when expected foreign financing did not materialize, and also because of technical reasons concerning project preparation and implementation.

Chad's new prospective ten year development plan (1971-1980) is still under consideration. Tentative priority targets indicate that, essentially, the development goals remain those of the previous plan. Although agriculture is allocated over one-third of the total capital outlay in the new plan, only ten percent is expected to be allotted to the key livestock sector. The intense development of the latter would probably have the widest impact on the country's economy, particularly in view of the current strong demand for and high prices of meat which are likely to continue. Most of the investment planned for the agricultural sector continues to support the expansion of export crops i.e. cotton, sugarcane, and processing. Food crops and the traditional economy seem to have received relatively little attention. Only five percent is to be spent on education and health.

The new plan may have some effect on the productivity and the standard of living of the rural masses, but it is unlikely to change in any significant way the sharply dualistic structure of the economy. It is expected, however, that in the final analysis the impact of the drought and its consequences will increase the emphasis on the traditional agricultural sector and on the production of basic necessities for the domestic market.

In Gambia the planning process and the planning machinery are relatively new. Although Gambia has had three successive plans since 1964, these have consisted essentially of public investment projects, to be implemented within

the framework of annual development budgets. They did not contain any over-all quantitative development targets for the economy, such as GDP growth rates or sectoral growth rates. Nor did they include private investment projections.

The first two development programs of Gambia were devoted almost entirely to the improvement and expansion of the country's economic infrastructure. Investment projected in the third development program (1971/72-1973/74) emphasizes development and diversification of agricultural production to which one quarter of projected investments is allocated. The shift towards capital outlays favoring an increase in agricultural output includes the expanded cultivation of crops such as rice, cotton, and groundnuts. Although half of the projected investment is still allocated to infrastructure, it permits the execution of an integrated road and river network which would facilitate the transport to markets of agricultural produce from outlying areas and also encourage the cultivation of new areas.

Water Resources

The severe droughts of recent years, and especially that of 1973, have clearly demonstrated that under a lasting water shortage situation, the Sahelian countries face a collapse of their fragile economy, a degradation of their environment, social structures and services, and losses of human life and livestock.

It would be erroneous, however, to think that a lack of water resources are responsible for the low and precarious standard of living of the population. In fact, in the populated areas a large water potential is available for development in the six countries, both with respect to surface streams and underground water.

The main drainage systems cover a substantial fraction of the area. The Senegal River system, in its lower section, conveys some 22,000 million m³/year on the average; the Niger River brings into its inland delta - between Mopti and Timbuktu - some 70,000 million m³/year, of which 30,000 million m³ flow at Niamey. The Logone-Chari floods into Lake Chad amount to 40,000 million m³/year. If only one quarter of these resources were available for the countries concerned more than 1,000 m³/year could theoretically be available for each inhabitant; that is more than the highest consumption rate for industrialized countries.

In order to view this problem in perspective, it may be pointed out that the total vast area covered by the six countries of the Sahelian Zone is 5,172,000 km². More than half of the area is desert (with less than 60 mm/year of rainfall), and almost no population. The southern part of Senegal, Upper Volta,

and Chad fall within the Guinean climatic zone where water problems are much less acute owing to the relatively adequate rainfall (more than 1,200 mm per year).

The populated arid area in the seven countries as a whole covers about 2 million km².

It must also be noted that the sedentary population is mostly gathered along main river courses, which even in their natural state offer perennial water supply.

The supply could, of course, be considerably improved by the regulation of the river flows. To give an idea of the possible impact of such flow regulation, if it is assumed that the population is concentrated within a band of 5 km on either side of the river bank, it is possible to calculate the approximate average annual amount of water available per square km as a result of regulation. This can then be evaluated as an annual average depth of water to be compared with rainfall availability.

On the basis of these figures, it is apparent that in the areas which have, or are likely to have, the major concentrations of population the lack of water resources is not the real problem. The main problems lie in the lack of application of an integrated water policy which may take into account, inter alia, the uneven distribution of rainfall and water resources over space and time, and the limited number of permanent surface streams and water bodies.

The Significance of the Water Sector to the Economy and Relationship to Other Economic Sectors

It is apparent that for any development project in the area, water resource

development is involved as an essential, if not key, factor. Water resource availability is in fact both a limiting factor and an incentive for development plans.

In the agricultural sector availability of water would change the present condition of traditional agriculture, closely tied to the occurrence of rainfall. Limited irrigation provided at the right time, for instance, after germination and before harvesting, would increase the yield of most fodder and cash crops. Small scale irrigation of this type can be provided with limited resources, through direct pumping from wells or rivers.

Cultivation of industrial crops, on the other hand, where technically and economically warranted needs perennial irrigation over large areas, at an acceptable cost. In this case, the necessary control of surface water resources is required and regulation and storage behind various size dams. A limited number of irrigation projects can use ground water. In specific instances high value cash crops can bear the relatively high cost of water thus provided.

In the pasture, livestock and wildlife sector an optimal distribution of water points, and proper selection of specifications for well construction and water extraction devices has to be arrived at to ensure that herds and wild animals will neither perish from thirst nor overgraze certain areas in their displacement. Such conditions are far from being reached at present.

An important trend at present is to associate agriculture and livestock activities. Large scale cultivation of irrigated fodder is a necessary condition for standard quality livestock feeding. Waste from some agro-industries may be used as

food for animals. On the other hand, manure is necessary for high yield industrial agriculture. Such agro-industrial complex can only be organized in areas where water is available in great quantity.

Creation of industries derived from agriculture and livestock is a direct consequence of relatively large scale development of the two sectors indicated above. Important aspects will also be the availability of water and low cost transportation and power which suggest that their location might be envisaged along large rivers where the industrial crop schemes and cattle fattening fodder schemes are likely to be concentrated.

Fisheries already represent a considerable proportion of the national income of the Sahelian countries. The question has been raised whether the regulation and control of large rivers for other purposes would be beneficial for fish production. On one hand, storage dams of several billion cubic meters apparently constitute ideal conditions for fish growing. On the other hand, the variable level of artificial lakes, and the reduction of inundated areas downstream from the dam owing to flood limitation may create serious difficulties. For the Selingue scheme, the only benefit expected from the dam construction in Mali, would be the availability of fish nearer to the market places than the traditional fisheries.

In the energy sector, it is apparent that hydro-power offers at present the cheapest prospects. No fossil fuels have been found so far in this largely landlocked area; geothermal potential seems to be much less promising than in East African countries. Radioactive minerals seem to be in modest supply and in any case their entire production is exported and subsidized due to high mining costs. Extensive studies were made on solar energy, especially in Niger;

however, practical applications still appear to be quite limited. Thus the main potential for energy appears to be in harnessing rivers for hydro-power; development appears to be the only broad possibility for developing local resources. This consideration is related to the industrial sector which cannot expand if it relies on imported and thus precarious and expensive energy.

In the transport sector, river navigation offers some interesting possibilities, considering the relatively good natural conditions and the low cost for river transport. However, the expansion of river navigation in the sense of an increase in the time period during which navigability of rivers is feasible, of ship tonnage, and of length of navigable waterways also requires a control of streamflow, and the construction of large scale water management works. Road construction in the Sahel requires large amounts of water (up to $800 \text{ m}^3/\text{km}$ for compacting alone).

The mining development sector needs water at various levels of exploitation, treatment and transportation.

In desert or arid areas water has sometimes been an obstacle to mineral ore exploitation, with regard to providing a minimal supply for personal and for preliminary dressing or concentration on site. For example, the mine of Tambao in Upper Volta for manganese exploitation, is expected to require $1,100 \text{ m}^3/\text{day}$ and the cement factory of Tin Hrassan, $1,200 \text{ m}^3/\text{day}$. In Mauritania, the copper mine of Akjoujt requires $6,000 \text{ m}^3/\text{day}$. These relatively small amounts of water can be supplied either from ground water or by artificial ponds, or pipelines (Akjoujt is supplied by a 115 km long pipe). Metallurgic complexes would require a much more considerable discharge.

Low value mineral ore can only be exploited if its transport to the refining plants (often far from the mine sites in relation to power and fuel availability) can make use of waterways. For example, bauxites along the Faleme River, near Kenieba in Mali could perhaps be exploited if this river and the Senegal River were navigable all year round. The same would apply to the copper ore in the southeast region of Upper Volta.

Of course, a prerequisite for waterway transportation is the regulation of the waterflow in the large rivers.

The health and well being of the population are closely dependent upon the availability of good quality drinking and domestic water in sufficient supply.

The present distribution of the population in this region, as vast as Western Europe, is closely related to present local availability of water supply, often precarious and unsatisfactory in terms of quality and quantity. Improvement of water supply conditions can be considered a major incentive for maintaining population groups in certain areas and moving others to areas where better prospects for economic development can be expected, through the development of new resources. In fact, social aspects for water development in this part of the world are particularly important and the benefits of the projects should not be assessed using conventional economic standards only. In fact, in some cases, such as the construction of simple water wells in rural areas where the issue is the survival of human communities, this general remark is particularly relevant.

Irrigation

All documents and studies available recommend the need for intensive land use that would be achieved mainly by reduction of fallows, flood control, drainage, soil conservation and other land improvement measures, together with improvement and extension of irrigation and investments in mechanization and other imports aimed at mitigating the limitations imposed by low fertility and other hindrances.

A key element of strategy of development is that water be treated as an essential production input, and that priority be given both in new irrigation and improving existing systems to the creation of facilities which will allow farmers to make full use of modern production technology and to provide an assured water supply and drainage system down to the farm level.

There is now 41,966 ha of arable land in the Sahel-Sudano region from which only 10,904,000 ha are cultivated and only 26 percent of the total land available is producing.

Until now an imbalance situation involving from uneven population growth in relation to local land and water resources, has often been solved by large scale migration, but the present economic situation has raised barriers to many of these flows whether they are across international boundaries or between regions of a country.

In order to reverse this situation there is a need for more land development and more irrigation.

The Provisional Indicative World Plans for Agricultural Development (FAO 1970), recommends a rate of growth of one to 1.50 a year in the cultivation of arable

land.

Unfortunately, the six Sahelian countries cannot follow the trend recommended. Constraining resources have to be considered as an example. None of the six countries have the cadres necessary to develop 500 ha a year next year of irrigated land.

The Ministry of Rural Economy of Niger, through its agricultural statistics section, devised a plan in 1973 for irrigating all feasible land in the Niger region by the year 2010. This plan would include utilizing water from the Niger and Komadougou Rivers and Lake Chad, as well as building dams to form artificial lakes in certain rivers of the Niger "Valleys Sections". Estimated cost is \$4,100 at the current exchange rate, or up to 740 million for the entire scheme.

Our estimation of the total investment for the next 20 years is in the magnitude of 1,431,043,000 (at current rate of exchanges) for the development of 810,000 ha divided among the six Sahel-Sudano countries is as follows:

	ha	\$
Chad	136,000	276,624,000
Mali	157,000	260,670,000
Mauritania	50,000	83,000,000
Niger	137,000	269,479,000
Senegal	222,000	368,520,000
Upper Volta	108,000	172,800,000
	<hr/>	<hr/>
Total	810,000	\$ 1,431,043,000

Cost Estimation: Taking into account the land use in various countries, the remoteness of area suitable for irrigation, the type irrigation needed

for various soils, etc. We based our estimation on studies of various maps of the six countries. We have also, in our tentative estimation of costs, reviewed all available World Bank studies and exhausted several other sources, such as: various universities, Institute of Research, UN/UNDP, Library of Congress, Brookings Library, FAO (New York and Washington), Corp of Engineers, Department of the Interior, Salt River Department, Colorado River, Tennessee Valley Authority. We have also taken into consideration crucial factors in each country of the development of land and irrigation systems prior to derivation of a cost estimate and various feasible alternatives. These factors are based on our reviews of pertinent literature and are as follows:

1. That many hydromorphic soils should be drained before irrigation (Lake Chad).
2. Many vertisol type soils have a micro relief that must be leveled before irrigation.
3. Some saline soils require a large volume of irrigation water and good drainage to avoid saline phreatic ground water from rising to the surface. Others are sodic giving rise to perched water table which must be drained from the surface.
4. Tropical ferruginous soil is generally too sandy, and prohibitive to irrigation. Typical of this condition is Lake Chad and some areas of the Niger River.
5. Many soils are already cultivated in recession crop; however, a stable irrigation network requires flood control through costly and dangerous daming of water.
6. The difficulty to install large irrigation schemes in some areas.
7. Type of irrigation -- surface, sprinkler, etc.

The cost adjusted for each country are as follows:

Chad	\$ 3,000	
	1,800	average ha \$ 2,034
	1,300	
Mali	1,600-2,000	

Mauritania	1,600-2,000	average ha \$ 1,660
Senegal	2,200-2,300	
Niger	2,500-1,800	1,600 average ha \$ 1,967 ¹
Upper Volta	2,000-1,600	1,200 average ha \$ 1,600 ²

Route of Return

Using a rule of thumb we found that the economic return will not be high in some areas and negative in gross terms in total. For example, the cost of growing millet will be very high.

This does not allow to calculate the amount of food needed in year 2000/2025. I have developed a methodology based on rate of growth of various cohorts of population, consumption unit, and productivity under various alternatives.

It appears that the Sahel-Sudano countries with the rate of growth of their populations will be faced with a food shortage and the strategy recommended is dry land farming without intensive irrigation.

1

More than 1000 studies, reports, Ph.D. thesis articles concerning new technology and cost in areas similar to Sahel have been located in various areas in the U.S.

2

The cost for Upper Volta would have been higher (2,526 ha) and for Niger 2,500 a ha if \$100 million allocated to eradicate onchocerciasis was not planned under investment for environment.

Transport and Communication

One of the most efficient methods of exposing tradition bound people to new concepts and attitudes is the commerce of ideas that has always developed along transport routes. Throughout history highways have spread plants, animals, products, processes, wants and ambitions, breaking through the hard crust of custom and monotony. The modern equivalent of the caravan are the truck and bus. One of the greatest handicaps of the Sahel-Sudano countries is interior isolation. Their capitals are often linked to the outside through other countries (Chad, Niger, and Upper Volta) but the countryside lacks roads.

The transport conditions in the Sahelian countries as analyzed by World Bank and the UN are as follows:

Chad

Chad is a vast, very poor, landlocked country concentrated in the Chari River Basin in the South, which depends on cotton and livestock production. The remaining northern 90% of the country consists of desert and Sahelian grasslands. Transportation plays a critical role in the economy, and the lack of adequate international connections constitutes one of the prime obstacles to development. Trade is dependent on long external routes using multiple modes. The resulting high transport costs inflate the domestic prices of imported inputs and consumption goods, and threatens to hamper the development of exports.

Internal transport is generally inadequate due to poor, insufficiently maintained roads, and the ~~season variations~~ of water transport. There is no railway. The highway system consists of 7,232 km of classified

roads (232 km paved) and about 25,000 km of unclassified tracks. The riding quality is generally poor. Water transport, although seasonal, was more important in the past when all roads were primitive; it is now concentrated on the Chari River between Lake Chad, N'djamena, the capital and Sarh, and accounts for only about 5% of total transport activity. There is an international airport at N'djamena and a local airline company operates scheduled services between the four principal towns.

Chad relies on four major transport routes to the sea, and pursues a policy of dependence on no single route. These routes are as follows:

- a. Trans-Equatorial rail, river and road system from Pointe Noire (Congo) through Bangui (C.A.R.) to southern Chad;
- b. the Trans-Cameroon route from Douala to N'Gaoundere, from where it connects by a road system still under construction to Moundou and Bongor and N'djamena;
- and c. the Nigerian routes, the main one from Nigeria's sea ports by rail to Maiduguri and then by road to N'djamena, and the secondary one over the seasonally navigable Benoue River through northern Cameroon by road to the cotton zones in southern Chad.

Transport infrastructure absorbed about 23% of public investment during the 1966-70 Development Plan. Over 90% of this amount was for roads, particularly in the South. Unfortunately, road transport costs have been significantly reduced as a result, although the reliability of service during the rainy season has improved.

The development prospects for river transport are limited, and air

transport handles almost exclusively meat exports and high value imports. Domestically, air transport offers a potential for the Chadian economy, but the infrastructure of secondary airports is generally deteriorated. Low traffic levels in certain regions, mostly north and east of the Chari River, do not justify large investments in land transport, and air services are seen as a reasonable alternative to ensure the flow of goods and services to these areas.

Mali

The larger northern part of landlocked Mali is desert. Most of the population lives in the Southwest where most economic activities are concentrated, and along the Niger River. Because of the low population density, distances are long and traffic volumes are low. Of the seven countries bordering Mali only two (Senegal and the Ivory Coast) provide connections to the Atlantic to handle overseas trade; capacity is adequate only if both routes are used. The distance from Bamako to either Dakar or Abidjan is about 1,200 km; distances to either Conakry (Guinea) or Freetown (Sierra Leone) would be shorter, but these ports are not being used.

Mali has a fairly extensive transport system which serves most of the country adequately. The physical infrastructure consists of: a. a 640 km railway which links Bamako via the Senegal Railway with Dakar; b. about 1,650 km of inland waterways which are, however, navigable only seven months of the year, and because of rapids and rock outcroppings beyond Gao, do not provide river navigation all the way to the river's

mouth in Nigeria; c. a 13,000 km road system, of which 3,100 km are all weather and 1,630 km paved, with the rest a scattered network of secondary gravel roads and tracks. There is an international airport at Bamako, and about a dozen airfields which serve domestic commercial needs.

The transport infrastructure is generally adequate if used efficiently. The condition of the primary roads can serve present traffic levels, although several older paved roads need strengthening and rehabilitation. The secondary road and track system is in less satisfactory condition. Highest priorities are for adequate maintenance and for improvement of the secondary network.

The government exercises considerable control over the transport system. Public ownership applies to the Malian railroad; a trucking company which carries about 20% of total road freight; a navigation company handling about 70% of waterway traffic; and Air Mali, the only internal carrier. The key elements of transport regulation are: a. centralization of transport demand for imports, exports, and all domestic road haulage through government administered freight offices; and b. control of all freight rates.

Notwithstanding the government control of the transport industry, its performance is less than satisfactory because of misuse of the system. There is ample scope for increasing railway capacity, but improvements in operations can be successful only if the Senegal Railways are similarly

improved. In recent years, the road vehicle fleet has grown at a faster rate than the economy, but output is much too low; average annual truck kilometrage is only about 25,000 km. The fleet suffers from inadequate maintenance and from overloading. In general, the poor condition of the railways and the trucking fleet are the direct result of inadequate levels of government controlled freight rates and inefficient operations.

Mauritania

Agricultural activities in Mauritania are of necessity concentrated on a narrow strip of land along the southern border. Agricultural production is heavily dependent upon favorable weather conditions (rainfall and overflooding of the Senegal River), as was dramatically proved by the recent drought which caused an estimated 60% drop in cereal production. The only major economic activity possible in Mauritania's Sahel region is the raising of large herds of cattle, sheep, and goats, and this activity provides the main source of livelihood for 70% of the country's population. The drought has forced a substantial number of nomads to seek refuge in towns where populations have now increased sharply. The possibilities are limited for early departure of these nomads, as it is expected to take about a decade before livestock herds can be rebuilt to pre-drought levels. Enclave mining and fishing activities have developed in the northern areas of the country at Nouakchott, Port Etienne, Akjoujt, and Fort Gouraud, but have had little effect on the population concentrations in the south.

Historically, the transport system of Mauritania was designed to link

population centers with the major port of Dakar in Senegal, the import/export gate. The majority of the population located in the flood plain of the Senegal River was served either by river transport, or by the Senegal-Mali Railway which passes close to the Mauritanian frontier. Road transport and the traditional camel caravans were used to provide the limited onward movements from small river ports to more inaccessible areas. A main road running north from Rosso, the principal Senegal River port, offered access to the sparsely settled semi-desert areas lying hundreds of kilometers away.

When the new lighterage port at Nouakchott was completed in 1966, traffic movements were diverted from the Dakar oriented pattern, and a considerable reversal occurred in the northward flow over the Rosso-Nouakchott road, as imports tend to enter through Nouakchott rather than Dakar, and to move south or north from that point. However, movements through the more populated south and southeast remain largely unaffected by this change. Traffic destined for this area, regardless of whether it originated at Nouakchott or Dakar, must pass through Rosso and utilize the traditional river or road system (or both) to its ultimate destination. Seaport facilities are also located at Port Etienne in the north, primarily for export of iron ore.

The road system totalled about 6,000 km in 1967, of which 3,200 km are national routes and 2,800 km are dirt tracks serving the various subdivisions. Most of the roads are in poor condition. About 6,000 motor vehicles were in operation in that same year, of which about 3,700 were buses, trucks, and other heavy vehicles.

There is only one railway which covers the 670 km distance between the iron ore deposits near Fort Gouraud and the export outlet at Port Etienne. The railway traffic is largely confined to iron-ore movements, with small amounts in imported general traffic.

The organized waterway services on the Senegal River consist of a few powered crafts and barges. On the Mauritanian shore, several primitive ports provide manual loading and unloading facilities for the powered vessels and for small itinerant craft. The river is seasonally navigable from Rosso to Kaodi.

Mauritania has a relatively well developed air service network with 12 airports capable of handling four-engined aircraft, and 10 other fields. Local air services play an important role by compensating for the lack of adequate surface communication to remote or seasonally isolated areas.

Transport development policy has so far been appropriately confined largely to the maintenance and gradual improvement of the existing road network. The government is planning early construction of a paved road from Nouakchott to Boutilimit, and realignment and paving of the Boutilimit-Aleg-Kiffa-Nema roads. However, since the roads would bypass important agricultural regions, traffic might not be sufficiently heavy to make these projects economically justified. The government is also considering construction of a deep sea port at Nouakchott to further lessen the country's dependence on Dakar. The existing wharf at Nouakchott has a capacity of 250,000 tons, but in 1972 handled only 120,000 tons. Dry cargo traffic shipped through Dakar totaled only some 10,000 tons in 1972.

Niger

Niger is one of the largest landlocked countries in Africa. The northern 90% of the country is desert, a low plateau in the Saharan and sub-Saharan regions. The population is therefore largely concentrated on a strip of land over 1,000 km long in the extreme south; the urban population is still small. Long distances both within the country itself and to the nearest ocean ports burden the economy with high transport costs. There are three main outlets to the sea:

1. The Dahomey route (about 450 km from the Niger border to the sea) which connects Gaya by road to Parakou, and by rail to Cotonou;
2. The Nigeria route (about 850 km) which connects the central and eastern regions by road to Kano, and by rail to the port of Lagos; and
3. The Ivory Coast route (about 1,650 km) which connects Niamey by road to Ouagadougou (Upper Volta), and by rail to Abidjan.

Achieving reduction of Niger's external transport costs will depend on improvement in transport facilities in these neighboring countries.

About 80% of the groundnuts for export are usually routed to Kano in Nigeria, and from there via the Nigerian Railway to Lagos. Most of the remainder is exported through Dahomey under regulation by the Organization Commune Dahomey-Niger (OCDN), formed by the two countries in 1959. OCDN operates the Parakou-Cotonou railway, and has the exclusive right to charter road transport for evacuation of that portion of the groundnut production routed through Dahomey. The amount to be exported over this route is determined at the beginning of every crop season, however, the volume actually shipped via Dahomey has been larger in some years when

there were capacity problems on the Nigerian Railway.

Niger's internal transport system consists essentially of a road network. The system includes about 7,300 km of roads of generally low design standards. There are about 500 km of bituminous roads, of which 44 km have a sufficiently wide pavement (6 or 7 m) to permit two-lane traffic. About 40% of the national road system is gravel surfaced. Most gravel roads are considered to be all weather, but many are closed to truck traffic after heavy rains. In the sparsely populated north where transport requirements are limited, the volume of freight is too low to justify the infrastructure costs of modern highways. Camels are the most economical form of transport, even though their operating cost per ton-km is two to three times higher than that of trucking. The number of road vehicles was about 10,000 in 1972, increasing annually at about 11% on the average.

There is no railway, and water transport on the Niger River is at present of little significance. Internal air traffic, though increasing in volume, is relatively light. International air traffic is through the airport at Niamey.

In general, Niger's transport infrastructure can be considered adequate provided it is efficiently maintained and operated. Improvements of road links to railheads in Nigeria seem warranted. Recent declines in rail traffic are attributable to deficiencies in management, the unsatisfactory rate policy, and competition from road transport.

Senegal

Senegal is the smallest of the countries. The population is largely

concentrated in the west, and a considerably larger share lives in urban areas (29%) than in the other Sahelian countries (5-10%). This fact has its effect on traffic patterns: distances are shorter, especially to the Atlantic port of Dakar, and there are larger flows of food supplies from rural to urban areas.

Senegal has a fairly well developed transport system, due partly to its historically central position in the former French West Africa and partly to the emphasis of its Development Plans since independence in 1960. Most of the 9,100 km of roads and 1,032 km of railway lines are oriented toward Dakar, which is the only protected commercial deep water port among the Sahelian countries, and which also provides primary transport access for landlocked Mali.

The road network is concentrated in the western one-third of the country, which is the area of primary economic activity. About one-quarter of the roads are paved, and a further one-third are all weather gravel and earth roads.

The railway system comprises about 660 km of heavily traveled main trunk line between Dakar and Mali, and about 370 km of branch lines. The main line carries an estimated 36% of Mali's exports and 63% of its imports, and this traffic generates about 52% of the system's gross revenues. Other major freight traffic includes phosphates and groundnuts. Passenger traffic has declined recently with expansion of the road network and the vehicle fleet. The railroad still accounts for about 65% of total freight carried, but is suffering from management and operating

problems, and performance is unsatisfactory.

Little use has been made of the Senegal and Gambia Rivers for transport, and coastal shipping is not significant. Dakar serves as a major international airport, and a national airline provides service to a dozen outlying towns.

The transport infrastructure absorbed about 26% of public investment between 1968 and 1971. Foreign aid, in turn, accounted for 58% of 1971 public investment, and is expected to increase in the future. Transport investments supported by foreign aid have included, inter alia, highway projects emphasizing maintenance and feeder road construction; railway projects for purchase of new equipment, rehabilitation of existing items, and management improvement; and an operation for extension of port facilities at Dakar.

Several needs can be identified for future transport investment:

1. The construction of feeder and farm-to-market roads as an aid to agricultural development;
2. Improving the efficiency of existing rail services to cater for the resumption of substantial groundnut shipments in 1972 following the loss of preference in the French market; and
3. Solving the many problems in the area of inter-modal coordination (pricing, investment and entry regulation) which hamper the transport system. Approximately 80% of traffic is however captive to rail, including block train bulk (phosphate) and international traffic to Mali.

Upper Volta

Stagnating overall exports and growing imports have caused a large trade

deficit in landlocked Upper Volta. During the last few years, rising cotton exports helped diversify the country's export structure traditionally dominated by livestock products. At the same time, however, adverse weather and health conditions, as well as lack of investment and operational funds, have resulted in a significant decline of livestock exports.

Transport within the country is primarily by road. The system consists of about 8,900 km of classified roads, and about 8,000 km of rural tracks. The network of primary roads (4,450 km) radiates from the capital, Ouagadougou, and from the main commercial center, Bobo Dioulasso, and largely satisfies the current needs of the country. About 385 km of these roads are paved, with the remainder gravel surfaced. The latter are considered to be all weather, although the unpaved sections are generally closed to heavy traffic for short periods after heavy rains. Maintenance is carried out only on the primary network, and the other roads have deteriorated over the past decade to little more than trails. The secondary and tertiary roads are passable to heavy trucks and four-wheel drive vehicles, but only during the dry season; the rural tracks are used largely by bicycles, porters, and pack animals.

The most important international transport connection is the railway linking Ouagadougou with the seaport of Abidjan (Ivory Coast), a total distance of 1,145 km. The railway is a semi-autonomous agency jointly owned and operated by the governments of Upper Volta and Ivory Coast. Some 2.5 million passengers and 756,000 tons of goods were carried in 1970, with Upper Volta traffic alone accounting for over half of total passenger-km and ton-km. Purely internal traffic utilizing the 518 km

of track within Upper Volta is low, not less than 25,000 tons in 1970. Both Ouagadougou and Bobo Dioulasso have international airports. Internal air transport is negligible. A small domestic airline was created by the government and private interests in 1967, but it has not yet been able to operate profitably due to the lack of demand.

The government has been giving investment priority (dependent on external sources) to the improvement of international road links with Mali, Ghana and Togo. The roads between Bobo Dioulasso and the Mali border, and between Ouagadougou and the Ghana border have recently been paved with external financing, and work on the Ouagadougou-Togo border road is underway. The government's decision to upgrade the road links with Ghana and Togo has been based mainly on a desire to create alternative outlets to the sea and reduce the country's dependence on the railway connection to Abidjan. This rail link generally operates efficiently and, except for short periods of peak demand, has sufficient capacity to handle the requirements of external transport. The railway is at present the most economic route to the sea for the western and central areas of the country where economic activity is concentrated.

Future transport investments in Upper Volta include construction of additional trunk roads, rehabilitation of existing secondary roads, and construction of transport links to the Tambao ore project.

Investments should also concentrate on maintenance of existing secondary roads, and the construction/reconstruction of some primary roads where economically justified. Continued upgrading of the railway in the Ivory Coast is recommended.

Transport Development in the Sudano-Sahelian Countries

In considering the transport problems of the Sahelian Zone, the following features are significant : a) generally flat terrain; b) desert or semi-desert weather and soil conditions; c) long distances from the sea; d) sparse density of population; and e) meager and often disjointed inland transport lines. The economies, which had been growing at annual rates of 2-3 percent, are generally at very low economic and technological levels. Of the six countries in the zone, four are landlocked and are listed by the UN among the least developed.

The recent drought has seriously damaged the economic strength and transport facilities of the zone. Apart from the direct effect of the weather, it has exerted a serious drain on the available labor and material supplies for transport routes. The problems of relief and rehabilitation add to the requirements for transport infrastructure to facilitate longer term economic and social growth. Thus, the assistance needed falls into three categories: the short term, the medium term, and the long term. The short term measures are for meeting the needs of relief and rehabilitation, especially the movement and distribution of foodstuffs; the medium are for projects planned to be completed in two to four years; and the long term are those which should be extended beyond four years. The following proposals are made accordingly.

Inasmuch as the Sahelian Zone countries are all in the same Savannah and Sahara region, with similar terrain, soil, climate, and general economic and technical conditions, it is logical that a number of transport problems should be dealt with on a zonal basis. This is necessary, especially in view of the establishment of the West African Economic Community in 1971 by the seven countries, Dahomey,

Ivory Coast, Mali, Mauritania, Niger, Senegal and Upper Volta. In some cases, such as the development of navigation on river systems that connect more than one country, and in others, such as road links, the common concern calls for concerted and coordinated action.

Proposals of Sub-Regional Projects

In view of the large scale nature of such projects, these are mostly for the long term. Whereas these are listed as sub-regional projects, to provide wider perspectives, some of them are also itemized as country projects.

A. Navigability and Port Studies on the Senegal River

This UNDP project (RE6-86), which started in 1967, has been completed. However, the larger part of the recommendations made by the United Nations experts and a consulting firm aiming at the better utilization of the Senegal River for water transport and the improvement of the port facilities at St. Louis and Kayes has not been implemented yet.

B. Niger River Navigation Improvement

The river is now navigable in only four sections, and in most sections only seasonally. A preliminary study of the problems of the river for navigation purposes has been made. Further action for making feasibility and pre-investment studies is necessary on selected sections, especially in Mali and Niger.

C. Extension of the Trans-Saharan Road Network

The present project of feasibility and engineering studies covers routes from In Salah to Tamanrasset and to Gao and Arlit. In view of the long term needs of the Sahelian states, consideration may be given to extend the network:

1. To Niamey by road from Gao to Labbenzenga through Asongo;

- 2. to Bamako by Gao-Mopti road;
- 3. to Tambao (Upper Volta) from Gao.

Such extensions would provide links from the Mediterranean to the Gulf of Guinea in the Atlantic.

D. Links to the Trans-African Highways

From Chad to Cameroun and Nigeria, a road link to the projected Trans-African Highway would be of great benefit to Chad, a country severely handicapped by difficulties of transportation.

E. Lake Chad and the Chari and the Lagone

A link from the Lagone to Mayo Kebbi river (tributary of Benue River) would provide a through waterway to Nigeria. A preliminary study seems necessary.

F. Multi-Country Railways

- 1. A route linking Sudan-Chad and Nigeria. This is an old proposal which may be studied in due course.
- 2. Extension of the Kankua-Conakry Railway to Bamako.
- 3. Ouagadougou to Niamey, and to Tamboa.
- 4. Rail link from Bamako to Kayes. Consideration may be given to these possibilities, in due course, as steps toward eventual establishment of an integrated African railway network.

Chad

The country is landlocked with extensive distances between economic centers and to the sea. Lake Chad is open for navigation all year round but the two main rivers are navigable only seasonally. A ten-year plan from 1971-80 provides development of navigation and river facilities and boats.

Short Term

- a) Improvement of river boat and port facilities and navigation aids.

- b) Assistance to the government for establishment of Transport Department.

Medium Term

- a) Feeder road extension in rural areas.
- b) Fort Lamy-Fort Archabault Road Project (559 km) - presently dirt roads, not passable for period July-November.
- c) Fort Archabault-Lere Road Project - presently dirt road; washed away conditions; to be reconstructed. It handicaps cotton shipments.

Long Term

- a) Development of navigation on the Lake Chad system.
- b) Railway links to Sudan and Nigeria.
- c) Extension and upgrading of major road lines.

Mali

Mineral explorations underway; alternative routes to the sea are being developed.

Medium and Long Term

- a) Gao-Mopt Road, now earth track, to link the North, sparsely populated but rich in natural resources, to the densely populated South, and to link the Trans-Saharan Road to Bamako.
- b) Gao-Lahbenzenga Road, to link Mali to Niger, and Niger to the Trans-Saharan Road.
- c) Gao-Tambova Road to link Upper Volta to the Trans-Saharan Road.
- d) Rail link from Bamako to Kayes - Kayes - Dakar railway is in poor condition but under improvement, with IDA loan. The link would provide the country with a fast and large scale access to the sea.
- e) Extension of Kankou-Conakry railway to Bamko - it would provide an alternative route to the sea.
- f) Improvement of the navigability on the Senegal River - the present project may be extended to include upper stream sections

of the Senegal River beyond Kayes.

Mauritania

The northern part of the country has great mineral potentials and the South is mainly agricultural and pastoral. Copper deposits are being exploited at Akjoujt in the central region. Iron ore is being mined at Zoutirat. A railroad was constructed in 1952 between the deposit and Nouadhibau. There is need for an integrated transport network.

Long Term

Further Senegal River development (now under study between St. Louis and Kayes for improvement of navigation, crafts and trans-shipment links).

Upper Volta

A project of study for improvement of the Abidjan-Ougadougou Railway has been completed. Improvement of the railway is to be implemented.

Medium Term

- a) Improvement of the physical equipment and facilities of the Abidjan-Ouagadougou Railway.
- b) Fada N'gourma-Niamey Road, now under study and partly under construction.

Long Term

- a) Railway extension to Tamboa.
- b) Railway extension to Niamey.

Niger

Medium Term

- a) Road construction to link Niamey to the Trans-Saharan Road.

b) Link to Upper Volta from Niamey by road.

Short-term and Long-term Waterway Transportation
Development Projects in the Sahelian Region

The Sahelian region has two major river systems, the Senegal River, the Niger River and their tributaries. The Senegal River is navigable throughout the year up to Kaedi for vessels of about 2.50 meters draught. Upstream to Bakel navigation is possible only during periods of flood.

In a study made on the Senegal River it was found that the construction of the Manantali hydroelectric project would regulate the flow (about 300 cubic meters per second) in the upper portion in such a way that navigation would be possible for vessels of 1.2 meters draught up to Bakel throughout the year. In order to develop the navigation to Kayes additional reservoirs and flows would be required. The regulation of flow through construction of the Manantali Dam could be called an intermediate development plan for the navigation conditions.

There are no short-term development projects in inland waterway transportation except the use of very shallow draught barges.

The Niger River is navigable in its lower portion, namely from the ocean port, Harcourt, to Yelwa. On this lower stretch of the Niger, navigation is possible for barges of up to five foot draught throughout the year. Upstream from Yelwa to Gaya, Niger navigation is possible only during the approximately seven month period of high floods. Were there not the obstacle of the so-called Gaya-Malanville bridge, which incidentally, could be modified to permit vessels to pass underneath, navigation to Niamey would be possible for the same period of seven months when there are high

floods. Even during high floods navigation would not be possible upstream from Niamey unless the river were canalized. There exists a proposal that a dam be constructed at the place called Kandaggi, which would then permit navigation to Ankoun in Mali.

From Gao to Bamako there exists the possibility of year round navigation but for very shallow draught vessels only. The most difficult section would appear to be from Ansongo to Gao which has rapids. These can be negotiated only with very shallow draught vessels during floods. On the Niger the short-term project could be considered the reconstruction of the Gaya-Malanville bridge in such a way that it would permit navigation to proceed to Niamey during the six to seven month period of flooding. The long-term solution to the problem of sufficient flows can only be solved by the construction of reservoirs for storage of water during rainy seasons and the regulation of flow from these reservoirs during the dry low-water season.

The Senegal and Niger river basins have been studied in the past and documentation exists suggesting projects which would contribute to development of water resources and improve navigation conditions in these river systems. Among the documentation for the Senegal River, there was a separate study of navigation and ports. There was also a UNDP project for the development of hydropower in the upper portion of the Senegal river basin.

As regards the Niger River, the problems of the influence of projects in one section of the river upon other sections have been thoroughly investigated by ITALCONSULT in their report, "The Study of the Consequences which Projects Planned by the Governments of Riparian States may have on the Regime of the Niger River". This report was prepared at the request of

the United Nations. The navigation study of the Niger River between Tossaye and Yelwa was prepared by NEDECO, the Netherlands Engineering Consultants, and discusses in great detail the problems of navigation on the Middle Niger.

The lower portion of the Niger River is navigable year round, as well as portions of its eastern tributary, the Benue River.

In view of the many complexities which are involved in problems connected with navigation on the Senegal and Niger Rivers it is suggested that an interdisciplinary team of experts of the United Nations review the entire documentation of surface water resources in the area and undertake, in due course, a field mission in order to define in detail priority projects in connection with water resource development schemes of which navigation and inland waterway transportation should be an integral part.

CHAD -- New Permanent All Weather Roads

1) Moundou-Painamar-Cameroon Border	120 km
2) Baugor-Lai-Gabri Ngolo	170 km
3) Sarh-Abeche	611 km
4) Bridge Hellibongo (Chari)	18 km
5) Sarh-La Sido	123 km
6) Guelendano-Bongor	84 km
7) Gabri-Ngolo Doba	88 km
8) Moundou-Doba	90 km
9) Boda-Boumra-Sarah	170 km
10) Dum-Hadjer-Axe-Sarah-Abeche	75 km
11) Aboudia-Am Timem	135 km
12) Abeche-Adra	170 km
13) Ati-Mongo	160 km
14) Massaquet-Bokoro-Mongo-Man alme	510 km
15) Massa kory-Ngourmi-Bol	190 km
16) Massaquet-Massakory	190 km
Mousgoro	202 km

Total 3316 x \$120.000 = 397.920.000

Total Chad 397.920.000

1.101.000

1.518.000

400.539.000

1) Maintenance and Repair Principal Roads:

Fort Lamy-Massena	160 km
Massaquet-Bir Garat	103 km
Massaquet-Ngourma-Mongo-Maugalm	546 km
Djermaya-Djimtilo	82 km
Abeche-Adre	167 km
Abeche-Biltine	92 km
Abeche-Mangalme-Aboudeia	355 km
Sarh-Kyabe	98 km
Guolondang-Milton	234 km

Total 1835 km x U.S. 600 = 1.101.000

2) Maintenance Secondary Roads:

Mani-Karal-Tom-Karfin	73 km
Bir-Garat-Massouro	96 km
Ngoura-Ati-Djadda	199 km
Dum Hadjor-Haraz	101 km
Biltine-Amzer-Iriba	247 km
Abeche-Goz-Reida-Antimam	402 km
Kyabe-Am-Timam-Abou Deia	394 km
Am-Timam-Haraze-Mangueye	162 km
Mongo-Abou Deia	118 km
Melfi-Bokoro-Massena	921 km
Damtar-Kendigue-Abou Deia	450 km
Abeche-Am-Dam-Saraf	225 km

Total 3795 km x 400 = U.S. 1.518.000

TRANS-SAHELIAN ROUTE

This route which runs very close to the Border of Gambia would serve Senegal, Mauritania, Mali, Upper Volta, Niger, Cameroon and Chad.

This road which length is 4196 km will relay Dakar to Ndjamena as follows:

- Senegal : Dakar-Tambacounda-Naye
- Mauritania : Dakar-Nouakchott-Niuro Du Sahel
- Mali : Naye-Niuro-Bamako-San-Faramana
- Upper Volta : Faramana-Rodo Dioulass-Duagadougou-Gouina
- Niger : Gouina-Niamey-Maradi-Jibia
- Nigeria : Tibia-Maiduguri-Fotokol
- Cameroon : Fotokol-Malam-Fort Foureau
- Cameroon/Chad : Fort Foureau-Fort Lamy (crossing over Chari River)

Although the length of the road is 4196 km only 3609 km are all weather standard and 509 improved.

Cost 3069 x 120.000 = 433.080.000

Total	2.836.314
Port. Navigation	200.000
	<hr/>
Telecommunications	3.036.314

Telecommunications

According to the UN/ECA the current Pan-African telecommunications network plan would seem to cover the medium and long-term requirements of the area under consideration for telephone and telegraph services.

A survey which resulted in the plan which was to design an international network involving the minimum capital outlay and with adequate capacity for the expected traffic up to 1990 - at cost of 26.227(1).

Country	Route	Distance in Km	Route Cost US\$(000)	Total Cost US\$(000)	Internal Rate of return%	Remarks
Niger	Maradi-Kano (Nigeria)	241	270		15	Cost of Niger Section
	Niamey-Dosso (Dahomey)	310	1,355		10.2	" " "
	Niamey- Ouagadougou (Upper Volta)	120	569		0	" " "
	Niamey CT3		714		8.1	
	Total for Niger			2,908	8	
Upper Volta	Ouahadougou- Nalouou (Niger border)		1,560		5.0	
	Koupela-Sango (Togo border)	145	598			
	Bobo-Sikasso Ouagadougou CT3	145	424 747		0 11.6	
	Total for Upper Volta			3,329	11	
Mauri- tania	Akjout-Atar	200				
	Akjout-Choum	87	1,582		3.5	
	Nouadhibou- Choum Choum-F/Darik	500 163	3,294		4.1	
	Nouakchott- Rosso (Senegal)	12	32			
	Nouakchott CT3		460		15.7	
	Total for Mauritania			5,368	5	

(1) UN/ECA - ECA on going activities and proposed role in medium and long-term programmes in the drought affected countries of the Sudan-Sahel, 1973.

Country	Route	Distance in km	Route Cost US\$ (000)	Total Cost US\$ (000)	Internal Rate of Return%	Remarks
Senegal	Kanlack-Kidina	490	2,074		14.9	
	Tambacounda- Koundara	130	684		9.8	
	Total for Senegal				2,758	13.7
Mali	Bamako-Kayes	500	2,081		10.3	
	Bamako-Sikasso	370	1,605		1	
	Bamako-Mopti	560	2,638		13.1	
	Bamako-Siqouri	-	Not surveyed
	Sikasso-Korhogo	-	"
	Bamako CT3		692		13.4	
Total for Mali				7,016	9.3	
Chad	Ndjamena-Moundou- Sahr	700	4,078		11.2	Alternative 1
	Ndjamena-Moundou- Sahr up to CAR border	760	4,588		10.3	Alternative 2
	Ndjamena CT3		260		6.5	
Total for Chad				4,848	10.1	
Grand total for the area				26,227		

Indicative Estimated Investment for Potential
Dams and Hydro-Electric Plant

The indicative estimated investment for potential dams and hydro-electric plant planned to the year 2000 are based on studies by UN, OMVS, IMT and reports referring to studies by ITALCONSULT, SENEGAL CONSULT, CARLO/PONTI. There is a large discrepancy between all studies about cost. In our estimation we have largely used value judgement based on volume of dams and compared with OMVS quotations.

SENEGAL RIVER

US DOLLARS

Mantali Dam (12billion cubic meters)	80,000,000
Delta Dam (Diama)	16,000,000
Gouina	16,000,000
Felon	9,000,000

NIGER RIVER

Selingue (2 billion cubic meters)	24,000,000
Tossaye	55,000,000
Ansongo	13,000,000
Kaudaga (Niger North Niamey)	27,000,000
Asongo (Mali) Niger	13,000,000

THE VOLTA RIVER

Belli River (Black Volta)	30,000,000
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THE LOGONE AND THE CHARI RIVER

Komban (Chad) (4 billion cubic meters)	61,000,000
Gore (1billion cubic meters)	34,000,000

SENEGAL

Mantali Hydro-power (100 mw)	20,000,000
Gouina	4,500,000
Felon	3,000,000

NIGER RIVER

Selingue (140 mw)	8,000,000
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- A storage dam at Diama about 13 miles upstream from the Port of St. Louis to provide the Delta area with irrigation water.
- Improvement of the ocean/river port at St. Louis.
- The construction and improvement of a number of river ports.

Estimates are that when these projects are completed it will be possible to irrigate 430,000 hectares as against the present figure of 14,400 hectares. As a result wheat production will increase from 36,000 tons to 563,000 tons annually, rice from 221,000 tons to 1,344,000 tons, sorghum from 30,000 tons to 420,000 tons, and sugar cane from 120,000 to 325,000 tons. The creation of a stable agricultural economy would help stem migration to the urban areas. The introduction of irrigated forage land will boost livestock production.

Niger River

The regulation of the Upper Niger flow in Mali will be provided by the Selingue dam constructed on a tributary of the Niger, the Sankarani. The reservoir will have a two billion cubic meter capacity. The regulation will remedy a very critical situation in dry years, as was the case over the last three years, and maintain a flow of more than $50\text{m}^3/\text{s}$ in the Niger upper course. A pre-feasibility study of the dam has been completed. Financing is now seriously being considered by the European community and the German bilateral assistance.

The benefits of the construction would be the irrigation of 40,000 hectares ensuring, in addition, the permanent supply of the large scheme of the "Office du Niger".

The installed capacity of the dam site would be 40 mw, which will be required

for the supply of Bamko and Koulanga, a nearby town, from 1985 on. The regulation would also increase the production of other hydro-power schemes situated downstream from Selingue and in particular Sotuba, and in the future Kenie.

A considerable advantage of the regulation, which cannot be calculated is again the provision of water into the Sahelian zone at the most critical time of the year. The large loop which the Niger river course makes to the north, "la boucle du Niger" is an internal delta where the river diversifies into a complicated network of lakes and branches extending downstream to the Tossaye sill, a natural rocky dam. During the flood period this region is almost completely submerged. During the flow and after drying up by drainage and evaporation, large pastures remain which are the summer rendezvous for numerous migrating populations and herds. In addition to cattle breeding a main resource of the region is fishing.

The dam at Selingue will not be large enough to reduce the flood significantly, and therefore, will not impede the profitable inundation of the delta. But it will considerably increase the low flow discharge, thus providing the necessary water supply which has been missing these past years.

Downstream from Tossaye problems are different. As already stressed, the flood peak is considerably delayed and only arrives in Niamey in March; the middle of the dry season.

A project has been requested by the governments of Mali, Niger and Upper Volta on this part of the Niger River course: The study of the development of the Liptako-Burma region. More specifically, as far as the Niger is

concerned, a dam at the Tossaye sill would be studied. Its hydroelectric production would be used for the treatment of mineral existing in this sector (Maganese).

The Volta Rivers

Only the black Volta belongs to the category of large rivers flowing from south to north into the Sahelian zone. The other branches, the red and the white Volta, flow southward and have only reduced discharges due to their feeding in a low rainfall and runoff zone.

A project has been suggested by the United Nations for the study of the overall water resource development in the Upper Volta and for an integrated development study of the three Volta Rivers for the water supply of Ouagadougou: irrigation and eventually power production.

The Logone and Chari Rivers

These two rivers are most interesting examples of large rivers fed in the Guinean and Soudanese zones and bringing life into the Sahelian zone at the fringe of the desert. After merging at Fort Lamy, they flow into Lake Chad, the waters of which are fresh and may be used for water supply and irrigation.

The Longone River flows within a most populated area. This is not the case for the Chari which was a no-man's land border in the past between two races and remains underpopulated.

Over a distance of 300 km, the Logone and Chari meander in a sequence of internal deltas, vestiges of higher levels of the Lake Chad waters. These plains are inundated in the flood season and offer satisfactory pastures during dry months. On the other hand the almost complete breakdown of the hydrological network makes it difficult to reclaim these plains for irrigated cultivation

without regulation of the flow. A balance, therefore, has to be found between the conservation of favorable ecological conditions for fish reproduction and cattle breeding, and requirements for agricultural development.

Favorable dam sites exist on the Wina River at Koumban and on the Pennde River at Gore, two main tributaries of the Logone.

A reconnaissance study has been carried out by the United Nations at these sites and a pre-feasibility study completed from 1968 to 1970.

An important result of water storage in the reservoir of Koumban (4 billion cubic meters) and Gore (1 billion cubic meters) would be the reduction of the flood and consequently decrease the present evaporation losses in the inundated plains, therefore a significant increase of the Lake Chad supply might be expected. A diversion of some of the flow could eventually make power production possible at the Gauthiot falls on the Mayo Kebi (20 mw).

Despite some difficulties, the economic studies of the three schemes have been useful in finding which financing conditions and rates of development are required to ensure project feasibility.

For the Senegal River basin, according to a UNDP/United Nations report, final annual benefits would equal the cost only 18 years after the dam construction, despite a particularly favorable financing plan. Twenty years after the construction of the dam the benefits derived from agriculture (73,000 irrigated hectares at the time) would be \$3.89 million; from navigation fees \$1.60 million; and from energy sale \$6.43 million. On the other side of the ledger, the total financial charges for Manantali would be \$7.3 million per year (investment cost \$US 110 million). It must be stressed

that the report does not foresee mineral exploitation and industrial development which would certainly enhance the feasibility, but were judged to be unrealistic by the subcontractor.

For the Sankarni Niger River project at Selingue in Mali, benefits derive from 40,000 hectares of irrigated agriculture for which planned investment would equal approximately the same cost as dam construction, not including the power plant (\$24.5 million against \$27.0 million for the dam and \$1.3 million for the power plant). Other benefits would result from energy sale, taking into account savings from replacing diesel power by cheaper hydropower. The benefit-cost ratio (benefit-cost/cost) has been assessed at 1.5. Some 12 years after the termination of dam construction the production would stabilize and then annual benefits would accrue as follows: energy sale \$3.0 million, agriculture \$4.5 million, navigation \$0.09 million, and fisheries \$0.01 million. The annual cost for the dam would be \$1.3 million. Benefits from navigation are small because of the dredging necessary to improve the river bed. Fisheries also have a small return because fish production is already plentiful in the Niger River's northern loop (cuvette lacustre) and the only saving would result from the more favorable location of the Selingue reservoir with respect to the market places (Bamako and southern foreign markets).

The costs and benefits from development of the Logone River have been evaluated in the final report for the project "Feasibility study for the diversion of the Logone River floods". Despite the UNDP/United Nations recommendations, the necessary study for a more precise evaluation has not yet been initiated. As a first phase of development the construction of the dam at Kouman on the

Vina River appears to have special merit. The reservoir would store 3 billion m³ available for irrigated agriculture, water supply, energy production and navigation. The cost of the dam has been evaluated at \$22 million in 1969; the project cost would be approximately \$30 million. The annual cost is estimated at eight percent of the investment, i.e., \$2.4 million per annum while the cost of regulated water would only be \$0.08 mills per m³.

It appears that \$30,000 hectares could be irrigated rapidly. Other benefits are expected from a power plant established at the Gauthiot Falls (30 mw) at Mayokeli using a small diverted flow from the Logone through the Toubouri Lakes. This energy would already be entirely consumed in Fort Lamy, Bongor, Yagoua and Marola if it were available.

Water Development Dams - Electrical Plants

During the last 20 years the study of specific dam sites has been undertaken on all the large rivers. A preliminary inventory of the most suitable sites for dams and hydro-electric plants has been supplemented more recently by more sophisticated studies. These projects, which by no means exhaust all the possibilities for surface water study on the major rivers, include:

Senegal River Basin Development

The Senegal River flows through the Sahel-Sudano states of Mali, Mauritania, Senegal and Guinea. The river acts as an important avenue of transport, and source for irrigation and fishing, but little has been done, to date, to fully exploit its full potential.

During the past 20 years some \$10 million worth of studies have been conducted for the development of the Senegal River Basin. The UNDP

has drawn together, from these studies, a plan for the Integrated Development for the Senegal River. This plan envisages continuing investment requirements over a 35-40 year period totalling some \$3.5 billion. The objective of such an investment would be to develop agriculture and diversity crops through water control and irrigation; develop mining and agro-industries using inexpensive hydro-electric power; and development of river transport.

The keys to achieving these results are:

The construction of a regulating dam at Mannantalli plus a hydro-electric power plant of 100 megawatts.

Forest

The very foundation of all hopeful plans for agriculture and animal husbandry lie in the programs for forestation, stopping desert encroachment, and endemic disease eradication. In any landscape the forest is the anchor that holds the sheet of topsoil in place upon the ground. Trees exercise their beneficial influence on soils, water and climate in many ways. Their roots prevent the attacks on the soils of water and wind.

Studies carried on in Iraq by UNDP/FAO show that in the Upper Tigris Valley, poplar plantations can produce up to three times as much revenue as the wheat-clover rotation, and in lower Mesopotamia timber has demonstrated a comparable superiority over irrigated cotton. The forest can also play a major role in stopping the encroachment of the desert. When water is scarce, it has been proven to be more economical to utilize it for starting some kind of perennial vegetation rather than to exhaust it in the watering of agricultural crops that leave nothing behind. In fact, in most of the desert, fringe irrigation would no longer be necessary after five years and the tree plantations could rely solely on rainfall.

With the development of forests in the Sahel-Sudan, an industry could be developed in fifteen years which will provide jobs for the establishment and operation of pulp and paper factories, saw mills and other forest industries near the river basins, using rules of thumbs, we believe that planting, for example that involves extensive development around Lake Chad will generate more income than wheat or rice in longer terms.

The purpose of the approach is to develop also: 1) the cultivation of bush

that may constitute a forage for livestock; 2) to develop nurseries for various species of trees; and 3) to multiply tree plantations and to train personnel.

The estimate, for investment is based on a budget project of CBLT¹ and CLSS² in 1976 for forestation in the Lake Chad area of an area of 2000 ha.

We adjust the cost of \$750/ha. and the investment required will be near ~~\$1,050,000,000.~~

Chad	300,000 ha	\$ 225,000,000
Mali	200,000 ha	225,000,000
Mauritania	200,000 ha	150,000,000
Niger	300,000 ha	225,000,000
Upper Volta	100,000 ha	75,000,000
Senegal	200,000 ha	150,000,000
	<hr/> 1,300,000 ha ³	<hr/> \$ 1,050,000,000

¹ CBLT - Regional Commission on the Lake Chad Basin.

² CLSS - Committee permanent Lutte Contre Lasecheresse Dans le Sahel.

³ The numbers of ha needed for this scheme was developed from selection of areas from maps of various regions.

Rural Development

On the arable land that is to be kept under cultivation or to be developed, US technology and knowhow can be easily transmitted to Sahel-Sudano countries. The objective of our approach can be summarized as a movement away from some crops now accounting for more than 2/3 of the acreage under cultivation in the Sahel-Sudano, to more meat, more milk, and more cash crops such as cotton and sugar. In addition the land that must lie fallow each year under practice, accounting for another of the acreage in a given year, will be brought under sustained cultivation by diversification of crop and well planned schedules of rotation.

The strategy of rural development in the Sahel-Sudano calls for nothing less than a complete modernization of agriculture for the massive use of fertilizers, for mechanization and for the introduction of better seeds suitable for the regions.

A well planned rotation schedule calls for the production of forage and fodder crops. The reformation of agricultural development through rural development will lead naturally to its integration with animal husbandry. The present paradoxical situation of land overgrazed and overpopulated by livestock can be solved only through a rural development approach that can be acceptable to herders and nomads without hurting their values and beliefs. We estimate that at least five million head of cattle could be reared under these schemes.

Similar situations occurred in the Middle East, Southern Europe, Greece and Turkey, and also in the US when Mormons turned the arid land of Utah

The investment needed to develop such model in Sahel-Sudano for 2,000,000 families on arable and grazing land with light irrigation for an average of 900 ha of agricultural land and 900 ha of pasturage. The total area per village will be 210/250 ha. A full development of the project will necessitate the creation of 6,000 villages for 1,079,419 and 221,000 ha for future use of land divided between the six countries noted below at a cost of \$1,700 ha without the cost of expatriate management and extension field workers.

RURAL DEVELOPMENT

Country	No. of People	No. of Families	No. of ha	No of Villages	Total Cost
Madagascar	800,000	133,333	239,999	1,333	407,998,300
Mali	1,000,000	166,666	300,000	1,667	510,000,170
Niger	1,000,000	166,666	300,000	1,667	510,000,170
Sudan	200,000	33,333	59,910	333	101,999,838
Senegal	400,000	66,667	120,000	663	204,000,170
Upper Volta	200,000	33,333	59,918	333	101,999,830
TOTAL	3,600,000	599,998	1,079,419	6,000	\$1,835,998,470

into a prosperous state. Rural development will be an element for change in living habits, not only for nomads, but for a large section of the population.

For herdsmen and farmers the schemes on which we base our calculations offer the advantage of diversification and more productive utilization of their land. In their present dependence upon a single crop (principally millet) they are exposed to the hazards of weather and they must let a considerable portion of their land lie fallow from year to year. This scheme will introduce forage and fodder crop into their rotation and keep all of their land under continuous cultivation.

The suggested projects include light irrigation where possible, and livestock with dual animal and mechanization traction from the start. An average of from 1.5 ha to 4.5 ha cultivated is proposed per family with food crops based on improved varieties of millet and sorgham, maize and rice, and cash crops of rice, cotton and groundnuts. An average of 1.20 ha is to be cultivated per active person and 0.6-0.9 ha fallow. Each settlement of an average 100 families will include feeder roads (10% of the land), wells, watering ponds, health and education centers and expatriate management for seven years.

The model project is based on a pre-feasibility small scale study by FAC for an area of Upper Volta, which is part of the second five year plan of Upper Volta and, after modification, is now an operational project of IBRD, ¹ "Settlement of Bougouriba Valley."

¹ Appraisal of Bougouriba Development project - Upper Volta Report 297a - UV.

Inland Fisheries

A great potential for inland fisheries exists in the Sahel countries. The model calls for a development of inland fisheries centers and development of fish hatcheries.

Our estimates are based on UNDP project Niger RAF/71/273. Each center will have the ability to build small fishing boats adapted to the area, to train fishermen, to market fish, to do some kinds of food processing, and to collect statistics.

Each center will have the ability to multiply fingerlings and to reduce spoilage of fish caught. (In 1972, 5,000,000 were lost by spoilage in Lake Chad alone).

<u>Country</u>	<u>No. of Fishing Centers</u> ¹	<u>Amount</u>
Chad	50 x	\$4,30,000
Mali	100 x	8,500,000
Mauritania	25 x	2,125,000
Niger	75 x	6,375,000
Senegal	80 x	6,800,000
Upper Volta	100 x	8,500,000
		<u>\$85,050,000</u>

¹ The number of fishing centers to be developed are based on studies of MAPS and water resources of the six Sudan-Sahel countries.

Pasture in the Sahel-Sudano Region

Region Livestock:

Upper Volta

Tinarckachen	3,000 km ²
Voltaic Sahel	36,869 km ²
Sahel Pasture (North of 13 ⁰ parallel)	80,000 km ²
Leo Ranch	2,500 km ²
	<hr/>
	122,369

Mali

Mopti Area	88,750 km ²
Niono-Tenekou	8,000 km ²
Pasture North of Sohola	13,000 km ²
Pastures Area (others)	36,611 km ²
Yau/olilla Center	215 km ²
Pasture Segou-Sau	11,000 km ²
	<hr/>
	157,576

Mauritania

Sahel National Pasture	24,600 km
Southeast of Mauritania	15,000 km
1st, 2nd, 3rd and 4th	15,000
Pasture Region of Hodh	115,000 km ²

Fodder Resources in the 5th, 6th and 7-8th Region 30,000 km²

184,600

Niger

Varier Zones Niger	360,000 km ²
Sahel South of Tanzania	23,600 km ²
Zone of Zind	16,000 km ²
Dallol Maouri	7,500 km ²
Northern Region of Goure	6,180 km ²
North Sauam	3,450 km ²
North Dakoro	1,500 km ²

416,230

Senegal

North Part of Senegal	36,500 km ²
Eastern Part of Ferto	20,000 km ²
Gallael Area	4,015 km ²
Natural Pasture Delta Senegal	1,768 km ²
Natural Pastures of Upper and Mid Casamance	3,500 km ²
Triangle Tambocouda, Gioere Motom	16,500 km ²
Eastern Senegal	50,000 km ²

130,283

Chad

Kanew and Lakes South 16th Parallel	76,000 km ²
Pastures West of Batier	25,000 km ²

Ouaddi Haddad	15,000 km ²
Logone and Moyen Chari	36,000 km ²
Oulea Region and N'Djamena	2,000 km ²
	<hr/>
	152,000

Health

The WHO constitution proclaims "The health of all people is fundamental to the attainment of peace and security and is dependent upon the fullest cooperation of individuals and states". The achievement of any state in the promotion and protection of health in Africa is of value to all Sahelian-Sudano countries. There is a major challenge -- so many victories won by medical services during the past 35 years and they have been so well publicized that it is easy to believe that for every disease a remedy exists and that the old scourges have vanished. This is an illusion among people who are unaware of life expectancy in the Sahel-Sudano countries. Obvious malnutrition and deficiency diseases still exist.

In the Sahel-Sudano countries health problems are characterized by high mortality due mainly to CD and nutritional deficiencies coupled with inadequate basic services and a shortage of medical manpower.

In the Sahel-Sudano area people are more heavily parasited than in any other part of the world. Some health specialists state that there are on the average of two infections per man in Africa; schistosomiasis is the dominant form affecting nearly half of the population.

When communicable diseases are rife and malnutrition prevalent, infant and child mortality is high. This means that the population devotes a large part of its resources to bearing and raising children who do not live long enough to become the "economic units" needed to assure the country's prosperity. Thus the average life expectancy at birth is a basic indicator of the burden

of ill health. On the economy of a country, i.e. Chad there is a 160/1000 infant mortality rate. It is estimated that at least 15% of African children die before they are one year old. In some of the more remote zones of the Niger, for example, 30% of all children die before they reach five years of age.

If a collection of data were institutionalized and done in a more universal and structured way through an official government network communications system covering all segments of the population those figures would certainly be higher.

In the Sahel-Sudano area, the protein imbalance has become widespread by the decimation of the herd and it is felt that in the future certain clinical conditions will become even worse. This will likely gravely compromise the physical and mental growth and development of younger people.

A carbohydrate imbalance has always existed owing to a decrease in crop production. In fact, nutritional deficiency has lowered the resistance of inhabitants which makes them prone to the danger that their natural defenses and specific communities will be more susceptible to all kinds of diseases and their resistance to infection will be substantially lowered. It is expected that future generations who have been exposed to drought will have mental deficiency (Memphis, Tennessee - St. Jude Hospital study). It is recognized that the damage done by food deficiency, six months before birth to two years after, will be for life if not corrected in time.

The film "Prescription Food" in the US has been the basis of a federally funded program. The WIC program offered in a few locations in the USA free food and milk supplies for expectant mothers and children under one year of age.

Environmental and Basic Health

The provision of safe water supplies and sanitary disposal of wastes are fundamental requirements for healthy living in Africa in general and in the Sahel-Sudano countries in particular. Their importance far outweighs that of other environmental health problems such as improvement in housing and control of environmental pollution.

There has been no specific plan for the development of environmental health activities within the framework of the general socioeconomic development of the country; but only a series of incorporated microprojects. Most of them were designed as emergency measures to meet the dangers of rapid urban expansions. Health cannot be taken for granted when almost 90% of the inhabitants of the Sahel-Sudano countries are without adequate safe supply of water and when 98% of that population depends on the most primitive methods of disposal of excreta and refuse.

Parasitic Diseases

Malaria

In Africa in general and the Sahel-Sudano areas in particular, malaria is the most important public health problem affecting more than half the children under three years of age and virtually the whole population over that age. It is the direct cause of 10% of the health problems of children under five and disabilitates almost the entire population, causing miscarriage and highly complicating other diseases.

Malaria in the Sahel-Sudano area is one of the main obstacles to the economic

development. In endemic areas it may cause a loss of 20 to 40 working days a year per person of the working population.

It has been witnessed that Sahelian people who had to move to survival points have been exposed to malaria. Although those people have been practically untouched, in the past, by malaria because of their way of life in an environment ecologically unfavorable to the *Anophele gambia* and *Anophele funestus* vectors of malaria.

The fact that mosquitos cannot transmit malaria directly to each other make man's role in its diffusion a primary one. Widespread population movement caused by the last drought are a contributing factors of higher incidences of some diseases. It is expected that in the future malaria, if not eradicated, will expand with any project of water development in the area.

Trypanosomiasis (Sleeping Sickness)

The settlement and relocation of people in the area for the use of better land has always been a factor in the increase of sleeping sickness. Added to this, the expansion of roads and physical communication networks in Africa, all of which facilitate population movement, river crossing, etc., permits a danger of rapid reinvasion of areas by tse-tse fly if not completely eradicated. There is, however, a lack of information about the spreading of typanosomiasis. It is regrettable that the meager efforts of eradication have been more concentrated on areas recognized as cattle areas than human areas.

Onchocerciasis (River Blindness)

Contrary to the belief that onchocerciasis is limited in its distribution, one

can assume that its spread is around all rivers in Central and West Africa. It is too early to reach any conclusion on the control program that has been undertaken but success will be apparent only if extended to all the areas instead of limited to the Volta River area, which represents only a small place in comparison to the distribution of onchocerciasis in Central and West Africa.

Bacterial Diseases

Sahel-Sudano countries are prone to bacterial diseases such as cholera, salmonella, shigellas, and cerebro spinal meningites, that may be spread at any moment due to the lack of health education; the lack of measures for human waste disposal; and the lack of supply of water of good quality. As far as cerebral meningites, which has an outbreak period of epidemic proportions from November to February each year.

The available data of the prevalence of the diseases are great, 3.832, considering the health of Sahelian countries are shown in the tables below.

As for cholera, it has never been absent due to hygiene. TB has never been eradicated from the area and is always endemic, due to the undernourished population and the lack of available BCG for everyone.

Viral Diseases

Polioomyelitis: The absence of any systematic prevention measures to stop polioomyelitis added to conditions of poor hygiene make polioomyelitis permanent risk and is highly endemic in the area like viral hepatitis.

Measles: The lack of substantial facilities for transporting the delicate vaccine for measles has classified measles as one of the killers of young children, mainly because of pulmonary complications, it is a great threat, especially to the nomadic populations.

Yellow Fever: It is still present in Sahel and endemic and potentially endemic form. Outbreaks continue to occur sporadically either in the forest areas (*Aedes Africanus* and *Aedes Simponic*) and in urban areas (*Aedes Aegypti*).

Nutrition

In the sub-Sahara zones where populations are pastoral and closely dependant on their herds for food, diets are very unbalanced, with an emphasis on protein and fat, supplied by milk, the calories taken, in general, and the diet has always been imbalanced.

In the Sahelian zone food exchange between breeders (milk) and farmers (millet, sorghum and rice) or fisherman (fish) provide, when possible, some of the population with a more balanced diet than the sub-Saharan zone.

In the northern Sudanian zone the diet has always been unbalanced with an emphasis on carbohydrates provided by starch when available (millet, sorghum, and rice) which accounts for 60 to 70% of the calorie intake. In general, diet in the region has always been imbalanced.

The few nutritionists who have taken an interest in these situations have always been faced with a difficult task of adapting to a methodology of the conditions prevailing in the countries.

Schistosomiasis and Bilharzia

Certainly it is safe to say that there is no country in Central West Africa which is entirely free from schistosomiasis. Man made alterations in local ecological conditions have contributed to the geographical spread of this disease. There are already signs of contamination owing to regroupment of of the population group who had not previously been in contact with the disease and in the regroupment along a body of water harboring intermediary molusc or agents with the development of water resources. In the future schistosomiasis is apt to spread, for the same reasons as malaria.

The incidence of bilharzia has increased but it is of man's doing. Construction of dams, irrigation ditches, etc., sets up ideal conditions for the spread of the disease. It also increases the rate of transmission which is promoted by the population concentration. Intestinal bilharzia, the most severe form of the disease, is *oluetis schistosomo mousoni* and is the type found in Africa and increased mainly by irrigation.

In general, the health component of each project on water resource development has been omitted or minimized in Africa and in the Sahel-Sudano countries in particular. This is evident in the cost project in Chad, approved by the World Bank, for the rice production scheme, or in the corgol project in Mauritania which is under study. It is apparent that IBRD spent one million dollars in health study instead of having included this million into health prevention measures in an area of seven million people. Especially in view of the many examples of the spread of the disease contributed to by water resource development projects:

- In Uganda: bilharzia is more prevalent in the Nile Valley and along the shores of Lake Albert than in other areas.
- In Liberia: bilharzia is an occupational disease of women washing clothes and in Portugese Guinea in coastal areas where rice is grown by women.
- In Kenya: Lake Victoria is one of the hperendmic areas of the Rey childre (5 million people inflicted).
- In Tanzania: the incidence of bilharzia has increased as irrigation work has been carried out.
- Upper Volta Republic: 50% of the population, (11/2 million) are infected at sometime during their life. Ouagodougou has two public lavatories for a population of 70,000.
- In Sudan: three years after the establishment of irrigation (Sennar Dam) of the Gezira area the incidence of the disease never stopped increasing - in 1947 a survey showed 21% of adult and 45% of children were inflicted.
- In Nigeria: an increase from 6.5% to 20% was noted after the irrigation work at Bacila. Out of a population of 100 million in fourteen African countries, 4,000,000 persons are infected.

In some countries more than 50% of the population is infected with bilharzia.

In French West Africa in 1952 there was a mortality rate of intestinal bilharzia of 146/1000.

Since 1949, Egypt has been the most heavily infected country due to the irrigation network, showing a 30 to 75% increase over the previous prevalence rate of the disease. The news media reports that more than 60% living in Assowan Dam area are suffering from bilharzia. In other countries with similar climates irrigation work has been a complete failure and has been abolished because of a fact that the effects of malaria and bilhorzia were left out of the original cal culations.

The disease is spreading into southwest Africa following the stages of irrigation development.

The value of Bayluscide in the control of snail vectors bilharzia (effective drugs safe for mass administration under medical minimal medical supervision) are only now emerging.

POPULATION ESTIMATES 31 DECEMBER 1970, 1980 AND 2000

URBAN ^{1/}

<u>Country</u>	<u>1970</u> <u>N'000</u>	<u>1980</u> <u>N'000</u>	<u>2000</u> <u>N'000</u>
Chad	263	449	2,204
Gambia	37	53	
Mali	624	983	3,082
Mauritania	88	154	903
Niger	325	627	2,594
Senegal	1,043	1,565	3,999
Upper Volta	205	352	3,372

^{1/} Urban population estimates were derived as a percentage of total population in each individual country.

Chad	30%
Mali	30%
Mauritania	40%
Niger	28%
Senegal	50%
Upper Volta	35%

POPULATION ESTIMATES 31 DECEMBER 1970, 1980 AND 2000

<u>Country</u>	<u>RURAL</u> ^{2/}		
	1970 N'000	1980 N'000	2000 N'000
Chad	3,489	4,400	5,144
Gambia	381	406	
Mali	4,528	5,685	7,191
Mauritania	1,097	1,372	1,355
Niger	3,581	4,724	6,669
Senegal	2,932	3,588	3,999
Upper Volta	5,231	6,500	6,262

^{2/} Rural population estimates were derived as a percentage of total population in each individual country:

Chad	70%
Mali	30%
Mauritania	60%
Niger	72%
Senegal	50%
Upper Volta	65%

POPULATION ESTIMATES 31 DECEMBER 1970, 1980 AND 2000

TOTAL (URBAN + RURAL)

<u>Country</u>	<u>1970</u> <u>N'000</u>	<u>1980</u> <u>N'000</u>	<u>2000</u> <u>N'000</u>
Chad	3,752	4,849	7,348
Gambia	368	459	670
Mali	5,152	6,668	10,274
Mauritania	1,185	1,526	2,258
Niger	3,906	5,351	9,263
Senegal	3,975	5,153	7,998
Upper Volta	5,436	6,852	9,633

COMMUNITY WATER SUPPLY
COMPARISON OF SERVICES 1962, 1970, 1980 AND 2000

URBAN POPULATION SUPPLIED BY PUBLIC STANDPOSTS ^{4/}

Country	1962		1970		1980		2000	
	N'000	%	N'000	%	N'000	%	N'000	%
Chad	20	13	170	65	180	40	881	40
Gambia	-	-	26	70	21			
Mali	100	33	20	3	393	40	1,232	40
Mauritania	-	-	6	7	62	40	361	40
Niger	50	26	180	55	251	40	1,037	40
Senegal	160	31	722	69	626	40	1,599	40
Upper Volta	60	24	100	49	141	40	1,348	40

^{4/} Ibid.

COMMUNITY WATER SUPPLY
COMPARISON OF SERVICES 1962, 1970, 1980 AND 2000
URBAN POPULATION SUPPLIED BY HOUSE CONNECTIONS ^{3/}

Country	1962		1970		1980		2000	
	N'000	%	N'000	%	N'000	%	N'000	%
Chad	30	13	30	11	269	60	1,323	60
Gambia	-	-	10	27	32			
Mali	30	10	160	26	590	60	1,849	60
Mauritania	-	-	80	91	92	59	541	60
Niger	10	5	40	12	376	60	1,556	
Senegal	100	19	300	29	939	60	2,399	60
Upper Volta	20	8	40	20	211	60	2,023	60

^{3/} For all countries the targets set were: the supply of 60% of the urban population with house connections, the supply of 40% of the urban population with public standposts and the supply of 25% of the rural population with easy access to safe water.

COMMUNITY WATER SUPPLY
COMPARISON OF SERVICES 1962, 1970, 1980 AND 2000

TOTAL URBAN POPULATION SUPPLIED

Country	1962		1970		1980		2000	
	N'000	%	N'000	%	N'000	%	N'000	%
Chad	40	25	200	76	449	100	2,204	100
Gambia	-	-	36	97	53			
Mali	130	43	180	29	983	100	3,082	100
Mauritania	-	-	86	98	154	100	903	100
Niger	60	32	220	68	627	100	2,594	100
Senegal	260	50	1,022	98	1,565	100	3,999	100
Upper Volta	80	32	140	68	352	100	3,372	100

COMMUNITY WATER SUPPLY
COMPARISON OF SERVICES 1962, 1970, 1980 AND 2000

RURAL POPULATION WITH REASONABLE ACCESS ^{5/}

Country	1962		1970		1980		2000	
	N'000	%	N'000	%	N'000	%	N'000	%
Chad			780	22	1,100	25	1,286	25
Gambia			9	3	102			
Mali			-	-	1,421	25	1,798	25
Mauritania			114	10	343	25	339	25
Niger			570	16	1,181	25	1,667	25
Senegal			2,178	74	897	25	998	25
Upper Volta			1,300	25	1,625	25	1,565	25

^{5/} Ibid. f.n. 3

COMMUNITY WATER SUPPLY
COMPARISON OF SERVICES 1962, 1970, 1980 AND 2000

TOTAL POPULATION SERVED (RURAL AND URBAN)

Country	1962		1970		1980		2000	
	N'000	%	N'000	%	N'000	%	N'000	%
Chad			980	26	1,549	32	3,490	46
Gambia			45	12	155			
Mali			180	3	2,404	36	4,880	48
Mauritania			200	17	497	33	1,242	55
Niger			790	20	1,808	34	4,261	46
Senegal			3,200	81	2,462	48	4,997	63
Upper Volta			1,440	25	1,977	30	4,937	51

COMMUNITY WATER SUPPLY
TARGETS FOR 1980 AND 2000; COSTS ESTIMATED TO REACH THESE TARGETS

URBAN POPULATION TO BE SERVED - BY PUBLIC STANDPOSTS ^{I/}

Country	1980				2000			
	Population to be Served N'000	Increase Over 1970	Cost U.S. \$/ Consumer	Total \$ U.S. Millions	Population to be Served	Increase Over 1980	Cost U.S. \$/ Consumer	Total \$ U.S. Millions
Chad	180	10	17	0.2	881	701	17	14.9
Gambia	21	-	-	-				
Mali	393	373	25	9.3	1,232	839	25	30.8
Mauritania	62	56	280	15.7	361	299	280	101.0
Niger	251	71	25	1.8	1,037	786	25	25.9
Senegal	626	-	-	-	1,599	973	-	
Upper Volta	141	41	5	0.2	1,348	1,207	5	6.7

^{I/} Ibid., footnote 3

COMMUNITY WATER SUPPLY

TARGETS FOR 2000; TOTAL COST ESTIMATES TO REACH THESE TARGETS

Country	Urban Supply		Total	Rural	Total
	House	Public	Urban	Millions	(Rural + Urban)
	Connections	Standposts	Millions	Millions	\$ U.S.
	\$U.S. Millions	\$U.S. Millions	\$ U.S.	\$ U.S.	Millions
Chad	68.8	14.9	83.7	28.2	111.9
Gambia					
Mali	70.2	30.8	101.0	35.9	136.9
Mauritania	162.3	101.0	263.3	16.9	280.2
Niger	87.1	25.9	113.0	-	113.0
Senegal	134.3	-	134.3	-	134.3
Upper Volta	<u>404.6</u>	<u>6.7</u>	<u>411.3</u>	<u>31.3</u>	<u>442.6</u>
TOTALS	<u>927.3</u>	<u>179.3</u>	<u>1,106.6</u>	<u>112.3</u>	<u>1,218.9</u>

COMMUNITY WATER SUPPLY
TARGETS FOR 1980 AND 2000; COSTS ESTIMATED TO REACH THESE TARGETS

POPULATION SERVED URBAN - HOUSE CONNECTIONS ^{6/}

Country	1980				2000			
	Population to be Served N'000	Increase Over 1970	Cost		Population to be Served	Increase Over 1980	Cost	
			U.S. \$/ Consumer	Total \$ U.S. Millions			U.S. \$/ Consumer	Total \$ U.S. Millions
Chad	269	239	52	12.4	1,323	1,054	52	68.8
Gambia	32	22	22	0.5			22	
Mali	590	430	38	16.3	1,849	1,259	38	70.2
Mauritania	92	12	300	3.6	541	449	300	162.3
Niger	376	336	56	18.8	1,556	1,184	56	87.1
Senegal	939	639	56	35.8	2,399	1,460	56	134.3
Upper Volta	211	171	200	34.2	2,023	1,812	200	404.6

^{6/} Ibid, footnote 3

SEWAGE DISPOSAL TARGETS FOR 1980 AND 2000
AND COST ESTIMATED TO REACH THESE TARGETS

URBAN
Household Systems

	Population to be served <u>1980</u>	Population to be served <u>2000</u>	Cost per user \$ U.S.	Total Cost 1980 \$ U.S. (millions)	Total Cost 2000
CHAD	269,000	1,322,658	9	2.2	11.9
MALI	590,000	1,849,248	20	4.0	36.9
MAURITANIA	92,000	541,896	28	1.8	15.2
NIGER	376,000	1,556,184	28	9.7	43.6
SENEGAL	939,000	2,399,520	13	12.2	31.2
UPPER VOLTA	211,000	2,023,014	20	<u>0.3</u>	<u>40.5</u>
TOTALS				30.2	179.3

SEWAGE DISPOSAL TARGETS FOR 1980 AND 2000
AND COST ESTIMATED TO REACH THESE TARGETS

URBAN
Connected to Public Sewerage System

	Population to be served	Population to be served	Cost per user \$ U.S.	Total Cost 1980 \$ U.S. (millions) 1980	Total Cost 2000 2000
	<u>1980</u>	<u>2000</u>			
CHAD	180,000	881,772	35	6.3	30.8
MALI	393,000	1,232,832	35	13.8	43.1
MAURITANIA	62,000	361,264	35	0.1	12.6
NIGER	251,000	1,037,456	38	8.8	36.3
SENEGAL	626,000	1,599,680	35	21.9	55.9
UPPER VOLTA	<u>141,000</u>	<u>1,348,676</u>	35	<u>4.9</u>	<u>47.2</u>
TOTALS				<u>55.8</u>	<u>225.9</u>

SEWAGE DISPOSAL TARGETS FOR 1980 AND 2000
AND COST ESTIMATED TO REACH THESE TARGETS

RURAL
With Adequate Disposal

	<u>Population</u> <u>to be Served</u> <u>1980</u>	<u>Cost</u> <u>(millions)</u> <u>1980</u>	<u>Population</u> <u>to be Served</u> <u>2000</u>	<u>Cost</u> <u>(millions)</u> <u>1980</u>	<u>Cost</u> <u>per</u> <u>User</u> <u>U.S.\$</u>
CHAD	1,100,000	3.3	1,285,917	3.8	3
MALI	1,421,000	2.8	1,797,880	3.6	2
MAURITANIA	627,000	6.6	1,667,340	16.7	10
NIGER	343,000	3.4	338,685	3.4	10
SENEGAL	733,000	3.6	999,800	5.0	5
UPPER VOLTA	1,625,000	<u>8.1</u>	<u>1,565,427</u>	<u>7.8</u>	5
TOTALS		27.8	7,655,049	40.3	

SEWAGE DISPOSAL TARGETS FOR 1980 AND 2000
AND COST ESTIMATED TO REACH THESE TARGETS

	<u>Rural Population to be Served 1980</u>	<u>Total Cost (millions) 1980</u>	<u>Urban Population to be Served 2000</u>	<u>Total Cost (millions) 2000</u>
CHAD	449,000	8.5	220,443	42.7
MALI	983,000	17.8	3,082,080	80.0
MAURITANIA	154,000	1.9	903,160	27.8
NIGER	627,000	18.5	2,593,640	79.9
SENEGAL		34.1	3,999,200	87.1
UPPER VOLTA	352,000	<u>5.2</u>	3,371,690	<u>87.7</u>
TOTALS		86.0		405.2

APPROXIMATE COST OF 5 YEAR CYCLE IN PRIMARY SCHOOL FOR EACH COUNTRY
BASED ON \$100 PER STUDENT FOR 5 YEAR PRIMARY EDUCATION

	<u>Approximate Estimated Cost 1974</u>	<u>1975 to 1980</u>	<u>1980 to 1985</u>	<u>1985 to 1990</u>	<u>1990 to 1995</u>	<u>1995 to 2000</u>	<u>Total by 2000</u>
CEAD	(12,459,000)	18,077,800	24,706,900	33,692,700	45,946,700	61,666,700	184,090,800
MALI	(16,536,700)	24,402,500	33,748,600	46,674,300	64,550,500	89,908,000	259,283,900
MAURITANIA	(2,571,600)	4,242,100	6,437,800	9,770,000	14,827,000	22,554,400	57,831,300
NIGER	(7,915,300)	12,945,500	19,495,900	29,360,800	44,217,500	67,162,000	173,201,700
SENEGAL	(22,997,100)	29,948,600	37,323,200	46,512,200	57,963,500	72,219,400	243,966,900
UPPER VOLTA	(9,597,700)	<u>16,363,800</u>	<u>25,525,900</u>	<u>39,817,900</u>	<u>62,112,000</u>	<u>96,949,000</u>	<u>240,768,600</u>
TOTALS	\$	<u>105,980,300</u>	<u>147,238,300</u>	<u>205,827,900</u>	<u>269,617,200</u>	<u>410,479,500</u>	<u>1,159,143,200</u>

	Theoretical Age Group	Population of Theoretical Age Group 1974	Enrollment Theoretical Age Group 1974	Enrollment Projected in 1974	Projected Population of Theoretical Age Group in Year 2000	Enrollment Theoretical Age Group Year 2000	Projected Enrollment Rate in Percent	Yearly Rate of Growth from 1974 to 2000
CHAD	7-12	602,514	124,590	21%	1,235,334	617,667	50%	6.4%
MALI	7-12	877,023	165,367	19%	1,798,160	899,080	50%	6.7%
MAURITANIA	7-12	220,010	25,716	12%	451,087	225,544	50%	6.7%
NIGER	7-12	655,338	79,153	12%	1,343,640	671,820	50%	3.6%
SENEGAL	7-12	704,477	229,971	33%	1,444,389	722,195	50%	4.5%
UPPER VOLTA	7-12	<u>945,706</u>	<u>95,977</u>	10%	<u>1,938,981</u>	<u>969,490</u>	50%	9.3%
TOTALS		<u>4,005,068</u>	<u>720,774</u>	Average 18%	<u>8,211,591</u>	<u>4,105,796</u>		

HEALTH MANPOWER REQUIRED AND INVESTMENT NEEDED TO YEAR 2000

	Physicians	Cost	Nurses	Cost	Midwives	Cost	Technicians	Cost	Health Auxiliary	Cost	Sanitarians	Cost	Sanitary Engineers	Cost
CHAD	1,027	<u>359</u>	2,055	<u>10275</u>	2,055	<u>16440</u>	2,055	<u>1640</u>	10,274	<u>10274</u>	685	<u>822</u>	41	<u>1025</u>
GAMBIA	67	<u>2345</u>	134	<u>335</u>	134	<u>1072</u>	134	<u>1072</u>	670	<u>1072</u>	45	<u>54</u>	4	<u>100</u>
MALI	1,027	<u>35875</u>	2,055	<u>10275</u>	2,055	<u>16660</u>	2,055	<u>16660</u>	10,274	<u>16660</u>	685	<u>822</u>	41	<u>1025</u>
MAURITANIA	226	<u>7910</u>	452	<u>2260</u>	452	<u>3616</u>	452	<u>3616</u>	2,258	<u>3616</u>	151	<u>1812</u>	10	<u>250</u>
NIGER	922	<u>3227</u>	1,845	<u>9225</u>	1,845	<u>9225</u>	1,845	<u>9225</u>	9,223	<u>9225</u>	615	<u>738</u>	37	<u>925</u>
SENEGAL	800	<u>28000</u>	1,600	<u>8000</u>	1,600	<u>12800</u>	1,600	<u>12800</u>	7,998	<u>12800</u>	533	<u>6396</u>	32	<u>800</u>
UPPER VOLTA	963	<u>33705</u>	1,927	<u>9635</u>	1,927	<u>15416</u>	1,927	<u>15416</u>	9,633	<u>15416</u>	642	<u>770.6</u>	33	<u>975</u>

TOTAL COST

U.S.	\$406,434,200.
Physicians	35,000.
Nurses	5,000.
Midwives	8,000.
Technicians	8,000.
Health Auxiliary	1,000.
Sanitation	1,200.
Sanitary Engineers	20,000.

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4. E201e - 22 140182 Copy 2: Carte Redologique Du Guidimake, Mauritanie, Office De La Recherche Scientifique Et Technique Outre-Mer, 1961.
5. E201H - 22.3 229507 Copy 1: (Set of 4)¹ Carte Geologique De Reconnaissance Du Nord Du Bassin De Taoudeni.
6. E201E - 22 220586 Copy 1: (Set of 5) Hydrogeologie Et Aménagement Hydraulique Du Sud-est Mauritanien - Meiriya - Mboud, Bureau d'Etudes de Geologie Appliquee et d'Hydrologie Souterraine, 1966.
7. Carte Geologique, Bureau de Recherches Geologiques et Minieres, 1968.
8. Mauritania, Northern border by Algeria shown.
9. Mauritania, bordered by Mali.
10. Mauritania, Precambrien
11. Mauritania, Map of.

¹ Map (1) of (4) of this series not in collection.

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1. E201g - 9 199771 Copy I: The Ecology of Malnutrition in French-Speaking Countries of West Africa and Madagascar, Hafner Publishing Company, 1968.
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11. Senegal - Cartes Dubliees, Conquis Structural, Auteurs Des Leves De Base, Recherches Geologiques et Minieres, 1968.
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13. A Map of Senegal and Gambia.