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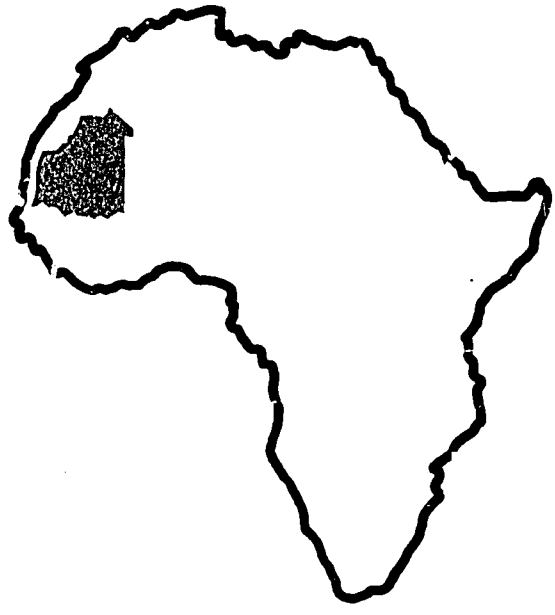

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SUMMARY AND CONCLUSIONS

The RAMS studies have shown that rural sector production in Mauritania is dependent on climatic factors. The agricultural sector is dependent either on rainfall or on flooding in walo lands. The quality of grazing lands is also dependent on rainfall. Inland fishing is also dependent on rainfall in the Fouta Djalon of Guinea and flooding in the middle valley of the Senegal River. In a word, the rural sector is an area of complexity and risks.

It has been discovered that grain production has been falling at an annual rate of 5.2% since 1961[1] and steps must be taken to put an end to this trend.

At present the agricultural sector produces only 20% of domestic demand for grains and major efforts are needed to reduce the country's dependency on foreign grains. The road to development in the rural sector is a narrow one. The basic idea is "risk minimization" in rural production as a means of increasing income.

There are numerous constraints to rural sector production and they fall into 3 categories: (1) natural constraints (rainfall, flooding of lands, etc.); (2) technical contraints (types of technology) (3) human and organizational (land tenure, taxation, pricing, economic management, etc.).

This report is one of a series of seven RAMS reports on development strategies in Mauritania and this report must be seen in this context. Based on conclusions drawn from the RAMS base-line studies, this report presents production options which will permit a minimization of risks through better techniques of production. Human and organizational constraints are treated in another report focusing on methods of implementation.[2]

One of the main reasons of poverty in Mauritania is the low productivity in the rural areas, so no sector of rural production should be neglected. Three sub-sectors are analyzed in this report.

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1) See page 18.

2) Agricultural Institutional Framework Options Paper, RAMS, 1981.

Agriculture

At present, agriculture contributes 1.8% of GDP and constitutes 8% of value added in the rural sector.

Government agricultural policy has given priority to irrigated agriculture. However, it must be noted that rain-fed agriculture can, with a modest amount of investment, contribute up to 30% of the grain for domestic consumption in the year 2000. Rain-fed agriculture has been neglected until now, but it must receive priority attention during the transitional period which will last until irrigated agriculture can reach its maximum rate of development: An increase in production in rain-fed agriculture can be made possible through improved technology, intercropping and animal traction.

Grain consumption both in the rural and in the modern sectors will rise to 316,000 tons in the year 2000 given present consumption patterns (D_1 demand); given nutritional norms (D_2 demand), consumption will be 306,000 tons.

Rain-fed agriculture will thus enable the country to save about 30 million dollars (330 US dollars/ton of imported grain X97,000 tons), while giving employment to about 100,000 persons (farmers and farm workers).

Three agricultural production options are to be considered in this sub-sector:

Option A_1: Reaching the goal of food self-sufficiency by the year 2000.

Option A_2: Increasing production through improved technology while taking into account human constraints.

Option A_3: Continuation of present trends.

Option A_1:

In order to reach self-sufficiency in grains by the year 2000; the following investments are necessary:

(1) investment in rain-fed and in irrigated agriculture;

(2) rain-fed agriculture could comprise 142,000 ha (82,000 in the South-East, 40,000 in the River Valley and 20,000 in the wadis;

Investments in rain-fed agriculture should amount to 275 million UM (175 million UM in the South-East, 4 million in the River Valley and 104 million in the wadi areas).

(3) the rate of expansion of irrigated fields should be 4.000 ha between 1990 and 1995 and 4,500 ha after 1995. The cost of opening new irrigated fields will amount to 2,250 million UM/year (1,100 million UM in the event of decreasing development costs, dropping from 0.5 million UM/ha to 0.25 million UM/ha in the year 2000) and recurring costs at 2,425 million UM/year in 1980 prices, not including inflation. (See table XXVII page 72 .)

Se[illegible]-sufficiency in grains can be attained with Option A_1, which will yield 3[illegible],000 tons, or 97% of demand, according to 1980 consumption patterns (D_1[illegible], and 100% of demand according to nutritional norms (D_2). Rain-fed agr[illegible]culture yields 97,000 tons and irrigated agriculture 210,000 tons

Gi[illegible]en a yield of 5 tons/ha, production under Option A_1 could reach 410,00[illegible] tons, of which 307,000 tons would come from irrigated agriculture [illegible]d 97,000 from rain-fed agriculture. Option A_1, with a level of productio[illegible] rising to 5 tons/ha, amounts to 130% of D_1 demand and 133% of D_2 demand.

Op[illegible]ion A_1 could have some problems in the area of manpower, and several solu[illegible]ions could be considered:

- [illegible]ntensive mechanization and therefore higher costs;
- [illegible]tabilization and relocation of manpower in the river region;
- [illegible]artial abandonment of dieri lands.

Th[illegible] table showing costs and production levels of the various options comp[illegible]res the cost of investments and their corresponding productivity of different options.

(4 investment and recurring costs are high (if the cost of creating new irrigated fields does not drop) and come to 5,400 million UM/year in the year 2000. Irrigated agriculture represents 4,700 million UM whereas rain-fed, wadi and oasis agriculture require costs amounting to only 700 million UM.

Summary Table of Production Costs in the Agricultural Sector

(Millions of UM, 1980 prices)

	1985	1990	1995	2000
Option A_1				
Costs	1,900	2,600	4,200	5,400
Production	1,900	2,900	4,300	6,300
Option A_2				
Costs	1,400	1,800	2,500	2,900
Production	1,800	2,500	3,400	6,300
Option A_3				
Costs	1,100	1,400	1,700	1,900
Production	1,700	2,000	2,200	2,700

Rounded figures. See details, pages 71 and 72.

Option A_2, yielding 211,000 tons of grains, is possible and feasible. It me ts 67% of the D_1 and D_2 demand levels. It must also be noted that pr sent production meets only 15% to 20% of domestic demand. The rain-fed agr cultural sub-sector yields 97,000 tons whereas the irrigated sub-se tor yields 114,000 tons. Assuming a yield of 5 tons/ha, Option A_2 amount to 267,000 tons, or 85% of D_1 and 87% of D_2. Under Option A_2, irrig ted fields are to be created at the rate of 1,200 ha/year between 1980 an 1990 and at the rate of 2,000 ha/year between 1991 and the year 2000.

Invest ent and recurring costs amount to an average of 2,900 million UM/year 1980 prices), of which 2,280 millionUM go into irrigated agric ture (1,000 million UM as investment and 1,280 million UM for recurring cc sts. The development costs could drop to 500 million UM, in the case of f lling development costs.) and 620 million UM for the rest. It must be remem bered that under both options (A_1 and A_2), improved rain-fed agricul ure can meet 30% of domestic demand in the year 2000 at little cost (27 million UM) and provide jobs for a large portion of rural manpower, therei re reducing migration to the cities.

Optio A_3 (continuation of present trends) yields 135,000 tons and meets 43% o the D_1 and D_2 demand levels. Investment and recurring costs represent n average of 1,700 million UM/year in 1980 prices (the development cos s of irrigated fields amount to 600 million UM but could drop to 300 mil ion UM if development costs decline). Of the 135,000 tons this option yie ds, 83,000 tons are produced by irrigated fields and 52,000 tons by ain-fed agriculture. With a yield rising to 4.5 tons, Option A_3 could attain 153,000 tons/year by the year 2000, or 48% of D_1 and 53% of D_2. The rate of development of irrigated fields in Option A_3 is 1,000 ha/yea between 1980 and 1990, and 1,200 ha/year between 1991 and the year 20 0.

It ca not be over-emphasized that these potential levels of agricultural pr duction cannot be reached unless certain constraints are overcome. Thes are technical (inputs, roads,...), human and organizational (agraria reform, credit, insurance, training, etc.). For example, in order to rea h a high level of grain production, the land tenure problem will ha e to be solved, installation and operating costs will have to be reduced, ultivated areas extended, supervision increased, etc. Removing these onstraints is a prerequisite to increasing production and insuring proper development in the agricultural sector.

Livestock

Herding made up 16% of GDP in 1979 and contributed 75% of value added in the rural sector.

The livestock sector will level off and will barely be able to meet domestic demand in the year 2000. The rainfall factor will always be one of the major constraints in herding. Unlike the agricultural sector, where rapid progress is possible, there are no rapid solutions to the problems of development in the livestock sector.

Improvement is possible in the areas of herd productivity and in range management. Present resources can thus be maximized. Production, which is now 2.2 million UBT, could rise to 3.6 or 4.5 million UBT in the year 2000. However, all activities in this sector will depend upon how the government structures the role of herding as a rural sector activity between now and the year 2000.

This is a neglected sector. It produced 75% of value added in the rural sector but received less than 0.5% of the national budget. The lack of resources restricts the effectiveness of the livestock service and prevents there being a balance between animal health and production.

The improved RAMS rainfall model has made it possible to project growth of herds, assuming that there are no major changes. Three projections of herd size changes up to the year 2000 have been made. These predictions, or scenarios, are conditions of:

normal rainfall (N)

poor rainfall (P)

good rainfall (G)

Optimal herd sizes in the year 2000, taking rainfall factors into account as well as carrying capacity of pastures; and assuming that no major changes take place, are as follows:

0.6 to 1.4	million	head	of	cattle
3.0 to 3.7	"	"	"	sheep
2.7 to 3.4	"	"	"	goats
0.7 to 0.73	"	"	"	camels

These herds represent 2 to 2.8 million UBT's in the year 2000. In the livestock sector, which is largely dependent on rainfall, it can be said that the path of development is a narrow one because a certain number of actions must be accomplished in order to improve animal husbandry. At present, grazing lands are able to support 3.6 million UBT's (Unité de Bétail Tropical -- Tropical Animal Unit), of which only 2.23 million are used: Better range management would enable an improvement of this situation, so that production could reach 4.5 million UBT's toward the year 2000. (See chart LII, page 92 .) Three options for developing the livestock sector are presented in this report and each will depend mainly on the country's financial resources:

Option L_1 : increase herd size

Option L_2 : improve herd productivity

Option L_3 : continuation of present trends

All of these options are concerned with the system of extensive production.

Under Option L_1; there can be an increase in herd productivity. This is a combination and maximization of all of the action in Options L_2 and L_3. In addition, new grazing lands are to be opened, enabling a rise in the number of UBT available to herds to 4.5 million. Option L_1 is based on an average cost of 200 UM/UBT/year, or ten times the budgetary expenditures on herding in 1980. Full development can begin only 20 years after investments are made.

The range management is as important to the livestock sector as the Guelb project to the mining sector. The only difference is that the range land is a renewable resources.

Option L_2 involves improving production as well as increasing the number of UBT available to herds from 2.6 to 3.6 million UBT. This option represents an average cost of 150 UM/UBT/year. The increase would amount to 20 to 25% in the year 2000. Option L_2 is an essential element in efforts to protect the environment through range management.

Option L_3 maintains present production levels (see chart LII, page 94). Costs are about 70 million UM/UBT/year. L_3 will probably lead to a certain drop in production in the long run because of environmental deterioration.

Furthermore, a comparison between D_1 demand for meat (following present trends) and D_2 demand (according to nutritional norms) and the productive potential of the livestock sector, assuming no important changes in the sector, indicates that:

--depending on rainfall patterns, satisfying D_1 demand for meat is possible until

1986, if rainfall is poor;
1996, if rainfall is good.

D_2 demand can be met until 1995 under conditions of bad rainfall and possibly in all other cases.

Thus, meat consumption in the country must be reduced from 23.6 kg/per capita/year to 18 kg/per capita/year in the year 2000, in other words, adjustment to a lower level.

Fisheries

The fisheries sector has a promising future. However, it will be necessary to invest in traditional inland and marine fisheries and, in order to plan ahead for the day when coastal waters no longer have fish, it will be necessary to invest in traditional as well as semi-industrial fisheries in order to have a firm foundation for the ultimate development of a national fishing fleet. This sector is composed of river fishing, traditional marine and industrial fishing.

In the inland fisheries sector, which is completely different from marine fisheries, the creation of fish ponds will be necessary in order to stabilize production. These ponds should cover 5.000 ha in the year 2000.

Traditional and semi-industrial marine fishing are not yet structured but have a significant development potential. The structuring in question must take place on three levels: organization, infrastructure, and equipment and training. About 100 "terafiers" (fishing boats) and 200 motorized canoes could be used.

Summary of the possible options:

Option F_1 : development of industrial fishing

Option F_2 : starting of pisciculture, improvement of traditional marine and semi-industrial fishing

Option F_3 : continuation of present trends

Option F_1 would enable catches to reach 200 to 300,000 tons/year and produce a value of 3,000 to 5,400 million DM/year. Nevertheless, this is a costly option and will have an impact on the country's balance of payments through an export of currency (value added is low). Furthermore,

the option is confronted with the problem of trained manpower. The option requires investing in port facilities, importing 200 cold storage boats, 100 launches, 20 seine fishing boats and 50 trawlers with freezer facilities. See tableLVII, page 117 , for costs.

Option F_2 can meet domestic demand while at the same time providing fish for export. Potential catches could reach 91,000 tons, of which 14,500 would come from inland fisheries (in the river and in fish ponds), 36,000 tons from traditional marine fisheries, and 40,000 tons from semi-industrial fisheries. The value of the catches would be an average of 1,600 UM/year.

In the area of river fishing, Option F_2 provides for the creation of 5,000 ha of fish ponds in order to stabilize production in the river area Manpower requirements would be for 7,000 individuals in the year 2000.

The development of semi-industrial marine fishing would involve the use of 100 to 200 canoes and 50 to 100 "terafiers," but would depend particularly on better organization and an end to the physical isolation of this sector (canoe motorization program and program to train Mauritanian crews for terqfier-seiners).

The development of the fisheries sector will involve training a pool of skilled labor, which has been one of the limiting factors in industrial fishing. Option F_2 will also offer many more job opportunities than Option F_1.

Option F_2 does not exclude a selective granting of fishing licenses in order to obtain the foreign currency needed to develop this sector.

Option F_3 allows for potential catches of 37,000 tons/year, valued at 660 million UM/year. Domestic demand can be met but the balance of payments will not be much affected because this option does not allow for export of fish.

Rural Sector Potential

The best development strategy for the rural sector is one which combines in an optimal way the productive potentials of agriculture, herding and fishing while taking into account constraints such as foreign debt, manpower, organization, etc..

The judicious combination of investments in these three sectors will favor maximization of production and income in the rural sector. Three broad options combining agriculture, herding and fishing will be studied. These broad options correspond to the high, medium and low options.

Option Q combines high growth rates of agriculture, herding and fishing. This is the high growth option.

Option A $= \sum A_1 \quad L_1 \quad F_1$

Option B combines the three sectors assuming medium levels of production.

Option B $= \sum A_2 \quad L_2 \quad F_2$

Option C is a continuation of present trends in agriculture, herding and fishing.

Option C $= \sum A_3 \quad L_3 \quad F_3$

Potential Production = Agricultural Potential + Livestock Potential + Fishing Potential

Overall cost (investments and recurring costs) and annual production under each of the three options would be as follows:

	1985	1990	1995	2000
Option A (high productivity)				
Costs	8,600	6,000	7,400	6,400
Production	12,700	15,500	17,800	21,200
Option B (medium productivity)				
Costs	2,500	2,500	3,100	3,500
Production	11,300	12,800	14,600	15,700
Option C (low productivity)				
Costs	1,700	1,500	1,700	2,000
Production	11,100	12,000	12,700	12,800

Millions of UM, 1980 prices, rounded figures.

Output levels under the three options change slowly, and the differences between the options are visible only in the long run.

Investments and Value Added in 1980 UM Prices

	1985	1990	1995	2000
Option A (High)				
Investments	7,900	4,500	4,700	2,500
Value Added	10,400	12,200	13,800	15,600
Option B (Medium)				
Investments	1,800	1,350	1,400	1,500
Value Added	10,000	11,200	12,500	13,200
Option C (Low)				
Investments	1,200	700	600	500
Value Added	9,800	10,500	11,100	11,200

Rounded figures.

It must be noted here that the drop in costs between 1985 and 1990 is partly due to the completion of the Manantali Dam which will submerge the walo lands, but also because major investments in fisheries will come to an end in 1935. The value of investments and value added gives an idea of productivity. Nevertheless, only an analysis of the Input-Output table can give the precision necessary for decision-making.[3)]

Impact of the Options

In the long run, there is to be a change in the make-up of value added in the various sectors. A recovery in the agricultural sector is to be noted.

Agriculture is the sector which will offer the most employment.

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3) There is a computer program called "R.A.M. II" which is used to analyze the input-output table.

Option L_1 (Livestock) will maintain employment in that sector whereas Options L_2 and L_3 will lead to migration.

Fishing is a sector that is very capital-intensive and offers relatively little employment.

The Choice Among Options

Given the number of combinations possible, the choice will depend on a system of points. The points are dependent on priorities established by the plan.

As an example, the following combination is possible because it has the highest points:

L_1 A_2 F_2

In the final analysis, it is essential to overcome the technical, human and organizational constraints in order to improve production in the rural sector.

Finally, there must be a radical psychological change and an iron will on the part of the government as well as of the people in order to mobilize the energies needed to mobilize the rural sector.

Introduction

This report is part of a series of 7 RAMS reports on development strategies in Mauritania. Three "methodological" reports (the macro-economic model, the input-output model and the basic needs approach) constitute the first part of this series. A second group of sectoral reports focuses on problems and proposes options for the years 1985-1990 to the year 2000. These reports are on:

rural production (agriculture, livestock and fisheries);
the outcomes of rural production;
health and nutrition; and
manpower.

This report should be studied in its context as part of a series.

An "iterative process" is built into this whole in order to permit changes and integration in the data. Integration is achieved mainly through financial programs.

The report describes the rural sector and its main sub-sectors--agriculture, livestock and fisheries--while situating them in the overall economy of Mauritania. The analysis of the rural sector brings out constraints as well as policy guidelines.

The methodology, hypotheses, scenarios and projections are clearly spelled out in order to facilitate integration with the other reports. Three hypotheses are considered:

The high hypothesis allows for food self-sufficiency as well as fish exports, whereas the low hypothesis concerns a continuation of present trends. The middle hypothesis concerns the domain of the possible and attainable.

Projections are made for production, the value of this production, for investments, operating costs as well as for employment based on each hypothesis, or option. Data are disaggregated by subsector and ultimately regrouped in order to have an overall view.

The report shows that in order to "raise the level of income and to reduce dependence on outside support," [4] a development strategy to stimulate production must take the following criteria into account:

- simple technology, adapted to the economic and social environment where possible;
- small scale in size, requiring little capital and accessible to the private sector;
- employment generation;
- certain profitability.

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4) A. Diop, Politique de Développement: aspet macro-économique. Dept. of Studies and Programming, Nouakchott, Aug. 1980, p.23.

This production strategy is in accord with a strategy designed to make Mauritania less dependent on foreign countries. The new strategy should seek an optimal combination of fishing, herding and farming. It is no longer a question of sectoral but overall efforts.

Bringing about the recovery of the rural sector through an increase in production and strict management of domestic demand should permit a reduction of Mauritania's dependence on the outside.

Goal of the Study

The study is intended to:

(1) Survey potential production in the rural sector (agriculture, livestock, fisheries) based on various types of technology. Three broad production options are presented, together with their respective costs, for each sub-sector. Potential production in the agriculture sector are A_1 A_2 A_3; L_1 L_2 and L_3 for livestock, and F_1, F_2 and F_3 for fishing. Potential production in the rural sector for a given sector will be the sum of potential production in agriculture and livestock and fishing:

Option A: high level (the sum of the highest options in agriculture, livestock and fisheries.
Option B : middle level (improvement of the present situation).
Option C: low level (continuation of present trends in the rural sector).

The other combinations vary between the extremes of Options A and C (the highest and the lowest).

(2) Present the government with choices of various development strategies, allowing it to come up with optimal combinations given the constraints in agriculture, livestock and fisheries.

Methodology

This study is a synthesis of several of the RAMS base-line studies. The figures, data and conclusions come either from the RAMS surveys (on consumption, employment, revenue and production) undertaken in 1979 and 1980, or from data taken from studies done by the Rural Production Unit (dry-land, irrigated and oasis farming,

herding, continental and marine fishing), or from RAMS studies on health and nutrition, demography, geography, etc.

In a word, this is the culmination of the research and data analysis of the first phase of the project and not a duplication of previous research. This study leads up to various options in the area of rural production for the periods of 1980, 1985 and up to the year 2000.

This study covers three broad sectors: agriculture, livestock and fisheries. The industries connected to these sectors have been excluded. The resulting measures which would allow the removal of existing constraints are treated in another RAMS study. 5)

The approach is divided into two steps:

Step 1: A study of physical, human and technological constraints as well as the major constraints of the rural sector already discussed in the RAMS base-line studies. By proposing different production technologies and resources, various levels ofppotential production for groups of years stretching from 1980 to the year 2000 are obtained for each sector and sub-sector: irrigated, dry-land agriculture, etc..

Step 2: Projected demand for food is established for the year 2000, based on present or nutritional standards, in order to identify the country's nutritional needs (grains, meat, fish).

Based on existing resources, technologies and RAMS estimates, various combinations of potential production levels, of value added and of rural sector costs are presented. These options are tools which will help in making economic choices.

Limitations

Statistics on Mauritania are still very approximate at best. The RAMS research is but a first step towards a better statistical understanding of the country. There are still many gaps and much is left to be done in order to fill in missing data on the economy of Mauritania. The statistics which have been gathered are tested against other sources and verified by RAMS field trips whenever possible.

Furthermore, predicting the future is a risky business given the dependence of production on erratic climatic factors. This study has no goal other than presenting production options to be used as suggested policy guidelines for the government.

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5) See RAMS Report, 1981.

The Rural Sector

The economy of Mauritania is essentially rural, and according to the national accounts aggregates, the amount of GDP which supported 77% of the manpower pool was 65% in 1959-60 and 20% in 1979.

The rural sector is composed of three major sub-sectors: agriculture (particularly grain cultivation), livestock raising, and fishing (excluding industrial fisheries and its associated industries).

Agriculture varies according to agro-ecological zone and it is broken down into 5 main types of cultivation: rain-fed agriculture, which exists in the South-East and in the dieri lands of the river valley, walo, wadi, oasis and irrigated agriculture. Although the effects of the drought are not to be overlooked, it seems that agricultural production was dropping well before the drought.[6)]

Herding is an aspect of extensive transhumant production and contributed 16% of GDP in 1979, but its share of value added in the rural sector amounted to 75% of the total. Herding is subject to the irregularities of the weather, and production is directly affected by it. Improvement is possible in this sector.

Fishing includes inland fresh water fishing and traditional marine fishing. Fishing made up 3.8% of GDP and 18% of rural sector value added in 1979. Traditional marine fishing is an area of particularly promising growth potential.

Agriculture

In discussing agriculture, the most important aspect is grain production. Millet, sorghum and rice amounted to about 33,000 tons in 1979, or 20% of domestic consumption. The remaining amount consumed was made up of imports and gifts from donors.

Evolution of the Sector

A major transformation of the economy of the country took place between 1959 and 1979: production shifted from the primary to the tertiary sector.[7)] In 1959, the rural sector contributed 65% of GDP; by 1979, however, its share of GDP had dropped to 26%. Agriculture constituted 13.8% of GDP in 1959 but only 1.35% in 1979.

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6) International Food Policy Research Institute, Washington, D.C., 1978 and A. Diop: Politique de Développement: aspect macro-économique, Department of Studies and Programming, August, 1980.

7) Ibid.

Agriculture experienced negative growth (-4%) during the entire 1959-79 period, except for a short time between 1964 and 1969. The value added of the rural sector was maintained only with the help of herding activities. Per capita value added in agriculture has fallen 6% whereas per capita value added in livestock has remained unchanged. Grain production has fallen by about 5.2% a year since 1962.[8] Without a doubt, the drought, import policies, producers' price policies and other combined factors have worsened the situation.

The decline in grain production, combined with rural out-migration and population growth have increased Mauritania's dependence on imported grain.

Food Production and Consumption Trend and Variation, 1961-1977

Consumption of Cereals		Production			
		Staples		Cereals	
Trend	Coefficient of Variation	Trend	Coefficient of Variation	Trend	Coefficient of Variation
(% yr.)	(per cent)	(% yr.)	(per cent)	(% yr.)	(per cent)
1.22	18	-4.62	21.49	-5.22	22.91

Source: International Food Policy Research Institute (IFPRI), "Food Security Program," Washington, D.C., 1978 (computer printout).

There are five types of agriculture: irrigated, dry-land, oasis and recessional (inthe river valley or behind dams).

These types of agriculture are spread out in the South East, where dry-land farming has a productive potentialoof about 100,000 hectares; the River zone, where irrigated and recessional agriculture can be practiced in an area of 80 to 100,000 ha; the area of recessional agriculture behind dams (the Hodhs, Brakna, Gorgol, Tagant, with a potential area of about 30,000 ha; and the oasis zone, with a potential area of about 6,000 ha.

Methods of production are rudimentary (no improved seeds, no insecticides, etc.)[9] In the South-East, the methods of extensive

8) Ibid.
9) See RAMS report on Dry-Land Agriculture, 1980, p. 55.

dry-land farming do not make optimal use of resources. However, agriculture is beginning to be integrated with herding activities.

The introduction of irrigation allowing farmers to reduce risks stemming from irregular rainfall involves high costs and various constraints due to the innovation of modern technology.

The main grains are sorghum, millet, corn and rice; the main legumes grown are niébé (cow peas) and peanuts; the main vegetables are watermelons, gumbo and sweet potatoes.

Harvests vary from one region to another. They are approximately: (see appendix for yields)

Millet/sorghum in dieri lands: 240 to 460 kg/hectare [10)]
Sorghum in recessional fields: 430 kg/hectare
Corn in recessional fields: 650 kg/hectare
Millet/sorghum in the South-East: 285 kg/hectare [11)]
Millet/sorghum with animal traction: 316 to 514 kg/hectare

Harvests in irrigated agriculture: 12)

Single cropping methods: 5 tons/hectare
Double cropping methods: 9 tons/hectare

Production budgets for the various sub-sectors are summarized in Table AV, page 31

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10) Ibid, p. 65.

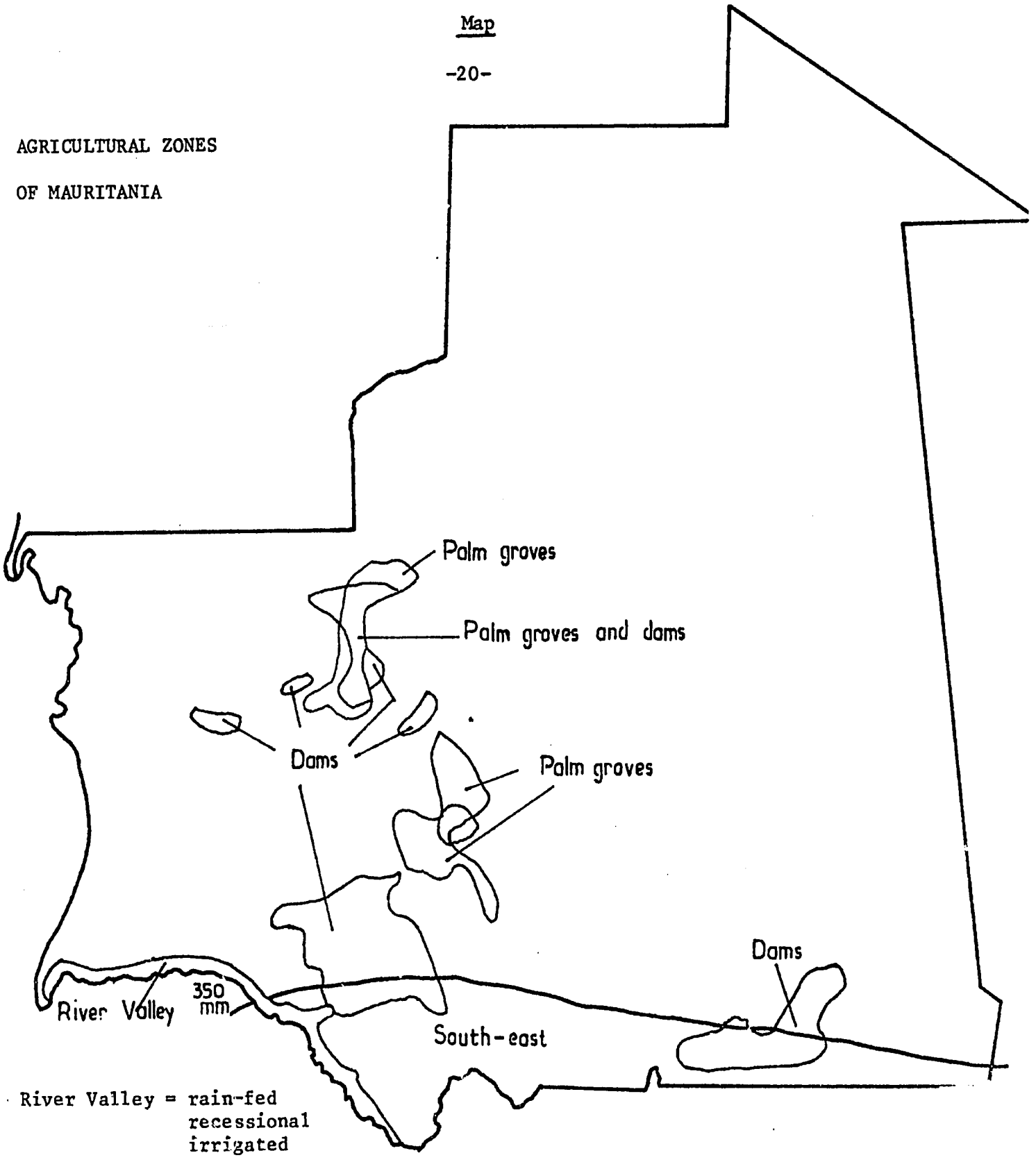
11) Ibid, p. 66.

12) RAMS report on Irrigated Agriculture, 1981, p. 52.

Map

AGRICULTURAL ZONES

OF MAURITANIA



River Valley = rain-fed
recessional
irrigated

Dams = recessional agriculture
behind dams

Oases = Palm groves

South-East = rain-fed

Scale:

1/6,500,000

Source:
RAMS; 1981

The Constraint of Land Tenure Legislation

The land tenure problem is a serious constraint in the development of agriculture, especially in the area of irrigated farming. The land tenure law of 1960 recognized traditional land rights but nationalized all lands without owners (problem of grazing lands). There have been many problems in the application of this law and a national commission is in the process of studying ways of applying it.[13] A lack of understanding of traditional rights (communal ownership of the land), payment for usufruct, control of the sale of land, etc., has held back certain development projects. Without resolving the land tenure problem, it will be difficult to organize new systems of production in Mauritania. The Syrian model of land tenure legislation (HEMA) could be useful in Mauritania. It would consist of recognizing as cooperatively owned the lands in recognized communities. These cooperatives would be obliged to maintain these lands [14] in good condition in return for supervision from the government.

Manpower

The 1977 census gives an idea of the overall distribution of manpower in Mauritania.[15] The manpower stock (persons aged 15 to 64) was composed of 709,000 individuals in 1977 (339,000 men and 370,000 women), and of 769,000 individuals (371,000 men and 398,000 women) in 1980. Manpower rose from 408,000 persons (321,000 men and 86,000 women) to 432,000 persons (333,000 men and 100,000 women) in the same period. Manpower in the rural sector (sedentary and nomadic) is 345,000 persons, or 77% of the 1977 total.

The farming population has been estimated to be as follows: [16]

South-East:	36,237	practicing farmers or farm workers
River Valley:	16,002	" " " " " [17]
Recessional areas:	16,552	" " " " "
Oases:	20-30,000	" " " "

Farmers are assisted by an average of 3.4 persons (wives, children, etc.).

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13) "Land Tenure and Community Development in RIM," Land Tenure Center, Univ. of Wisconsin, Jan.. 1981 p.25 and passim. Social Organization of Agricult[illegible], RAMS, 1980.

14) Ibid, p. [illegible].

15) Employment Implications of Alternative Development Strategies, Option Paper, 1981, chapter 1.

16) Dry-Land Agriculture, p. 37. Oasis Agriculture, RAMS, 1981, p.44.

17) It appears that the farm population in the River Valley was underestimated because the census was done during a bad year.

One important factor in productivity is the quality of the manpower stock. The national literacy rate is 17%. But this drops to 12% for the rural sector and to 8% among nomads.[18)]

In the area of health, only about 20 to 25% of the population has access to health care.[19)] Most health care services are concentrated in urban areas and particularly in Nouakchott. There is practically no health care at all for nomads. As a result of poor health care and education faci lities, the quality of manpower is poor.

Distribution and Farm Prices

A large proportion of agricultural production is consumed by the producers themselves; the small amount of marketable surplus is subject to wide annual and seasonal price fluctuations, as noted by the RAMS surveys.[20)] The marketing of cereals depends on "trader-transporters", producers, or parastatal organizations. The distribution of produce in the rural sector is mainly the responsibility of three parastatal organizations:

SONIMEX (National Import-Export Company) has a monopoly on imported rice, tea, sugar and textiles. It has the sole right to export gum arabic. SONIMEX imports, fixes the price of and distributes all of the above-mentioned products.

OMC (Mauritanian Cereals Bureau) is responsible for stockpiling grain and buying local production. OMC purchases were only 1,500 tons for the 1977-78 season and 1,800 tons for the 1978-79 season.

CAA (Food Aid Commission) is responsible for distributing a portion of donated grains (20%); it also establishes the selling price of the other portion of the grain stocks in order to cover distribu tion and transportation costs. At present the selling price of rice is lower than the price of imported or locally-produced rice, as table AI , page 23 .

The selling price takes into account the costs of importing and the costs of operating SONIMEX.

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18) RAMS report on Manpower Skill , 1980 Chapter 2.

19) RAMS report on Health and Nutritional Situation in Mauritania, 1981.

20) RAMS report on Consumption, 1980, page 115.

Table A-1

Costs of Rice

(UM/ton, 1980 prices)

Imported Rice		
Costs of the rice CAF	225 US$/ton	400 US$/ton
Cost in UM	14,625	18,000
Buying costs	292	626
Shipping & handling	1,500	1,500
Total	16,417	20,146
General costs	2,683	3,292
Taxes	493	604
Margin	294	352
Storage costs	320	320
Costs as far as Nouakchott	20,206	24,714
Transportation to the interior	3,000[1]	3,000[1]
	23,206[2]	27,714[2]

Local Rice	
Producer's price (paddy)	11,000
Transport	2,000
Hulling costs	1,800
Storage	500
Labor and packing costs	500
	15,800
Conversion rate	0.6
Price of rice	24,500
--by-products	-1,800
	22,700
Transportation to Nouakchott	3,000[1]
	25,700[2]

In 1980 the cost of imported rice varied between 23,200 UM/t and 27,700 UM/t including subsidies, depending on whether the price at the time of importation was 325 US$/t or 400 US$/t.21)

The cost of locally-produced rice comes to 25,700 UM/t. Broken rice is sold at UM/kg. Faced with rising subsidy costs, SONIMEX has had to raise the price to 17 UM/kg for broken rice and 30 UM/kg for rice containing 5% broken grains.

The subsidized selling price, the volume of imports, sales of donated rice at very low prices are not factors favoring production. The social concern for a low price to consumers should not sacrifice long-term development, which is the only way of reaching self-sufficiency in grains. A policy designed to encourage rice production should come to grips with the problem of true prices.

Credit

Agricultural credit is not yet widespread in Mauritania. The first efforts in agricultural loans were launched in Rodh Chargui in 1962 and were financed by the Mauritanian Development Bank. Because of the poor distribution system, farmers were not able to market their surplus as hoped and were not able to pay back the loans. Since then the loans have been suspended. In 1979 the Mauritanian Development Bank (now known as BMDC, Mauritanian Bank for Development and Commerce) was able to start making loans again with the help of a $2 million loan from the World Bank. So far, only 40% of the World Bank funds have been used.

Besides the BMDC, SONADER (National Rural Development Company) has been obliged to play the role of a credit agency for the irrigated fields along the river.

After the Commission on Agricultural Credit had issued its studies, a National Development Fund was created.22)

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21) RAMS report, Public Sector: Organization and Operation of Rural Development Activities, 1981, page 43.

22) Ibid. See the analysis of the National Development Fund, p. 90 passim.

Income

Annual rural sector income[23] is estimated to be 12,000UM per capita per year.

An analysis of rural sector income[24] shows that revenue coming from the productive sector is equal to only 31% of total sectoral revenue, and that services amount to 38% and transfer payments to 31% of total revenue. Thus, 2/3 of rural sector revenue comes from sources that are not directly productive.

Furthermore, regional income distribution is assymetrical. 70% of the budgetary units own less than 35% of total income. The Gini co efficient is R ≅ 0.46 for rural sedentary persons and 0.41 for nomads.

Government Development Policy

The 3rd Plan's goal was to establish conditions necessary for the "take-off" of the rural sector by eliminating major constraints. On the other hand, the objective of agriculture is to increase crop production. In order to carry this out, an investment of 4.8 billion UM had been planned.

Production

Imports will continue to rise unless there is an important structural change allowing for a reorganization of agricultural policies (price, import, agrarian reform poli cies, etc.). Such a change would require a rehabilitation period followed by a period of production. The major productive zones of Mauritania, based on types of production possible, are the following:

River region (dieri,[25] irrigated fields, walo land, until the construction of the Manantali dam);

South-East (dieri);

Wadi farming

Oases

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23) Rural Incomes, p. 15.
24) Rural Development Planning Commission, draft report, Oct.1980, p.40.
25) Dieri: land located on the upper slope of the river valley; area of rain-fed agriculture. Walo: land cultivated after the Senegal River recedes from flood stage.

In order to improve agricultural production; different technologies can be used. The technology now used by most people in the rural sector is traditional technology, which does not require modern inputs (no treated seeds, no fertilizer, etc.). This traditional technology can be improved by the quality of the seeds, the use of fertilizers, animal traction, etc.

Modern technology, which makes use of tractors, fertilizers, pumps, etc. requires skilled labor, as in the case of the irrigated fields.

The three main technologies being considered are the following:

T_1: traditional technology

T_2: improved traditional technology

T_3: modern technology

The following pages wi'l analyze potential production, its costs (excluding investment and financial costs), recurring costs and value added for each type of technology: T_1, T_2, and T_3 in each major zone of production.

Technologies Used

Increased production depends ,ainly on the technology used. According to the RAMS base-line studies, a given technology corresponds to a certain combination of given production factors (labor, inputs, capital, etc.).

In order to simplify the analysis, this report will focus on three technologies:

T_1 = traditional manual technology. This is what the majority of Mauritanian peasants now uses: wooden cultivation tools, no fertilizer, no selected or treated seeds, no control of water, etc.

T_2 = improved traditional technology. This technology involves using improved inputs (fertilizers, insecticides, etc.), improved cultivation methods and the use of animal traction. A description of this improvement appears in Chapter page

T_3 = modern technology. This technology involves using improved inputs, motor pumps, tractors for plowing and land clearing, etc.

These three technologies are related to three levels of using production techniques, each of which has its own investment and recurring cost, training and supervision factors.

These levels of technology are equally applicable to rain-fed and to irrigated agriculture. At present, rain-fed agriculture depends almost entirely on T_1, which means that cultivation is done by hand except in a few cases where farmers use animal traction and modern inputs (T_2 level of technology).

Recessional agriculture in wadis and the oualo depends on water retained by dams or on the flood waters of the river; cultivation techniques are traditional (T_1, or manual with few modern inputs).

T_2 technology is easily assimilated by rural people and requires few large investments.

Irrigated cultivation involves the ability to control the supply of water. This kind of cultivation requires a certain infrastructure in order to control water. Creating irrigated fields can be done only in the context of projects, and this requires investment in material, human and organizational infrastructures. This is T_3-level technology.

There are, of course, variations within a given type of technology. The use of a given type of technology. The use of a given technology can be more or less intensive and can thus require a higher or a lower level of investment.

The technical coefficients of production and the outputs used in making projections are average yields and are derived from various studies.[26] It must be remembered, however, that human, organizational follow-up and support factors (which are treated in another report) are as important, if not more important, than the technical factors in planning development policies.

Potential Production Using Traditional Technology

Traditional technology (T_1) is used in the various productive regions (the South-East, the River Valley, the areas of wadi cultivation).

Potential production using traditional cultivation techniques, the areas and the population involved in the various zones are presented in Table A-II page 28. Given present trends and traditional technology, the South-East region, the dieri and walo lands and the wadi areas will be able to produce about 52,000 tons of grain in the year 2000 which represents 17% of total needs according to nutritional standards (D_2). About 113,000 farmers and farm workers will be employed.

Production costs are presented in Tables A-III,IV and pages 29,30.

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6) See Appendix.

Estimated costs are based on the budgets established by RAMS[27)] and presented on page 31 . With an average total annual cost of 177 million UM in 1980 prices, it can be said that expenditures on rain-fed agriculture using traditional technology are negligible.

Traditional Technology (T_1)

Potential production in traditional agriculture is as follows:

Table A-II Potential Production With T_1

	1980	1985	1990	1995	2000
South-East region					
Population	36,237	40,995	46,383	52,478	59,374
Area (ha)	50,000	56,570	64,000	72,415	81,931
Millet/sorghum prod'n (tons)	15,660	17,707	20,083	22,666	25,645
Niébé production [1)]	2,110	2,376	2,688	3,042	3,441
River Valley					
Population	16,002	18,105	20,484	23,176	26,222
Dieri land (ha)	30,000	32,319	34,816	37,507	40,406
Millet/sorghum prod'n (tons)	12,900	13,897	14,971	16,128	17,375
Niébé production [2)] 5)	1,680	1,810	1,950	2,100	2,260
Oualo land (ha)	48,000	42,000	22,000	-	-
Sorghum prod'n (tons)[3)]	20,640	18,060	9,460	-	-
Wadi Farming					
Population	16,552	18,727	27,188	23,972	27,122
Area (ha)	12,000	13,500	15,000	18,000	21,000
Millet/sorghum prod'n (tons) [4)]	5,160	5,738	6,375	7,650	8,925
Total (I + II + III + IV)	54,360	55,402	50,839	46,444	51,945

See explanation of Table A-II on page

27) Agricultural Production: Analysis of Selected Aspects of Rural Production in Mauritania.

Explanation of Table A-II

1. Production rises with the growth of the active labor force by 2.5%. Production includes two dimensions: manual labor (74%) and animal traction (26%). A farmer can cultivate 0.74 ha, whereas a plow can cultivate 2.7 ha. Hand labor produces 300 kg per ha in crops whereas animal traction produces 350 kg per ha.

2. Average yield is 430 kg per ha for sorghum.

3. Average yield is 416 kg per ha for millet. After 1990, the construction of the Manantali Dam will put an end to oualo farming.

4. Yields are 425 kg per ha for sorghum.

5. Niébé yields are 280 kg per ha.

6. Rate of manpower increase = rate of population growth = 2.5%.

Table A-III Production Costs in Traditional (T_1) Agriculture
(Millions of UM, 1980 prices)
Source: Author's calculations

	1980	1985	1990	1995	2000
South-East [1]					
Area		56,570	64,000	72,415	81,931
Cost of manual cultivation		30	34	39	44
Cost of animal traction		61	69	78	88
River Region					
Dieri land area		32,319	34,816	37,507	40,406
Costs [2]		22	23	25	27
Oualo land area		42,000	22,000	-	-
Costs [3]		61	31	-	-
Recessional					
Area		13,500	15,000	18,000	21,000
Costs [4]		115	13	154	18
Total annual costs		185,5	171	157	177

1) Traditional agriculture in the South-East has two dimensions: animal traction (26%) and manual labor (74%). The cost per hectare using animal traction is 4,152 UM; for using manual labor, 728 UM per hectare.
2) Costs for dieri farming = 673 UM
3) Costs for oualo farming = 1,453 UM
4) Costs for recessional farming = 856 UM

Table A-IV Production Estimates Using T_1

(Millions of UM, 1980 prices)

	1980	1985	1990	1995	2000
South-East Region					
Millet/sorghum[1)]	219	248	280	317	359
Niébé[2)]	63	71	80	91	103
River Region					
Dieri land millet/sorghum	181	194	210	226	243
Niébé	50	54	58	63	68
Oualo land					
Millet/sorghum	289	252	132		
Wadis					
Millet/sorghum	72	80	89	107	125
Value of production	874	899	849	804	898

1) Price of millet/sorghum: 14 UM/kg

2) Price of Niébé: 30 UM/kg

Table A-V Operating Budgets of the Various Kinds of Agriculture in Mauritania (1979)

Type of agriculture	Costs per Hectare			
	Materials	Maintenance & Depreciation	Other costs	Total costs
Rain-fed				
Oualo	103	100	1,250	1,453
Dieri (Senegal River Valley)	168	100	405	673
Dieri (South-East)	172	100	455	727
Dieri (animal traction)	172	2,960	1,020	4,152
Recessional (dams)	133	100	623	856
Irrigation				
Rice (1 crop)	19,380	4,500	9,550	23,430[2)]
Sorghum	5,600	4,500	8,870	18,870
Tomatoes	10,580	4,500	23,490[2)]	38,570
Oases				
Group 1	11,550	16,775	31,720[5)]	60,045
Group 2	1,760	7,315	19,106[6)]	28,175

Income per Hectare						
Crop	Yield	Price (UM/kg)	Gross income	Net income	Days of work	Daily income
Sorghum Niébé	430 45	14.5 30	6,235 1,350	6,134	85.5	72
Millet Niébé	300	13.5	4,0[illegible]0	3,877	70.4	55
Sorghum Millet, niébé	325 60	14 30	4,5[illegible]0 1,8[illegible]0	5,623	72	78
Sorghum, millet Niébé Ox	375 60 0.33/head	14 30 7,280	5,2[illegible]0 1,[illegible]0 2,[illegible]0	5,298	55[1)]	96
Sorghum Niébé	430 60	14.5	6,[illegible]35	7,179	[illegible]	81
Rice	4,000	10	40,[illegible]00	16,570	150	110
Sorghum	3,500	14.5	50,[illegible]00	31,880	120	266
Tomatoes	2,500	20	50,[illegible]00	10,820	75[3)]	145
Dates	3,200	35	112,[illegible]00	203,435	174	1,169
Vegetables	6,000	25	150,[illegible]00			
Date palms	592	2.5	1,480			
Dates	3,200	35	112,000	105,305	17	900
Vegetables	800	25	20,000			
Date palms	592	2.5	1,480			

1) Implicit or explicit costs in rain-fed agriculture and in recessional agriculture behind dams, plus investment and other costs at 6% in irrigated and oasis agriculture.
2) Annual capital costs = 175,000 UM/ha at 6% a year.
3) Assuming that transportation and harvesting costs = 15% of the value of the harvest.
4) Work done by family members.
5) Investment cost of 500,000 UM at 6% included.
6) Investment cost of 300,000 UM at 6% included.

Source: Agricultural Production: Analysis of Selected Aspects of Mauritanian Agriculture. RAMS, 1981.

31

Potential Production Using Improved Traditional Cultivation Techniques

T_2 technology is an improved form of traditional technology. Because of the very low level of agricultural technology nowiin use in Mauritania, it is possible to improve crop yields by simply improving inputs and by spreading the practice of inter-cropping and animal traction.[28)]

Potential production for the various regions, arable land area and population concerned are presented in Table A-IV,page 33 . Totalpproduction using improved technology in the South-East, dieri and walo lands and wadi lands amounts to 97,000 tons by the year 2000, or 31% of total demand, according to the D_2 nutritional norms. Employment for 113,000 farmers and farm workers will be available on an arable area of 143,000 hectares. Production costs are presented in table A-VII on page 35 . Annual costs (investment and recurring) for production using improved technology come to 342 million UM in the year 2000, or about double the cost of traditional technology for about double the production.

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28) See explanation in Annex.

Table A-VI T_2 Technology (Improved Traditional Agriculture)

Potential production in improved traditional agriculture is:

	1980	1985	1990	1995	2000
South-East					
Population	36,234	40,995	46,383	52,478	59,374
Area (ha)	50,000	56,570	64,004	72,415	81,931
Prod'n millet/sorghum (tons)[1] (I)	15,660	17,707	24,868	40,881	61,790
Cow-pea (niébé) production	2,110	2,747	3,863	5,412	7,778
River Valley					
Population	16,002	18,105	20,484	23,176	26,222
Dieri lands (ha)	30,000	32,319	34,816	37,507	40,406
Prod'n millet/sorghum[2] (II)	12,900	13,897	15,967	18,754	22,223
Cow-pea (niébé) production	1,680	1,810	2,228	2,701	3.232
Walo lands (ha)	48,000	42,000	22,000	-	-
Sorghum prod'n[3] (III)	20,640	18,060	9,460		
Wadi Lands					
Population	16,552	18,727	21,188	23,972	27,122
Area (ha)	12,000	13,500	15,000	18,000	21,000
Prod'n millet/sorghum[1] (IV)	5,160	5,585	7,500	9,900	12,600
Total(I II III IV)	54,360	55,469	57,795	69,535	96,613

Potential production using T_2 technology, given normal rainfall conditions (production figures calculated on a basis of 4 years of successful harvests out of 5).

1), 2) and 3): See explanation of the table on the next page.

Explanation of Table A-VI

1) Active farm population is expected to grow at the rate of 2.5%. Manual cultivation is 74% of the total, animal traction 26%. Using manual techniques, each agricultural worker can work 0.7 to 1.8 ha. whereas a plow can cover 2.7 to 7 ha. The years 1980-85 are considered a period of rehabilitation. After 1985, yields will be:

South-East	Manual Labor		Animal Traction	
	Millet/sorghum	Cow-peas	Millet/sorghum	Cow-peas
1980-85	310 kg/ha	210 kg/ha	350 kg/ha	255 kg/ha
1986-90	400 "	235 "	450 "	300 "
1991-95	500 "	260 "	650 "	350 "
1996-2000	600 "	310 "	810 "	400 "

Fertilizer requirements are 6 kg of TSP (Triple Super Phosphate) and 12 kg of urea per hectare, assuming 6,000 plants per hectare.

River Region

2) Yields for millet/sorghum:

	Millet	Cow-peas
1980-85	430 kg/ha	280 kg/ha
1990-	459 "	320 "
1995-	500 "	360 "
2000	550 "	450 "
Fertilizer required	TSP	Urea
1980-85	6 kg/ha	12 kg/ha
1985-90	9 "	" "
1990-95	12 "	" "
1995-2000	15 "	" "

3) Sorghum yields:

1980-85	420 kg/ha
1985-90	500 "

After 1990, the Manantali dam will submerge walo lands.

Table A-VII Production Costs Using T_2 - Improved Traditional Agriculture

(Millions UM, 1980 prices)

	1980	1985	1990	1995	2000
South-East					
Area (ha)		56,570	64,000	72,415	81,931
Costs 1)					
Manual labor		29	32	36	40
Portion investment cost		4.5	5	5.4	6
Animal traction		88	123	168	227
Portion investment cost		62	86	118	159
River Valley					
Dieri lands area (ha)		32,319	34,816	37,507	40,406
Costs 2)		22	23	25	27
Portion investment cost		3.3	3.4	3.7	4
Walo land area (ha)		42,000	22,000	-	-
Costs 3)		61	32		
Portion investment cost		9	4.8		
Recessional agriculture					
Area (ha)		13,500	15,000	18,000	21,000
Costs 4)		11.5	13	15.4	18
Required fertilizer (tons)		2,599	2,445	2,302	2,580
Costs (millions of UM) 6)		57	54	51	57
Total costs per year		269	277	295	342

Source: Author's calculations.

Explanation of Table A-VII

Production costs are based on the budget established by RAMS.[29]

The costs of production per hectare are as follows:

1) South-East

Manual cultivation	728 UM
Animal traction	4,152 UM

Investment costs amount to 15% of the total cost of manual cultivation and 70% of the cost of animal traction.

Animal traction is expected to be used by 50% of the farmers in the year 2000.

River Valley

2) dieri lands 673 UM

3) Walo lands 1,453 UM

Investment costs equal 15% of total costs.

Recessional agriculture

4) Recessional agriculture 856 UM

Infrastructure costs are calculated on page

5) Fertilizer needs are established according to the norms proposed in the "improved traditional technology package." Average needs per hectare = 18 kg (6 of urea and 12 of tri-super-phosphate).

6) The price of a ton of fertilizer was 22,000 UM in 1980 prices.

Table A-VIII Infrastructure Costs in Wadi Agriculture

	1980	1985	1990	1995	2000
Area (ha)	12,000	13,500	15,000	18,000	21,000
Annual infrastructure costs[1]	52	52	104	104	

1) The average infrastructure cost in developing one hectare of recessional land is 175,000 UM in 1980 prices.

29) Agricultural Production: Analysis of Selected Aspects of Mauritanian Agriculture.

Tabl : A- IX

Value of Production Using T_2

(Millions UM, 1980)

	1980	1985	1990	1995	2000
Sout -East					
Mill t/sorghum 1)	219	248	348	572	865
Cow- eas 2)	63	82	116	162	233
Rive Valley					
Mill t/sorghum in di ri lands	181	194	223	262	311
Cow- eas	50	54	67	81	97
Walo lands					
Mill t/Sorghum	289	253	132		
Wadi	72	81	105	139	176
Valu of production	874	912	991	1,216	1,682

1) M llet/sorghum = 14 UM/kg

2) C w-peas = 30 UM/kg

Potential Production Using Modern Technology (T_3)

Modern technology is essentially in the domain of irrigated agriculture and requires large-scale use of modern inputs and infrastructures.

Potential production using modern technology depend upon:

1) varied scheduling of infrastructure development;
2) planned use of inter-cropping, and
3) planned production outputs.

These production potentials are shown in Table A-X, page 39. Under assumption A_1, 210,000 tons of rice can be produced in the year 2000 at a yield of 3.5 tons/ha and 313,000 tons under the same assumption at a yield raised to 5 tons of paddy/ha in the year 2000.

Assumption A_1 at a yield of 3.5 tons/ha amounts to 68% of D_2 and Assumption A_1 at a yield rising from 3.5 to 5 tons/ha comes to 102% of D_2 demand.

Assumption A_2 at present production levels yields 114,000 tons, or 37% of D_2 demand, whereas assumption A_2 with production rising to 5 tons/ha yields 170,000 tons, or 55% of D_2 demand.

Assumption A_3 yields 83,000 tons under present conditions, or 27% of D_2 demand and the same assumption with yields rising to 4.2 tons/ha produces 101,000 tons or 33%.

It must be noted that by changing yields, production levels can be increased by 34% under assumption A_1 and by 18% under assumption A_2 and by 5% under assumption A_3.

The initial installation and the operating costs of irrigated rice paddies are shown in Tables XI and XII.

Average installation costs are 0.5 million UM/ha and could be cut in half by the year 2000 (3.5% reduction per year) with the help of improved infrastructures such as roads and ports, better training leading to greater productivity and improved management.

Operating and recurrent costs are assumed to be constant although a slight rise in productivity can be expected because of better support activities.

The value of production is shown in Table A-VIII page 43.

Table A-X T_3 Technology: Irrigated Agriculture --10^3 tons

	1980	1985	1990	1995	2000
Option A					
Area (ha)	4,311	14,311	24,311	44,311	68,811
Rice production, scenario 1 1)		30,053	76,580	139,580	210,455
Rice production, scenario 2		30,053	51,053	139,580	210,455
Rice production, scenario 1 2)		33,181	93,350	187,856	312,725
Rice production, scenario 2		33,181	62,233	187,856	312,725
Option B					
Area (ha)	4,311	10,311	16,311	26,311	36,311
Rice production, scenario 1		21,653	51,380	82,880	114,380
Rice production, scenario 2		21,653	34,253	82,880	114,380
Rice production, scenario 1 2)		23,907	62,632	111,545	169,963
Rice production, scenario 2		23,907	41,754	111,545	169,963

Table A-X T_3 Technology: Irrigated Agriculture --10^3 tons

	1980	1985	1990	1995	2000
Option C					
Area	4,311	9,311	14,311	20,311	26,311
Rice production, scenario 1		19,553	45,080	63,980	82,880
Rice production, scenario 2		19,553	30,053	63,980	82,880
Rice production, scenario 1 3)		20,529	49,796	74,279	101,129
Rice production, scenario 2		20,529	33,203	74,279	101,129

Table A-X: Assumptions

There are three broad options:

Option A	Rate of installing rice paddies
1980-1990	2,000 ha/year
1991-2000	4,000 ha/year
1996-2000	4,500 ha/year
Option A_2:	
1980-1990	1,200 ha/year
1991-2000	2,000 ha/year
Option A_3:	
1980-1990	1,000 ha/year
1991-2000	1,200 ha/year

In addition, there are two other scenarios:

Scenario 1: double-cropping in half of the rice paddies after 1985.

Scenario 2: double-cropping in half of the rice paddies after 1990.

1) Average yield per hectare is 3.5 tons of paddy.
2) Average yield per hectare rises by 2% to reach 5 tons/hectare in the year 2000.
3) Average yield /ha rises by 1%, reaching 4.3 tons/ha in the year 2000. The paddy-rice conversion rate = 0.6.

Table A-XI Operating Costs in Irrigated Agriculture

(Millions of UM/year)

	1980	1985	1990	1995	2000
Option A_1 (ha)		14,311	24,311	44,311	68,811
Scenario 1[1] (millions)		336	857	1,562	2,425
Scenario 2[2]		336	571	1,562	2,425
Option A_2 (ha)		10,311	16,311	26,311	36,311
Scenario 1		242	575	927	1,280
Scenario 2		242	383	927	1,280
Option A_3 (ha)		9,311	14,311	20,311	26,311
Scenario 1		219	504	716	927
Scenario 2		219	336	716	927

1) Double-cropping in half of the rice paddies after 1990.

2) double-cropping in half of the rice paddies after 1995; operating costs of one hectare of irrigated field: 23,500 UM in 1980 prices (RAMS).

Table A-XII

Annual Installation Costs of Irrigated Rice Paddies

(Millions of UM/year)

	1980	1985	1990	1995	2000
Option A_1 (ha)		2,000	2,000	4,000	4,500
Costs 1) (millions of UM)		1,000	1,000	2,000	2,250
Costs 2)		842	709	1,134	1,141
Option A_2		1,200	1,200	2,000	2,000
Costs 1) (ha) (millions of UM)		600	600	1,000	1,000
Costs 2)		505	425	597	503
Option A_3 (ha)		1,000	1,000	1,200	1,200
Costs 1)		500	500	600	600
Costs 2)		421	354	358	301

1) Installation costs of one hectare = .5 million UM/ha. (1980)

2) Installation costs per hectare drop due to economies of scale and other factors; costs assumed to drop by 3.5%, reaching an average per hectare installation cost of 250,000 UM/ha in the year 2000.

Table A-XIII

Production Using T_3

(Millions of UM; 1980 prices)

	1985	1990	1995	2000
Option A_1				
Value of production 1)	300	766	1,400	2,100
Value of production 2)	332	934	1,878	3,127
Option A_2				
Value of production 1)	216	514	828	1,114
Value of production 2)	239	626	1,115	1,699
Option A_3				
Value of production 1)	195	450	640	830
Value of production 3)	205	497	742	1,011

1) Price of rice: 10 UM:kg

2) Assuming a rise in yield per ha. of 5 tons/ha in the year (2% annual rise).

3) Assuming a rise in yield per ha. of 4% a year until the year 2000.

The Oases Sector

At present, the oases cover an area of some 4,500 hectares spread out over several regions[30], and, according to the RAMS studies,[31] they are the most profitable type of economic activity in the rural sector because they integrate several different economic activities: The oasis sector comprises 2,000 to 6,000 active farmers and farm workers and 20 to 30,000 persons make a living in this sector.

There are numerous well-known constraints in the oasis sector:

-they are widely scattered and difficult to reach;

-the technology of production is unsophisticated;

-there is a low level of investment; and

-the oasis environment is deteriorating.

In addition, there are constraints that are not unique to the oasis sector: land tenure problems, a lack of credit, etc..

At present, there are about 1 million date palms and their[32] number is increasing slowly. By the year 2000 there will be about 1.1 million date palms producing about 18,000 tons of dates a year. Production could be slightly higher than this figure once young trees reach their productive age (young trees are about 40% of the total).[33] Sub-jacent crop yields are modest. See Table A-14, page 45. The value of production assuming a continuation of present trends is shown in Table A-15, and the average production costs per hectare amount to 41,000 UM in 1980 prices (40% of the oases are of the Type 1 variety and 60% are of the Type 2 variety).

The Type 1 oases are the most accessible ones and are near consumption centers; they also produce many vegetables. The Type 2 oases are difficult to reach and have few sub-jacent crops.

The oasis sector has significant potential which can be classified in two ways:

higher levels of production through rationalized cultivation techniques and prevention of environmental deterioration;

creation of new ecosystems by tapping deep water resources.

30) Oasis Agriculture, page 62.

31) See Budget, page 31 · RAMS, 1980

32) Oasis Agriculture,

33) Ibid, page 72.

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Table A-XV

Oases: Production Using T_2 Technology

(Millions of UM, 1980 prices)

	1980	1985	1990	1995	2000
Production					
Dates 1)	581	595	605	616	630
Grains 2)	0.3	0.3	0.3	0.3	0.3
Vegetables 3)	22	22	22	22	22
Henna 4)	20	20	20	20	20
Value of production	623	637	647	658	672
Production costs	185	185	185	185	185

1) Dates: 35 UM/kg.
2) Grains. 10 UM/kg.
3) Vegetables: 25 UM/kg.
4) Henna: 100 UM/kg.
5) Average production costs: 41,000 UM/ha in 1980 (40% in Type 1 oases and 60% in Type 2 oases).

Table A-XVI

Oasis Sector T_2

	1980	1985	1990	1995	2000
Number of date palms	1,025,100	1,046,600	1,068,100	1,089,633	1,111,600
Production 1)	16,600	16,955	17,303	17,652	18,000
Improved production 2) (to double in 15 years)	16,600	16,955	22,370	27,785	33,200
Sub-jacent crops					
grains	100	100	200	300	300
vegetables	1,500	1,500	1,800	2,500	2,500
forage crops	3,000	3,500	5,000	5,000	5,000
henna	200	250	250	300	300

1) 16,600 T/1,025,100 or a production rate of 16.2 kg per palm (see Oasis Agriculture, RAMS, 1980.

2) Improved production based on the possibility of launching a program to:
-safeguard 2000 hectares between 1981 and 1990;
-rehabilitate oases by improving methods of production and management of water resources.

Table XVII Investments Required in the Oasis Sector 10^6 UM)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991-2000
Action I											
-Study of safeguarding possibilities	10	10	10	10	10	-	-	-	-	-	
-Implementation						90	90	90	90	90	
Action II											
Rehabilitation											
-Studies, research				2.5	2.5						
-Implementation of research/ extension work						6	6	6	6	6	7/year
-Training	2	2	2	2	2	0.5	0.5	0.5	0.5	0.5	0.5
TOTAL	12	12	12	14.5	14.5	96.5	96.5	96.5	96.5	96.5	7.5

Effect on balance of payments: 70% in currency: Technical assistance —equipment, until 1990.

Source: RAMS calculations.

Table A-XVIII

Oasis Production Under T2

(Millions of UM, 1980 prices)

	1980	1985	1990	1995	2000
Production:					
Dates 1)	581	593	783	972	1,162
Grains 2)	1	1	2	3	3
Vegetables 3)	37	37	45	62	62
Henna 4)	20	25	25	25	25
Value of Production	639	656	855	,062	1,252
Production Costs 5)	202	202	202	202	202

1) Dates: 35 UM/kg.

2) Grains: 10 UM/kg.

3) Vegetables: 25 UM/kg.

4) Henna: 100 UM/kg.

5) Production costs: 45,000 UM/ha, 1980 prices.

Table A-XIX

Oases: Potential Production Under T3

	1980	1985	1990	1995	2000
Area					
Date palms (ha)		100	500	500	500
Sub-jacent crops (ha)		150	375	250	250
Production					
Dates (tons) 1)			500	3,000	4,500
Vegetables (tons) 2)		300	1,800	1,250	1,250
Grains (tons) 3)		200	400	300	300
Forage crops (tons) 4)		1,000	4,000	10,000	6,000

Source: RAMS calculations.

1) Dates: 150 palms/ha Yield per tree: 12 kg. after 4 years of growth;
60 kg. after 10 years of growth.

2) Vegetables: 15 tons/ha

3) Grains: 4 tons/ha

4) Forage crops: 80 tons/ha

Table A-XX

Oases: Required Investments Under T3

	1980	1985	1990	1995	2000
Area (ha)		100	500	500	500
Sub-jacent crops (ha)		150	375	250	250
Investments		23	46	-	-
Production costs 1)		8	41	41	41

Source: RAMS calculations.

1) Average production costs/ha: 82,000 UM, 1980 prices.

Table A-XXI

Oases: Production Under T_3

(Millions of UM, 1980)

	1980	1985	1990	1995	2000
Production:					
Dates 1)	581	593	800	1,077	1,319
Grains 2)	1	3	6	6	6
Vegetables 3)	37	44	90	93	93
Henna 4)	20	25	25	25	25
Value of production	639	665	921	1,201	1,443

1) Dates: 35 UM/kg.

2) Grains: 10 UM/kg.

3) Vegetables: 25 UM/kg.

4) Henna: 100 UM/kg.

Consumption:

Factors Influencing demand for food

There are three main fqctors that influence the demand for food in Mauritania: population, food habits and urbanization. The growth rate of the population is, however, the most important factor.

Accordine to the data of the 1977 census and the RAMS demographic studies. 34 the population in the year 2000 will be distributed as follows:

Population 10^3 inhabitants

	1980	1985	1990	1995	2000
Rural population	1,240	1,340	1,449	1,563	1,683
Modern urban population	203	296	403	533	688

According to the RAMS studies on consumption patterns, 35 and assuming an annual 2.5% growth rate of the population and constant consumption patterns (which will be called D_1 demand), demand for grains will be:

D_1 Demand for Grains (10^3 tons)

	1980	1985	1990	1995	2000
Rural sector	147	162	179	197	223
Modern sector 36	27	40	54	72	93
TOTAL	174	202	233	269	316

34) Demographic Projections, p. 124.

35) Rural Consumption, p. 115.

36) 135 kg./per capita annually.

Nevertheless, according to the health-nutrition studies carried out by RAMS, grain demand in the year 2000 (D_2) will be 340,000 tons 37. This demand for grains is based on nutritional norms which combine a daily intake of meat, fish, vegetables, milk and grains . . . for sedenatary rural people, for nomads and for city dwellers. This calculation of energey values takes into consideration the case of women and children.

The sum of desirable intake levels is the basis of estimating total food demand from a nutritional point of view.

D_2 Demand for Grains (10^3 tons)

	1980	1985	1990	1995	2000
Rural sector	187	202	218	235	253
Modern sector	25	37	50	67	87
Total	212	239	268	302	340

However, the energy value of these intake levels can be reduced by 10%, which will be just enough to meet nutritional needs: 38

	1980	1985	1990	1995	2000
Total	191	215	241	272	306

4) Health Nutrition Part II, RAMS, 1981.

5) Ibid., page 38.

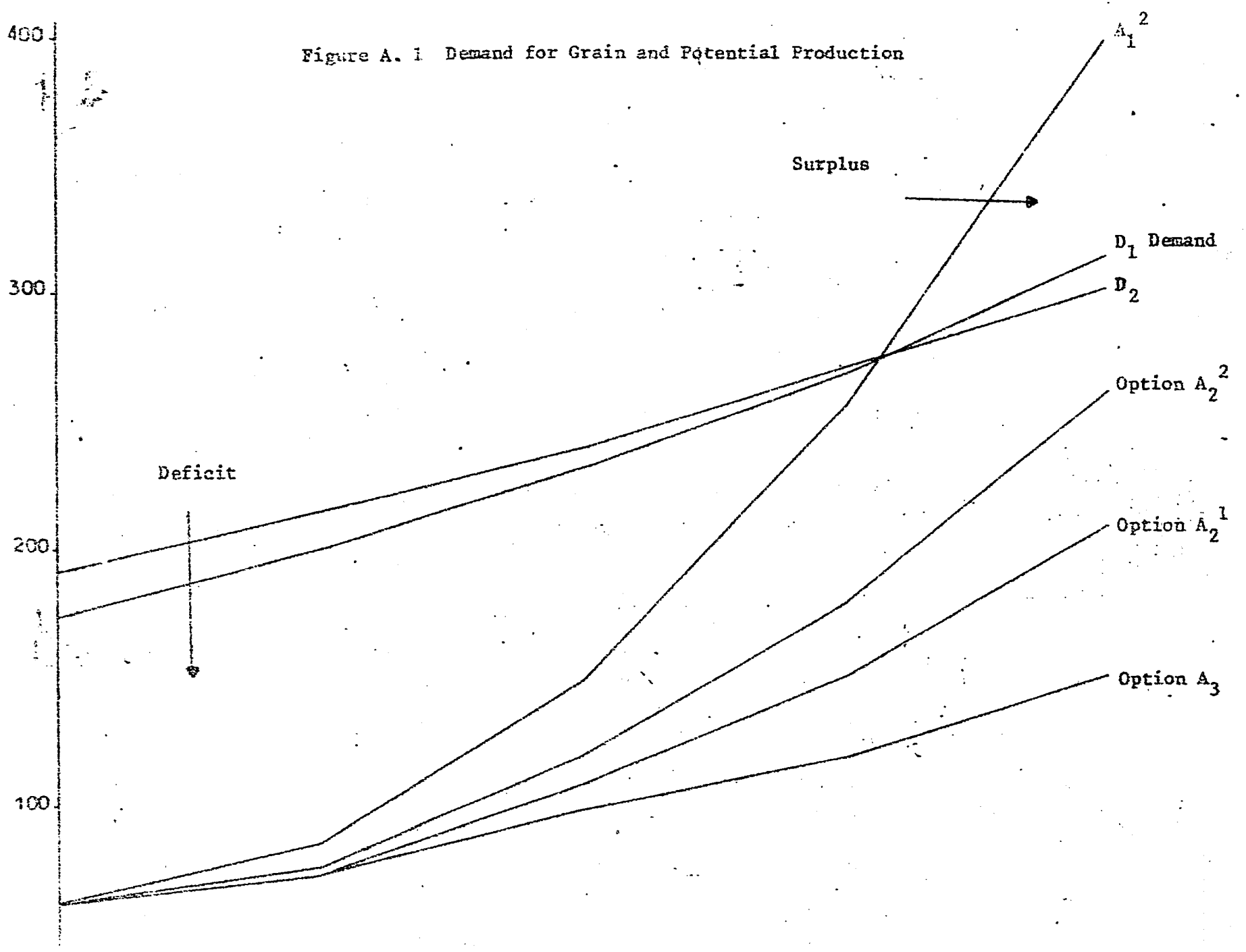
Table: A. XXII: Breakdown of the Demand for Grains[1)] (10^3 tons) D_1

	1980	1985	1990	1995	2000
Total demand	174	202	233	269	316
which is composed of the demand for:					
millet/sorghum[1)]	87	101	116	134	158
rice	75	87	100	116	136
wheat	10	12	14	16	19
Others	2	2	3	3	3

1). Demand for grains is made up as follws: 50% is for millet/sorghum
43% is for rice
6% is for wheat
1% is for other grains.

According to Rural Consumption.

Figure A. 1 Demand for Grain and Potential Production



Explanation of Figure A.1

According to Figure A.1, there are two levels of demand for grains: the demand for grains, based on present-day consumption patterns (D_1), and the demand for grains based on nutritional norms (D_2).

In 1980, D_2 is higher than D_1, but is less than D_1 by the year 2000. This is because of the fact that the nutritional norms take into account an intake of meat, fish, grains and vegetables. This type of intake assumes reduced consumption of meat and an increased consumption of fish and grains. Grain production under Optios A_1, A_2, and A_3 is slow but grows exponentially over time.

Option A_1 produces an exportable surplus
Option A_2 meets 84% of D_1 and 87% of D_2.
Option A_3 meets 48% of D_1 and 50% of D_2.

Each agricultural option includes production from:

rain-fed agriculture (South East);
oases;
recessional agriculture along the river and wadis;
irrigated agriculture.

The Different Options

In the rural sector and particularly in grain production, potential production using T_1, T_2 and T_3 can be calculated in irrigated, rain-fed, wadi and oasis agriculture. Potential production in all of these sub-sectors put together makes up potential rural sector production.

Three broad option are being analyzed:

Option A_1 : This option enables Mauritania to become self-sufficient in food by the year 2000.

Option A_2 : This is the option which uses present resources combined with improved traditional technology.

Option A_3 : This is the continuation of present trends, including the present rate of development of new irrigated lands and the continued use of traditional technology.

Option A_1 comprises 2 large components: irrigated and improved traditional agriculture:

1) Irrigated agriculture will require the following rate of creating new irrigated fields:

2,000 ha./year between 1980 and 1990
4,000 ha./year between 1990 and 1995
4,500 ha./year between 1996 and the year 2000

By the year 2000, grain production will yield 210,000 tons of rice (assuming that double cropping is practiced in half of the irrigated fields and that average production is 3.5 tons/ha.).

It can be estimated that a production level of 3.5 tons of paddy/ha. could rise to 5 tons/ha. through better organization and improved productivity. Production would be 313,000 tons of rice in the year 2000 (assuming double cropping in half of the rice paddies and an average yield rising from 3.5 tons/ha. to 5 tons/ha.).

2) Improved traditional cultivation, which depends upon population growth, a greater use of animal traction, double-cropping and modern inputs, will yield 97,000 tons of grains.

3) Thus, Option A_1 will yield 307,000 tons of grains (210,000 tons from irrigated agriculture and 97,000 tons from imrpoved traditional cultivation) assuming a constant yield of 3.5 tons/ha. in irrigated agriculture.

Production under Option A_1 would be 410,000 tons of grains 313,000 from irrigated agriculture and 97,000 tons from improved traditional agriculture) assuming that yields in irrigated agriculture rise to 5 tons/ha.

Option A_1 would satisfy 97% of present (D_1) demand and 100% of D_2 (nutitional) demand if production were 3.5 tons/ha. and 131% of D_1 and 134% of D_2 if production were 5 tons/ha.

4) The average cost of Option A_1 would be abpat 5,400 million UM/year in the year 2000 of which 4,7000 million UM/year would be for irrigated agriculture and 700 million UM/year for the rest.

Furthermore more, it can be expected that improved roads and port facilities will be available by the year 2000 and thus reduce the installation costs in irrigated agriculture. Better management and economies of scale can also reduce costs.

In such a situation, the costs of Option A_1 would be about 4,200 million UM, of which 1,100 million UM/year would be for installattion costs, 2,400 million UM/year for recurring costs and 700 million UM/year for the other types of agriculture (see Table XXVIII page 72 .

There are,however, certain important conditions to be considered. Under Option A_1 there are certain manpower constraints in addition to the constraints of investments, recurring costs, land tenure nad management:

There are 3 conditions to be considered:

1) that each farmer or farm worker can cultivate 0.25 ha.
2) that each farmer or farm worker can cultivate 0.5 ha.
3) that each farmer or farm worker can cultivate 1.5 ha.

The following table shows the present manpower stock in the River region 38) and the growth of this stock until the year 2000. Under Option A_1, each farmer or farm worker would have to cultivate 2.62 ha., under Option A_2, each would have to cultivate 1.33 ha. and under Option A_3, each would have to cultivate 1 ha.

---

38) The growth of active farming population is assumed to be 2.5%/year (the same as overall population growth). The estimation of the manpower stock is drawn from the ,977 census, which was carried out in a bad year in the River region. It is likely that the actual number of agricultural workers in the region was somewhat underestimated.

Table A.XXIII: Irrigated Agriculture and Active Farmers and Farm Workers (River Region)

	1980	1985	1990	1995	2000
Number of active farmers and farm workers	16,002	13,105	20,484	23,176	26,221
Number of ha. - - Option A_1	4,311	14,311	24,311	44,311	68,811
Number of ha./agric. worker					2.62
Option A_2 (ha.)		10,311	16,311	26,311	36,311
Number of ha./agric. worker					1.38
Option A_3 (ha.)		9,311	14,311	20,311	26,311
Number of ha./agric. worker					1

Therefore, if self-sufficiency if food is to be attained by the year 2000, a farmer or farm worker would have to be able to cultivate 2.62 hectares, or 10 times more than what is cultivated at present. (Farmers and farm workers now cultivate 0.25 ha. of irrigated fields on the average.) See Table XXVIII, page 60.

On the other hand, if each farmer and farm worker were to continue cultivating only 0.25 ha. as is now the case, there would have to be 275,244 farmers and farm workers in action to meet planned production levels under Option A_1 in the year 2000.

If 1.5 ha. were given to each active farmer and farm worker, there would still be a need for 45,874 agricultural workers. Under Option A_1 there will be a slight manpower problem 39). Furthermore, agricultural population is distributed between irrigated and *diari* lands. If the irrigated fields absorb all of the active farming population there is little chance that the *diari* lands in the River region will be cultivated.

39) RAMS report on Manpower, 1981.

The manpower constraint can be overcome if:

a) mechanization is introduced in the form of tractors and power-driven cultivators or if animal traction is used to increase the amount of cultivable land per farmer/farm worker;

b) there is a relocation of population in the areas of irrigated agriculture;

Under Option A_2 there will have to be an increased rate of creating irrigated fields:

1,200 ha./year between 1980 and 1990;

2,200 ha./year between 1991 and the year 2000.

1) Irrigated grain production will amount to 114,000 tons of grain if there is a yield of 3.5 tons/ha. and 170,000 tons if there is a yield of 5 tons/ha. in the year 2000.

Explanation of the table: XXIV

There are three conditions:

Condition 1) : Each active farmer/farm worker cultivates 0.25 ha. of irrigated fields.

Condition 2) : Each active farmer/farm worker cultivates 0.5 ha.

Condition 3) : Each active farmer/farm worker cultivates 1.5 ha.

Demand for manpower corresponds to each option:

A_1 : 2,000 to 4,500 ha./year to the year 200

A_2 : 1,200 to 2,000 h./year to the year 2000

A_3 : 1,000 to 1,200 ha./year to the year 2000 and for conditions 1,2 and 3.

Table XXIV: Demand for Manpower in Irrigated Agriculture

		1980	1985	1990	1995	2000
Option A_1						
Area (ha.)		4,311	14,311	2,411	44,311	68,811
Number of active farmers/farm workers	A_1 1)		57,244	97,244	177,244	275,244
	A_1 2)		28,622	48,622	88,622	137,622
	A_1 3)		9,540	16,207	29,541	45,874
Option A_2						
Area (ha.)			10,311	16,311	26,311	36,311
Number of active farmers/farm workers	A_2 1)		41,244	65,244	105,244	145,244
	A_2 2)		20,622	32,622	52,622	72,622
	A_2 3)		6,879	10,874	17,541	24,207
Option A_3						
Area (ha.)			9,311	14,311	20,311	26,311
Number of active farmers/farm workers	A_3 1)		37,244	57,244	81,244	105,244
	A_3 2)		18,622	28,622	40,622	52,622
	A_3 3)		6,207	9,541	13,541	17,541

2) Improved traditional agriculture will yield 97,000 tons of grain.

3) Option A_2 will yield 210,000 tons of grain/year in the year 2000 (114,000 tons from irrigated agriculture and 97,000 tons from improved traditional agriculture) assuming a yield of 3.5 tons/ha. in irrigated agriculture.

Option A_2 will cover 67% of D_1 demand and 68% of D_2 demand assuming a yield of 3.5 tons/ha./year and 84% of D_1 and 87% of D_2 assuming per hectare yields of 5 tons a year.

4) The average cost (investment and recurring costs) of Option A_2 is about 2,900 million UM in 1980 prices of which 2,280 million UM/year are for irrigated agriculture and 620 million UM/year for the rest.

If installment costs of irrigated fields were to drop by one half, average costs of Option A_2 would be 2,400 million UM/year of which 1,8000 million UM/year would be for irrigated agriculture and 620 million UM/year M/year for the rest.

5) According to Table XXIV, page 62, it seems that the manpower problems are less serious under Option A_2.

Under Option A_3, irrigated agriculture will continue to grow but the rate of expansion will rise:

1,000 ha./year between 1980 and 1990

1,200 ha./year between 1991 and the year 2000.

1) Irrigated agriculture will yield about 83,000 tons of of grain assuming a yield of 3.5 tons/ha. and 100,000 tons assuming a slight rise in productivity.

Traditional agriculture will produce 52,000 tons, which is very similar to the present situation if one takes population growth into account.

2) Option A_3, will produce 135,000 tons of grain or 43% of D_1 or D_2 demand assuming yields of 3.5 tons/ha. and 152,000 tons of grain or 48% of D_1 and 49% of D_2 demand.

3) The average annual cost of A_3 is 1,700 million UM (of which 1,500 million UM are for irrigated agriculture and 200 million for the rest) assuming constant installation costs and 1,400 million UM/year (of which 1,200 million UM/year are for irrigated agriculture and 200 million for the rest), assuming decreasing installation costs.

In addition to manpower constraints, there are also infrastructure constraints (roads, transportation, warehouses, etc.) and organizational constraints (land tenure, pricing policy, credit policy, training policy, marketing facilities, etc.)

It is a fact that if there is a surplus crop in productive regions, this surplus will have to be sent to regions where grain is in short supply. Given the size of the country, the infrastructure constraint is a very serious one.

In addition, there are social tensions in the grain-producing regions which stem from the problems of land tenure. In order to encourage production, it will be necessary to solve a certain number of problems in a way that is satisfactory to the farmers: these problems center around producers prices, credit to buy modern inputs, insurance against bad years, means of collecting surplus production, etc.

Overcoming these constraints is a gigantic task.[40)]

Unless solutions can be found to this technical, human and organizational constraints, it will be very difficult to reach the production goals of Options A_1, A_2 and A_3.

The grain strategy must be based on the principle of risk minimization. As opposed to the bias of past policies, which focused all efforts on irrigated agriculture (with mixed results), it will be necessary to invest in various sectors simultaneously (irrigated, dry-land, oasis and wadi agriculture).

In the area of agricultural production, the grain strategy should give particular attention to ascertain number of points:

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40) See Agricultural Institutional Framework Option Paper.

- a deliberate policy to rehabilitate rain-fed agriculture until the rate of development of irrigated agriculture has reached a satisfactory level. This policy is justified by its per hectare costs, which are much lower than those of irrigated fields. See Table XXVIII.

- quick increase in production because of the simplicity of the techniques used and the ease with which the peasants could learn them.

- the large size of the manpower involved in this sector (100,000 active agricultural workers.)

A rehabilitation policy in rainfed agriculture should be based on principles of self-help (the government should make available to farmers inputs such as seeds, fertilizer, credit, insurance, etc.) and on a policy of judicious investment combined with realistic pricing and import policies. The means or implementing these measures are treated in another RAMS report 41.

Raising grain production is tied to:

1) rehabilitating the land and increasing yields through gradual technological changes (fertilizer, animal traction, inter-cropping, etc.) of traditional cultivation techniques at modest cost (medium term).

2) creating irrigated fields at a realistic price and rate (medium and long term).

3) rehabilitating the oasis sector.

In the medium and short terms, a certain number of steps must be taken in order to re-orient agriculture to increase productivity:

1) Research in systems of production: improved cultivation techniques, modern inputs, alternative equipment, farm management . . .

41) Ibid.

2) Supervision in order to raise productivity: diffusion of inter-cropping (cow-peas, legumes, etc. in order to increase the productivity of the soil), animal traction, diffusion or research findings . . .

3) Actions favoring production: it would be wise to concentrate short-term efforts on low-cost methods of increasing the productivity of dry-land agriculture.

4) Efforts to create a realistic price policy that would encourage farmer-herders to moernize and to increase investments leading to greater productivity and larger surplus. At present the prices received by producers are too low and thus discourage the expansion of grain farming, animal traction and the use of modern inputs in general. Prices paid to producers should take into account the price of locally-produced grains as well as the price of imported grains.

5) Research efforts and the implementation of labor-intensive projects such as re-forestation, canal construction, dike repairs. . .

6) Efforts to solve the problem of land tenure which will prevent the growth of the irrigated agricultural sector.

Annual Production and Costs of Different Options in Agriculture

Potential production under different options is summarized in Table XXVIII, page 72.

(1) Under Options A_1 A_2 and A_3, production increases by expanding the areas under cultivation and by increasing productivity.

Extending irrigated agriucltue is costly but one can count on better productivity and management and therefore a 50% drop of installation costs from 0.5 million UM/ha. 0.25 million/ha. in the year 2000.

- Crop yields in irrigated agriculture could rise from 3.5 tons/ha./year to 5 tons/ha./year without too many problems if there is adequate support and training.

- Crop yields in traditional agriculture could double, rising from 3000 kg/ha. to 500 or 600 kg/ha. in the year 2000 through the use of modern inputs, training, inter-inter-cropping and animal traction.

(2) Table XXVI, page 70 shows that production under Option A_1 varies between 313,000 tons and 410,000 tons depending on whether crop yields are 3.5 tons/ha. or 5 tons/ha. Costs vary from 5,400 million UM/year to 4,200 million UM/year depending on whether the cost of installing irrigated fields is constant or decreasing.

In Option A_1 there is going to be a slight manpower problem 42) in the River region and dieri crops will probably be sacrificed in favor of irrigated agriculture.

This problem can be solved - either by mechanizing several aspects of cultivation.

- using animal traction on a larger scale.

- relocating population in the River region.

The value of production is low and this is due to the low price paid to grain farmers. This is a consequence of price controls. In order to make agriculture more attractive and to increase the desired surplus production, grain pricing policies must be revised.

(3) Under Option A_2 production varies between 211,000 tons and 267,000, PPP tons according to yield levels. Costs vary between 2,900 million UM/year and 1,800 million UM/year depending on the cost of installing irrigated fields.

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42) See Employment Implications of Alternative Development Strategies Option Paper.

Improved traditional cultivation could increase the productivity of traditional agriculture by 86% in 15 years and at low cost (18 kg. of fertilizer per hectare). Improved traditional cultivation could meet 30% of D_1 or D_2 demand in the year 2000 for a negligible direct investment of 275 million UM/year.

It must be noted that in Options A_1 and A_2 that there will have to be a natural change in food habits, favoring rice consumption. Because of irrigated cultivation, rice production will surpass millet and sorghum production.

(4) Under Option A_3 production varies between 135,000 tons and 152,000 tons depending on per hectare yields. In the case of Option A_3, yields will grow slowly. Costs (investment and recurring) will vary between 1,700 million UM/year and 1,400 million UM/year depending on installation costs.

Table 4.XXV : Costs and Value of Production Under Different Options* (10^6 UM, 1980)

	1980	1985	1990	1995	2000
Option A_1					
Costs[1)]		1,900	2,600	4,200	5,300
Costs[2)]		1,700	2,300	3,400	4,200
Production[3)]		1,845	2,700	3,800	5,200
Production[4)]		1,875	2,900	4,300	6,300
Option A_2					
Costs[1)]		1,370	1,800	2,500	2,900
Costs[2)]		1,270	1,600	2,100	2,400
Production[3)]		1,750	2,400	3,100	4,100
Production[4)]		1,780	2,500	3,400	4,600
Option A_3					
Costs[1)]		1,100	1,400	1,700	1,900
Costs[2)]		1,000	1,200	1,400	1,600
Production[3)]		1,700	1,300	2,100	2,400
Production[4)]		1,700	2,000	2,200	2,700

Table A.XXVI : Potential Production Under Different Options* (tons)

	1980	1985	1990	1995	2000
Option A_1					
Rate A[1)] of irrigated agr. prod.		30,000	76,000	140,000	210,000
Rate A[2)] of irrigated agri. prod.		33,000	93,000	188,000	313,000
Improved traditional cultivation		53,000	58,000	69,000	27,000
Total, Option A_1 [1)]		83,000	134,000	209,000	307,000
A_1 [2)]		86,000	151,000	257,000	410,000
Option A_2					
Rate B[1)] of irrigated agri. prod.		22,000	51,000	83,000	114,000
Rate B[2)] of irrigated agri. prod.		24,000	63,000	111,000	170,000
Improved traditional cultivation		53,000	58,000	69,000	97,000
Total, Option A_2 [1)]		75,000	109,000	152,000	211,000
A_2 [2)]		77,000	121,000	180,000	267,000
Option A_3					
Present rate, irrig. agri. prod. [1)]	9,000	19,000	45,000	64,000	83,000
Present rate, irrig. agri. prod. [3)]		20,000	50,000	74,000	101,000
Traditional cultivation prod.	54,000	55,000	50,000	46,000	52,000
Total Option A_3 [1)]	63,000	74,000	95,000	110,000	135,000
A_3 [3)]		75,000	100,000	120,000	153,000

1) Production with a constant yield of 3.5 tons/ha.
2) Production with yields rising to 5 tons/ha. in the year 2000.
3) Production with yields rising to 4.5 tons/ha. in the year 2000

* Rounded figures; author's calculations.

Table XXVII: Value of Production Under the Various Options* (10^6 UM, 1980 prices)

	1980	1985	1990	1995	2000
Options A_1					
Irrigated agriculture, A_1 1) prod.		300	760	1,400	2,100
Irrigated agriculture, A2 2) prod.		330	930	1,880	3,130
Wadi and rainfed agricultural production		880	990	1,220	1,700
Oasis production		664	970	1,200	1,450
Total production, Option A_1 1)		1,845	2,720	3,820	5,250
Total production, Option A_1 2)		1,875	2,890	4,300	6,280
Options A_2					
Irrigated agriculture, A_2 1) prod.		215	515	830	1,115
Irrigated agriculture, A_2 2) prod.		240	626	1,110	1,700
Wadi and rainfed agricultural production		880	990	1,220	1,700
Oasis production		656	855	1,062	1,252
Total production, Option A_2 1)		1,751	2,360	3,112	4,067
Total production, Option A_2 2)		1,776	2,471	3,392	4,652
Option A_3					
Irrigated agriculture, A_3 1) prod.	90	195	450	640	830
Irrigated agriculture, A_3 3) prod.		205	500	740	1,100
Wadi and rainfed agricultural production	876	899	849	804	898
Oasis production	639	637	647	658	672
Total production, Option A_3 1)	1,603	1,731	1,346	2,102	2,400

* rounded figures, author's calculations

1) yields 3.5 t/ha

2) yields 5 5 t/ha in the year 2000

3) yields 4.5 t/ha in the year 2000

Table A. XXVIII: Annual Cost of the Different Options*

	1985	1990	1995	2000
Option A_1				
Production costs, irrigated ag.	340	860	1,600	2,400
Installation costs[1)]	1,000	1,000	2,000	2,250
Installation costs[2)]	840	700	1,200	1,100
Development costs, rainfed agr.	80	100	125	170
Development costs, wadi agricul. +	52	52	104	104
wadi agriculture	190	180	170	173
T_3 development costs, oasis ag.	25	50	-	-
T_3 production costs, oasis agri.[3)]	-	40	40	40
T_2 production costs, oasis ag.[4)]	200	200	200	200
Total A_1[1)]	1,897	2,572	4,239	5,337
A_1[2)]	1,737	2,272	3,439	4,187
Option A_2				
Production costs, irrigated agri.	240	570	930	1,300
Installation costs[1)]	600	600	1,000	1,000
Installation costs[2)]	500	420	600	500
Development costs, rainfed agri.	80	100	125	170
Development costs, wadi agric.	52	52	104	104
Production costs, rainfed + wadi agriculture	190	180	170	173
T_2 development costs, oasis agri.	10	90	-	-
T_2 production costs, oasis ag.[4)]	200	200	200	200
Total A_2[1)]	1,372	1,792	2,529	2,947
A_2[2)]	1,272	1,612	2,129	2,447

1) Installation costs of 1 ha. irrigated fields : 0.5 million UM.
2) Decreasing installation costs of 1 ha. irrigated fields: 0.25 million UM in the year 2000.
3) T_3 production costs of 1 ha. oasis : 82,000 UM.
4) T_2 production costs of 1 ha. oasis : 45,000 UM.

* Figures rounded

Table XXVII (continuation)

Annual Cost of Different Options
(10^6 UM, 1980)

	1985	1990	1995	2000
Option A_3				
Production costs, irrigated agri.	200	500	720	930
Installation costs 1)	500	500	600	600
Installation costs 2)	400	350	360	300
Production costs, rain-fed wadi agriculture	185	170	160	180
T_1 production costs, oasis agri.	185	185	185	185
Total A_3 1)	1,090	1,355	1,665	1,895
A_3 2)	990	1,205	1,425	1,595

1) Installation cost of the irrigated fields: 0.5 million UM
2) Decreasing installation costs of 1 ha irrigated field : 0.25 million Um in the year 2000.

5) T_1 production costs of 1 ha. Oasis agriculture = 41,000 UM

Livestock

The Past Situation

The livestock sector provides, on the average, 15 to 20% of GDP at factor costs in Mauritania and 70 to 75% of rural sector GDP.43) Herding is in fact the principal source of value added in the rural sector.

The System of Production and Constraints.

Herding in Mauritania is part of a Sahelian system of production that permits efficient use of the scarce vegetation in the country. It is a system of extensive nomadic herding and is therefore directly adapted to climatic irregularities.

There are basically three components in the means of production: water, pastures and manpower. Grazing lands are estimated to be 55 million hectares, but more than hald the cattle, and a quarter of the sheep and goats are outside of Mauritania for part of the year because there are not enough pastures. It must be noted that there is an unequal exchange in terms of pasture quality across the borders.

In the manpower area, there is a tremendous transformation going on in the livestock sector as there is an increasing tendency to use hired herders, who are therefore less concerned with the animals. These herders may care for 150 to 200 head of cattle during the rainy season and 75 to 125 head during the dry season.44) There are numerous constraints but they fall into 2 categories :

- constraints concerning factors of production: water and pastures, which depend on rainfall.

- human and organizational constraints.

Herding is a way of life. Its economic function is in savings, consumption and income (principal source for nomads, supplementary for sedentary people), therefore any changes will be modest, slow and careful.

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43) "Aggregats des comptes nationaux" Statistic Department, Sept. 1980, p.8

44) See RAMS Sociological and Livestock Sector Studies, 1980

On the organization side, the weakness of the Livestock Department is striking. There are both material and personnel difficulties. Herding, which makes up 70 to 75% of rural GDP, receives only 0.50% of the government's budget. Furthermore, there are at present 4 veterinarians but no production specialists in the Livestock Department.[45] There is no range management specialist in the Environmental Protection Servie. Animal mortality is perhaps as much due to the drought as it is to the lack of pastures.

There is no supervision of animal production, setting of attractive prices or development of a marketing system and all of these factors complicate the problems of the livestock sub-sector.

The Animal Health Situation:

So far, the Livestock Department has concentrated on preventive health care for cattle. Because it lacks greater resources, the Livestock Service is involved mainly in vaccination campaigns.

Vaccinations[46] : 1976 - 79

	1976	1977	1978	1979
Rinderpest	636,207	570,875		608,031
Bouvine pleuro-pneumonia	267,255	335,035	Data	239,971
Botulism	294,665	210,685		75,791
Blackleg	157,427	125,580	Not	31,790
Anthrax	7,595	13,243		15,457
Hemorrhagic Septicemia	103,903	166,439	Available	-
Small ruminant plague	-	24,338		10,638

Source: Animal Health Division Livestock Department.

45) See RAMS Study on the Livestock Sector, especially Chapter on Government Organization.

46) Ibid. p. 39.

Vaccination campaigns have reduced the mortality of Mauritanian cattle, but this has upset the equilibrium between pasture resources and the number of animals. Each year about 1 million doses of vaccine are used.

Income - Consumption

According to RAMS calculations of production projects, average daily per capita income in herding varies between 276 and 287 UM 47). With the exception of the oasis sub-sector, herding is an activity with one of the highest income levels in the rural sector. The rate of return on investments varies between 8 and 15% according to the type of herding practiced. 48).

It is worth noting that herders consume little meat but have a great deal of milk. Auto-consumption amounts to 51% of total consumption. 49).

Government Policies

The government's goals in the livestock sector were the following, according to the 3rd Plan:

- improvement of traditional production through preventive medical measures and supervision by the Livestock Service;

- pastoral wells.

During the 3rd Plan period, 1,258 million UM were to have been invested in herding (in 11 projects), 50) but only 426 million UM were actually spent. This is an achievement rate of about 34%.

The Present Situation

In the 4th Plan, the livestock sector has the same objectives as in the 3rd plan, or:

- improvement of traditional production via preventive medicine and by reinforcing the resources of the Livestock Service

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47) Agricultural Production: Analysis of Selected Aspects of Mauritanian Agriculture. p. [illegible]

48) Ibid. p.28

49) Rural Consumption.

50) See draft report of the Rural Development Planning Commission.

- assistance in improving pastoral water resources;

- balance between forage and water resources.

The investments projected by the 4th Plan amount to about 1,600 million UM to be divided among:

Supervision and research,
Marketing,
Production,
Pastoral water resources.

This averages an annual investment of 400 million UM.

There is an important difference between the 3rd and the 4th Plans: that is the realization that it is necessary to maintain an equilibrium between grazing and water resources and that if this balance is to be achieved, assistance in the area of pastoral water resources will be a fundamental as well as a limiting factor.

Moreover, the distribution of investments in the Ministry of Rural Development was 11% for the Livestock Service and 80% for the Agricultural Extension Service under the 3rd Plan.

Budget of the Livestock Service (Millions of current UM)

	1976	1977	1978	1979	1980	1981
National Budget	5,618	7,908	10,395	10,726	10,647	10,300
Livestock Service Budget	41	42	46	56	53	48
Contributed Personnel	33	33	33,1	34	34	33
Materials and Operating Budget	7,9	9	12,6	20,1	19	15
% of National Budget	0.7%	0.5%	0,4%	0.5%	0.5%	0,45%

Source: Livestock Service * Rounded figures

The Livestock Service's budget is extremely low and does not even amount to 0.5% of the national budget. This shows that the government has not given the livestock sector the priority it deserves given its comparative economic advantage. Furthermore, the Livestock Service's activities are almost exclussively concerned with animal health rather than production.

Therefore, during the whole 3rd Plan period, the budget mounted to about 46 million UM per year, projects financed by foreign donors represented another 106 million UM/per year
152 million UM/per year
or about 63* UM 51) per UBT a year of which
21* UM per UBT came from the Budget
and 47* UM per UBT came from foreign donor projects.

Production

It is risky to project animal production through the year 2000. RAMS used an improved rainfall model 52) in order to establish production to the year 2000 according to three scenarios:

Normal rainfall scenario N.

Poor rainfall scenario P.

Good rainfall scenario G.

This model is designed to illustrate the constraints and potentials in the livestock sector.

In the year 2000 the numbers of animals could vary between 0.6 million to 1.4 million head (cattle) (See Table L-II p. 80).

Sheep: from 3 to 3.7 million head
Goats: from 2.7 to 3.4 million head
Camels: from 0.706 to 0.728 million head
Poultry: from 4.5 to 5.6 million head

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51) 2.23 million UBT in 1981 * Rounded figures

52) Livestock Sector Study ;

Table I.I: Estimates of Herd Sizes in Mauritania[1] in 1980

(Millions of heads)

Livestock Service (end of 1980)	Central Bank Jan. 80	FAO	RAMS
Cattle 1.2	1.245	1.2	1.06
Sheep and			2.634
Goats	7.963	5.45	2.513
Camels 0.72	0.735	0.720	0.656
UBT 2.370 (millions)	2.839	2.438	2.230

1 camel = 1 UBT

1 cow = 0.75

1 sheep or goat = 0.15

1) Sources: Livestock Service, Central Bank of Mauritania, FAO, RAMS, 1981.

These forecast of the growth of herd size make it possible to show what potential production could be given the carrying capacity of the country towards the end of the century.53)

The rainfall model is as follows:

$$P = H1 \left(F \times C \left(1 + \log {}^{R1}/R2 + K\right)^2 + \left(\log {}^{R1}/R2 + K\right)\right.$$

It includes rainfall data from 26 collection points 8 of which have data going back to 1922.

P = gross production for the given year (t)

H1 = ending herd size from the previous year (t-1)

F = coefficient for females in the herd of cald bearing age.

C = coefficient of living calves relative to the above females.

R1 = rainfall index for the given year (t)

R = rainfall index for the previous year (t-1)

K = a constant, which is specific to each type of animal (cow, sheep, etc. . .)

O = off-take

H2 = ending herd size for the given year.

The first part of the expression calculates the natural factor of herd increase while the second part calculates the loss factor. Together, these factors, when multiplied by the herd size, gives gross production.

Herd size at the end of a given year will be:

$$H2 = H1 + P - O$$

The "probablistic projection model" is able to give a certain idea fo animal production under different conditions.

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53 Ibid.

Framework for calculating rural GDP from basic production data, RAMS, 1981.

Table L. II: Potential Production in the Livestock Sector to the Year 2000 (10^3 head)[1)]

		1980	1985	1990	1995	2000
Cattle						
Scenario[2)]	N	1,060	1,101	1,050	1,036	990
	P	1,060	980	767	627	589
	G	1,060	1,246	1,392	1,361	1,425
Sheep						
	N	2,634	3,637	3,937	4,083	3,130
	P	2,634	3,390	3,387	3,064	2,979
	G	2,634	3,691	5,012	4,855	3,707
Goats						
	N	2,513	3,077	3,353	3,526	3,068
	P	2,513	3,055	3,173	3,001	2,762
	G	2,513	3,177	3,933	4,004	3,380
Camels						
	N	656	695	714	741	718
	P	656	689	678	672	706
	G	656	719	754	732	728
Poultry[3)]						
	2.5%	3,075	3,479	3,936	4,454	5,039
	2	3,060	3,378	3,730	4,118	5,547
	3	3,090	3,584	4,153	5,581	

Source: Livestock Sub-sector Study .

1 Based on RAMS rainfall model.

2 Scenario N = normal rainfall.
P = poor rainfall
G = good rainfall

3 Chickens do not depend on rainfall and a linear projection is used.

Explanation of Table L.II

Potential production to the year 2000[64)] as determined by

(N) - normal rainfall
(P) - poor rainfall
(G) - good rainfall

are presented based on present (1980) levels of production

1980.

44,497 tons of meat (carcass)

1985.

N	50,793 tons
P	47,941 tons
G	53,943 tons

1990.

N	52,389 tons
P	45,094
G	63,473

1995.

N	53,943 tons
P	41,622 tons
G	62,863 tons

2000

N	49,000 tons
P	40,909 tons
G	58,947 tons

A linear growth in poultry production gives:

2.5%
2 %
3 %

See Framework for calculating rural GDP from basic production data, RAMS, 1981.

Table L. III Value of Production in the Livestock Sector *

(millions of UM, 1980 prices)

	Scenario N[1)]	P	G
1980	7,982	7,978	7,984
1981	8,296	8,296	8,304
1982	8,647	8,724	8,575
1983	8,578	8,576	8,916
1984	8,981	8,332	8,896
1985	9,009	8,697	9,341
1986	8,810	8,531	9,852
1987	9,211	7,867	10,453
1988	9,688	8,124	10,338
1989	9,712	8,409	10,200
1990	9,482	8,717	10,835
1991	9,980	8,468	11,581
1992	10,126	8,224	11,696
1993	9,859	8,429	11,630
1994	9,522	8,373	11,421
1995	9,929	8,581	11,041
1996	9,732	8,819	10,698
1997	8,924	9,062	10,336
1998	9,117	8,848	10,019
1999	9,329	8,627	10,349
2000	9,516	8,717	10,667

Source: RAMS, 1981.

1) Normal, poor, good rainfall

* Figures rounded.

Table L. IV: Number of UBT's According to Various Production Scenarios (thousands of UBT's)

Scenario	N	P	G
1980	2,223	2,223	2,223
1985	2,529	2,390	2,684
1990	2,596	2,237	3,149
1995	2,659	2,042	3,082
2000	2,390	2,009	2,860

Source: Livestock Sub-sector Study RAMS, 1980.

Consumption:

According to the surveys on consumption[54], demand for meat in the year 2000(D1) given present conditions, will be:

Demand for Meat (10^3 tons) (D1)

	1980	1985	1990	1995	2000
Rural Sector	29	33	37	42	48
Modern Sector[55]	7	10	13	17	23
Total	36	43	50	59	71

If the same consumption pattern is maintained from the time of the surveys until the year 2000, Mauritanian herds will have take:

Cattle	2,580,000 heads
Sheep	3,200,000
Goats	1,180,000
Camels	1,080,000
Poultry	1,940,000

However, according to the nutritional norms developed by RAMS[56] meat consumption in the year 2000 will drop to 17.7 kg. per person per year.

According to the nutritional norms (D2), demand for meat in the year 2000 will be:

Demand for meat (103 tons) (D2)

	1980	1985	1990	1995	2000
Rural Sector	21	23	25	27	29
Modern Sector	4	5	7	10	13
Total	25	28	32	37	42

54) Rural Consumption p. 117

55) Consumption : 33 kg/per person/per year

56) Food and Nutritional Situation in Mauritania, RAMS, 1981.

This demand for meat based on nutritional rations will amount to the following in the year 2000.

Demand for meat D_2

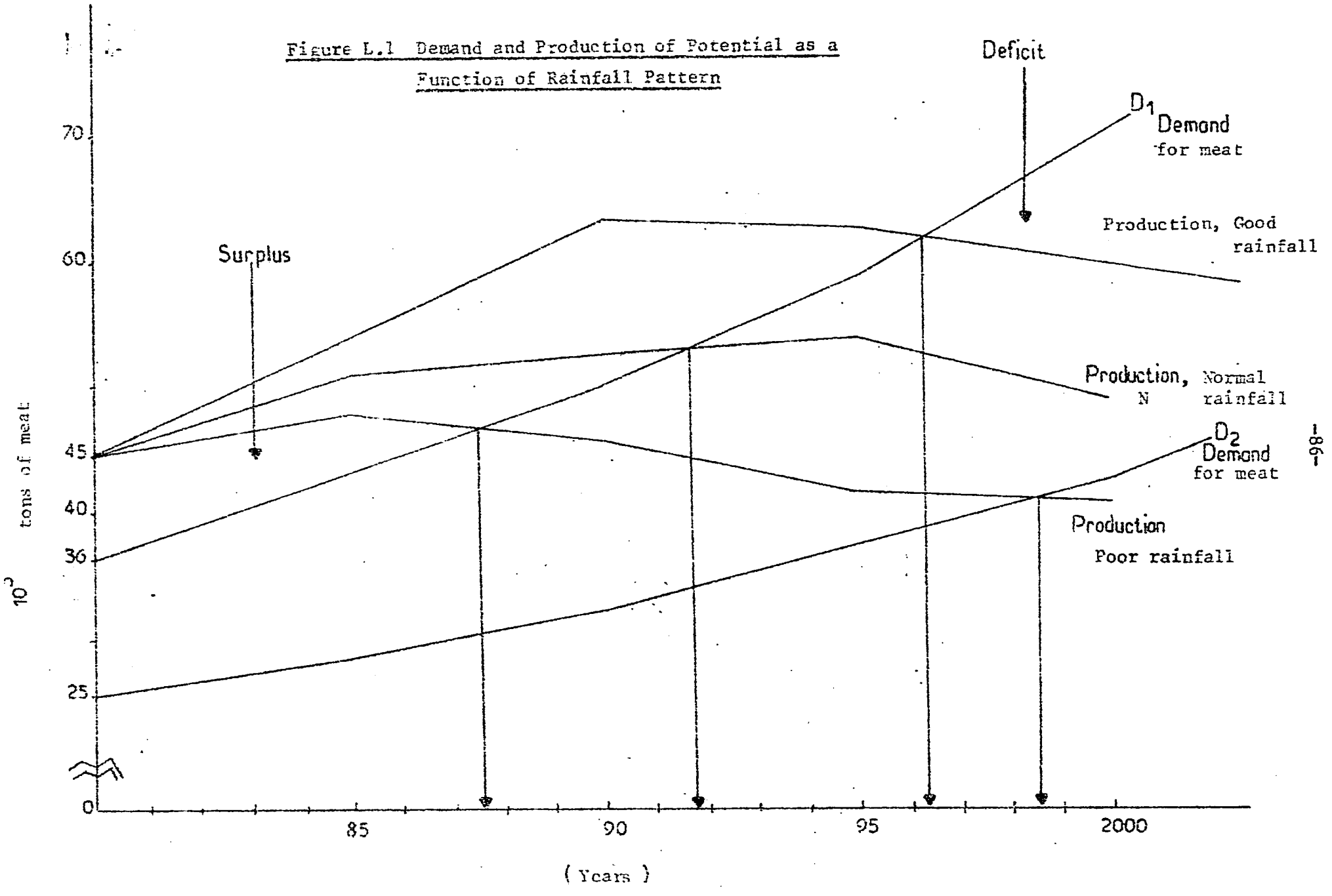
Cattle		14,587 tons
Sheep and goats		16,370 tons
Camels	7,163 tons	7,163 tons
Poultry	3,983 tons	3,983 tons
Total:		42,103 tons

A comparison between demand for Mauritanian meat and herd size according to the rainfall model shows that various rainfall models, D1 demand for meat will result in a meat deficit: see Figure L.1, page 86.

- after 1987 assuming poor rainfall conditions;
- after 1991 assuming average rainfall conditions;
- after 1996 assuming good rainfall conditions.

However, under conditions of D2 demand (nutritional norms that include intake of grains, meat, fish and vegetables), a deficit in meat can be expected only after 1995 and and in conditions of poor rainfall.

Figure L.1 Demand and Production of Potential as a Function of Rainfall Pattern



Alternatives

By studying potential production and demand, one sees that a dangerous situation will result unless a certain number of steps is taken to assist the livestock sub-sector.

However, it is not easy to understand the relationship between investment and production in this sub-sector because value added in herding is largely dependent on rainfall.

Mauritania is undergoing major changes and depending on what steps, it takes, it will either evolve towards the disappearances of herdingg as a way of life or towards a new kind of herding in which cattle will be fewer but more productive (meat, milk, leather, etc...), in which sheep and goats will produce more milk and meat while being more closely watched and in which camels will be use and raised more rationally.

The problems in herding are complex and cannot be resolved unless there is a psychological charge both in the government and among herders . Unlike agriculture in which rapid progress can be made through the use of improved technology, there is no rapid solution to the problem of development in extensive herding. The creation of pilot projects will help to find a solution to the dilemma of developing this sector. Stating that herding is dependent upon rainfall does not exclude undertaking certain projects until better rainfall enables natural resources to renew themselves. Certain principles must be followed:

Herders themselves must be involved both in better methods of animal production and in the conservation of natural resources.

Projects should be small-scale and should require modest financial resources, thus allowing the concerned population itself to be involved.

According to RAMS, a certain number of actions should be undertaken in order to remove both human and organizational constraints.

- Reorganize the Livestock Service in order to stimulate production in rural areas. This is a vital necessity because it is the service which is to furnish the necessary supervisory personnel and try to change the present methods of production through increasing herd productivity and improving animal health.

There are several ways of schieving reorganization:

1) animal health - treatment should not be free except in a few cases;

2) private care - treatment will be given by private veterinarian assistants and will therefore be paid for;

3) revitalization of present services..

- Increasing herd off-take - and raising productivity by:

1) creating a Livestock Bank which will offer an attractive interest rate comparable to investments in herding;

2) supervising and reorganizing the Livestock Service, which will help to reach this goal.

3) controling herd size (changing the make-up of the herd).

- Controlling prices will indirectly influence herding productivity and such a policy can be carried out in several ways:

1) price de-control (freely fluctuating prices);

2) raising of authorized selling prices;

3) price differentiation.

- Controlling herd movements as a way of controlling pastures use through:

1) herders organizations, which would be able to control herd movements themselves;

2) the police (force).

- Operating new grazing lands and thereby increasing production, (although controversial), by:

1) digging wells in new areas;

2) aerial fertilization and sowing.

- strengthening the CNERV (National Livestock and Vetirenary Research Center) to enable it to carry out its defined mission. Its activities should also be concerned with production constraints, human resource organization and with marketing problems.

These actions can be carried out in different ways depending on the government's choice.

Thus better range management would give the herds access to forage all year long. This management would go along with improved health care resulting in reduced mortality and increased off-take.

Better range management and development depend upon a combined strategy of:

protection against fire;

improving water sources;

monitoring herds.

Applying a single action (ex. improving water sources) will increase the possibility of satisfying a higher number of UBT's but this increase will be short-lived. (See Figure L. II , page 92).

Improving management will allow a 20 to 25% increase in potential forage production accessible to herds (expressed in UBT's); potential forage production could even be doubled if development were rapid.

All of these activities are located within a Sahelian system of production. Stratification of herding could also be foreseen as a pilot project.

The proposed strategies are aimed at improving the present situation. Given Mauritania's comparative advantage in terms of herding and given the reduced number of viable alternative in the short run, the government will be obliged to allocate more human financial and organizational resources in the short run:

- in order to implement pilot projects to test various solutions to problems confronting the development of herding: ranching, herding and marketing company, pasture rotation, etc.).

- eliminate constraints (infrastructure, butchers, etc.) in order to increase off-take.

The Options

The following three options for the development of the livestock sub-sector are general outlines within which specific activities are defined and costs calculated:

Option L_1 : Increasing herd size

Option L_2 + opening new grazing lands and improving trek routes.

Option L_2 : Improving herd productivity

Option L_3

+ improving the Livestock Service

+ improving range management (maximizing potential)

+ raising rates of off-take (through credit and supervision).

+ improving the capability of CMERV.

Option L_4 : continuing present trends

Continued allocation of existing budget to the Livestock Service.

- According to Figure L-II on p. 92 , there are 55 million hectares of grazing lands 57 , able to handle 3.6 million UBT's of which only 2.23 million UBT's are used. The other 1.37 million are unused.

This is the present situation. Government expenditure on herding amount to 21 UM/UBT/year. Besides the portion of the national budget, there is foreign donor funding in this sector.

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57) Livestock Subsector Report

In Option L_3, budgetary expenses are 21 UM per UBT/year and the annual cost of projects financed by foreign donors is 47 UM per UBT, or a total of 70 UM per UBT a year.

In Option L_2, the number of UBT's can be increased as pastures and trek routes are improved. The rate of herd off-take can be increased 58) through credit, better prices and extension services

The additional expenditures consist of reinforcing the Livestock Service, which would allow for more training and supervision (30 UM/UBT/year). A system of credit in the livestock sector would cost about 50 UM/UBT/year.

Option L_2 would allow for an increase in the use of potential forage, which would rise from 2.2 to 2.8 million UBT, or a 25% increase. The total cost of Option L_2 would come to 150

Option L_1 involves full development of forage potential and for higher levels of production. Full development of Option L_1 is very long and would not give results until 20 years after the initial investments were made. In the Sahelian system of production, 20 years are considered a short time in which to fully develop range management.

Full development of the potentials of Option L_1 involves simultaneously carrying out the following actions:

- protection against fire;
- development of pastoral water supplies;
- pasture land rotation;
- surveilance.

The option allows for doubled use of forage resources able to meet the needs of up to 4,5 million UBT's a year. The additional cost that goes along with the option amounts to 50 UM/UBT/year.

The total cost of Option L_1 is 70 UM/UBT, + 80 UM/UBT/year for Option L_2 + 50 UM/UBT/year additional cost which total 200 UM/UBT/year.

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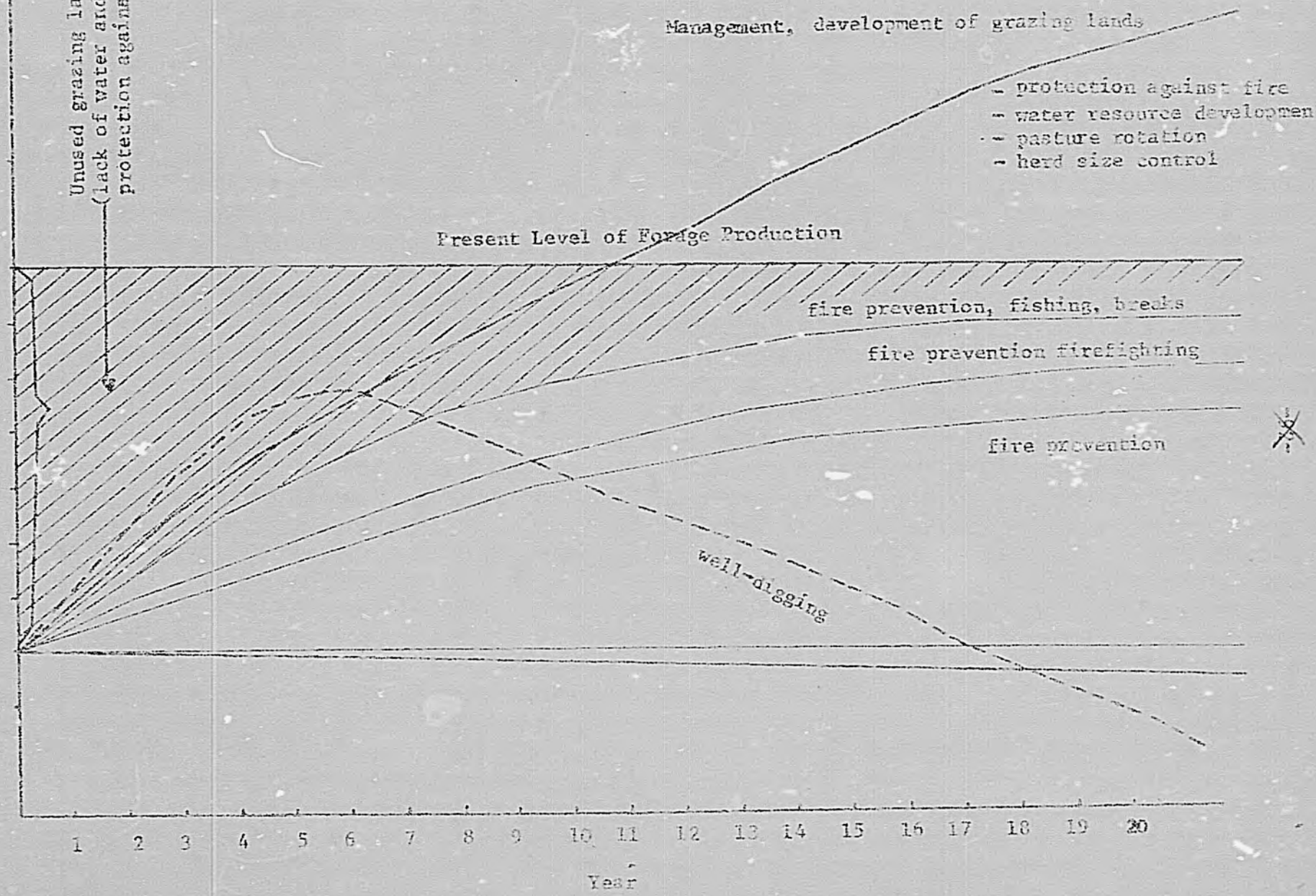
58) See page 97.

Figure 1.11 Range Management Options

Annual Forage Production



Average cost of the 3 Options in UBT per year

L1	L2	L3
200 UM/UBT/year	150 UM/UBT/year	68 UM/UBT/year

Explanation of Figure L.II

At present, forage production is able to satisfy 2.2 million UBT's out of an estimated potential of 3.6 million UBT's is actually used. The unused potential is a result of a lack of water sources or fire breaks.

The development of water sources will make available forage grow to 3.1 million UBT's in several years. After that, depletion in grazing lands will lead to a decline in UBT's (See curved pointed line).

- fire-fighting and fire prevention;
- development of water sources;
- rotation of grazing lands;
- monitoring of herds;

which will lead to a permanent increase in the pastures available to the herds.

Under Option L_3, there could be a meat deficit depending on rainfall scenarios. Under option L_2, there should be a 25% increase and with L_1 a 50% increase 20 years after the starting of the program.

See Figure L.III for improvements.

Figure L-III Forage Production Levels by Option (millions of UBT's)

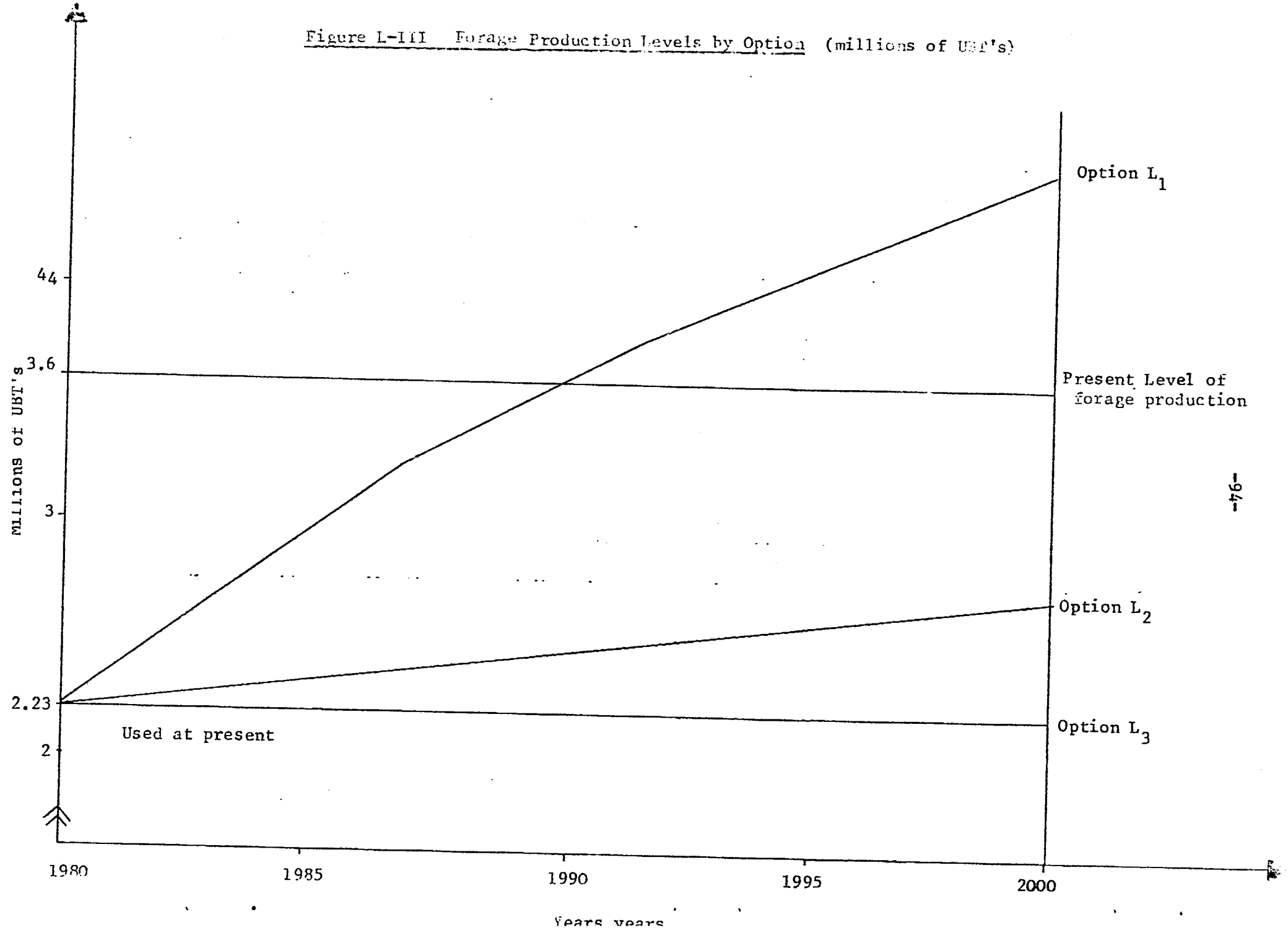


Figure L-IV Production by Option, as Rates of Off-take

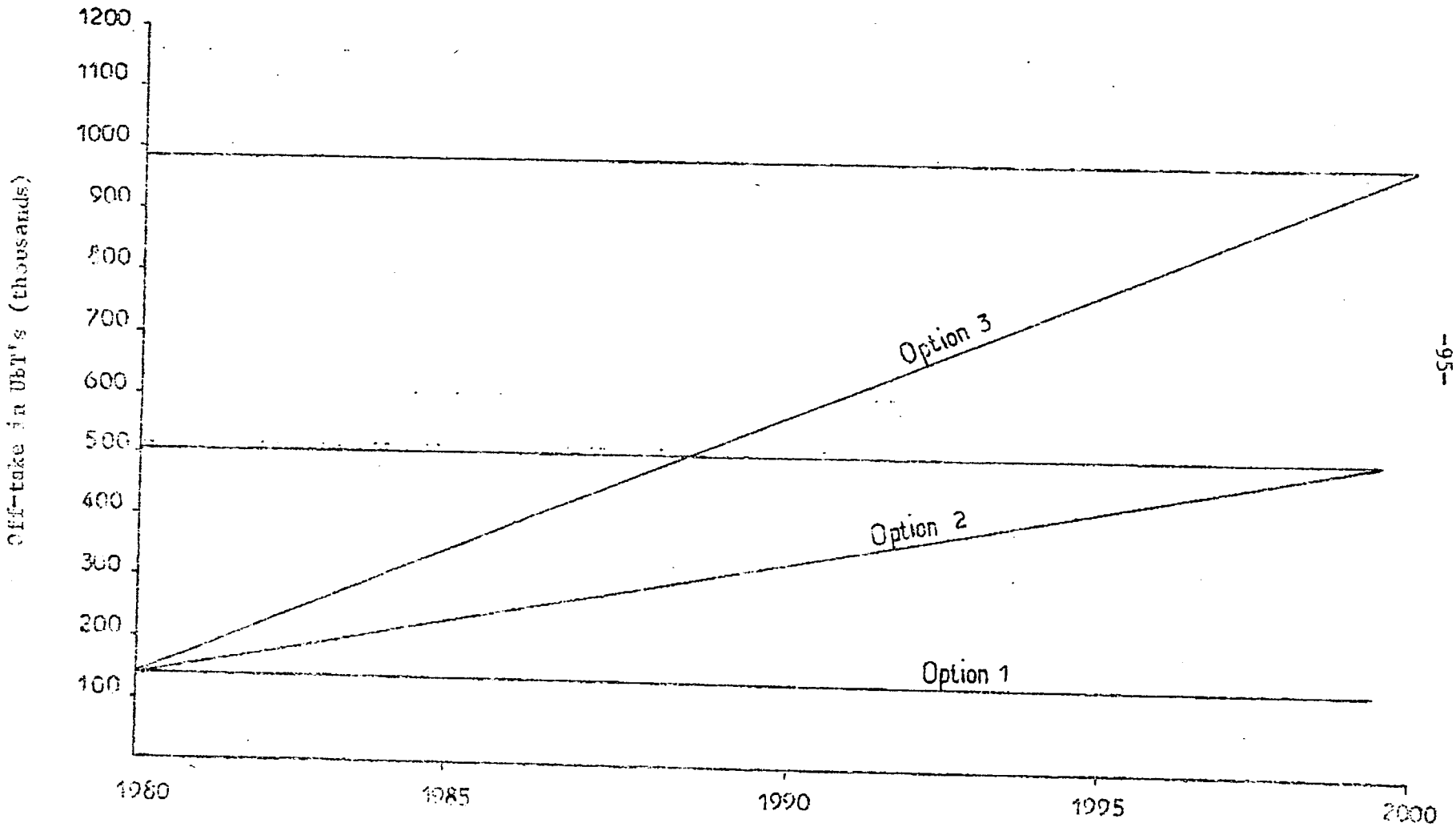


Table L.V: Costs of the Various Options*

(millions of UM, 1980)

	1980	1985	1990	1995	2000
Option L_1 1)					
Costs/Scenario A		500	520	532	478
Scenario B		480	447	408	402
Scenario C		530	630	616	572
Option L_2 2)					
Costs/Scenario A		382	392	401	361
Scenario B		361	338	308	303
Scenario C		405	475	465	432
Option L_3 3)					
Costs/Scenario A		172	176	181	162
Scenario B		162	152	139	137
Scenario C		182	214	209	194

1) 200 UM 1980/UBT
2) 151 UM 1980/
3) 68 UM 1980/UBT

* Figures rounded.

Appendix L.I: Options Expressed in Off-take Rates of Cattle

	UBT (thousands)	Births		Deaths		Off-take Rate		
Option 3	1,060[1]	(30%)[2]	318	(55%)	177	(13%)	141[1]	Present situation
Option 2	1,060	(60%)	636	(20%)	127	(48%)	509	Projections for the year 2000[3]
Option 1	2,160	(60%)	1.296	(20%)	259	(48%)	1.037	20-year projection[4] after the start of the program

1) RAMS Projections
2) Estimates
3) Projections based on the following hypotheses:
   - annual investment of 150 UM/UBT/years;
   - no increase in herd size. Rise in off-take rate because of improved range management and methods of production providing year-round supply of forage (range management, water resource management, fire breaks);
   - better means of managing production (herd composition, 95% females, calving season in July, August, September);
4) Projections assuming full development of the sahelian zone through range management and improved methods of production; also assuming that the number of head could reach 2.26 million UBT. Full development could begin only 20 years after investments were made.

Fisheries

The fisheries sector contributes an average of 3 to 5% of Mauritania's GDP in constant prices and between 15 and 16% of rural sector GDP 59). Furthermore, various studies have shown that Mauritania's potential fishing resources are estimated to be 750,000 tons 60). If rationally used, this potential could contribute considerably to GDP and a higher standard of living.

Systems of Production and Constraints

Traditional fisheries are distinct from industrial fisheries. Traditional fishing is practiced by Mauritanians whereas industrial fishing is in the hands of foreign boats. Production from traditional fisheries is consumed locally while virtually all of the production from industrial fishing is exported. There are two branches of traditional fisheries: river and marine fishing.

- River fishing is done along the Senegal River and in ponds. There are about 3 or 4 thousand fisherman and an annual production of 5 to 7 thousand tons 61) in this sub-sector. The principal means of production is the "seine".

  The Senegal River is not very productive and has a low mineral content (lack of SO_4, PO_4 and CL). However, the river's flood plain (600,000 ha.) is under water for upt to 3 months a year between Bakel and Dagana and provides a soil fertilized by animal droppings (350kg. per flooded hectare). Consequently, the availability of fish depends on certain ecological parameters (rainfall in the Foula Djalon in Guinea is the source of the flood in the middle valley, which enriches the river water and improves fish production). The innundation of the flood plain is irregular and sometimes does not happen at all. Potential catches vary greatly, from 0 to 36,000 tons a year, depending on the condition of the river, whose minimum flow

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59) See Table F-1 p. 100.
60) FAO figures.
61) See RAMS report Inland Fisheries.

between 1903 and 1980 was 260 m^3/ second in 1972 and whose maximum was 1,241 m^3/second in 1924.62) The flow in 1979 only reached 301 m^3/second, which was one of its lowest levels ever recorded. This variability of flooding leads to overfishing in bad years and reduced catches in good years.

- Traditional maritime fishing employs 1,800 fishermen and production rose from 2,000 tons in 1965 to 13,000 tons in 1980 63) : an increase of 650% in 15 years, or a rise of 40% annually - without any outside assistance.

There are various means of production: canoes, motorized canoes, launches terafiers, etc. (See table F-II , p. 101 .)

Traditional fresh water fishing is to stagnate due to the building of the Manantali Dam unless something is done to remedy this situation. Traditional marine fishing has developed rapidly in response to rising demand for fish in urban areas.

Nevertheless, marine fisheries are hampered by numerous constraints including:

means of obtaining materials: such as parts and boats, from the lack of repair shops and of trained manpower;

infrastructure: inaccessibility of fishing areas, a poor marketing network and a lack of fresh water in certain fishing communities.

organization: lack of financing for needed investments or credit for fishing expeditions.

industrial fishing: is principally the domain of foreign fishing boats. The 1st and 2nd Plans allowed the construction of a very costly infrastructure and the functioning of a processing capacity of 300,000 tons a year in Nouadhibou. Parallel to this infrastructure, joint venture agreements with foreign companies were signed to use this fishing infrastructure.

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62) Ibid.

63) See RAMS report Traditional Maritime Fisheries, 1981.

Table F.1: Contribution of Fishing and Fishing Industries to GDP
(1973 constant prices)

	1973	1974	1975	1976	1977	1978	1979	1980
Fishing	771	822	562	482	489	491	527	545
Fishing Industries	150	191	139	167	181	179	193	174
GDP factor costs	11,848	12,635	13,931	15,046	14,814	111,777	14,409	15,359
(%)	7.7%	8%	5%	4.3%	4.5%	4.8%	5%	4.7%

Source: National Accounts Aggregates, p.8.

Table F. II : Current Situation in Fishing (1980)

Types of Fishermen	Number
Traditional marine	1,800
Industrial marine	700
River	3,000 - 4,000

Types of Fishing Boats	Canoes	Motorized canoes	Launches	Terafiers	Seine trawler
Traditional marine					
Industrial marine		354	89 40	3	26
River	1,000				

Catches	Tonnage	Exports	Value
Traditional marine	13,000		
Industrial marine[1)]		15,333	887 million UM.
River	5,000 - 7,000		

1) 1979 figures - National Accounts Aggregates (Statistics Department) Sept. 1980 p. 29.

Mauritania had hoped to attract foreign vessels to its fish-processing factories. Landings in Nouadhibou for processing amounted to 30,000 tons in 1969, 80,000 tons in 1973 and 53,633 tons in 1979. The quantities landed have never permitted optimal operation of the shore-based processing facilities. The processin industries, composed of 5 joint venture companies, were operating at merely 30% of their capacity in 1979.

In return for these landings, government expenses in paying back loans used to pay for installing the various facilities are high - amounting to an average of 44 million UM a year from now until the year 2000.

The government is obliged to deliver fishing licenses in order to supply the industrial complex and to "amortize" the facilities in Nouadhibou. The system of licencing is intended to:

1. bring in currency through fees charged for fishing;

2. receive part of the catches made by foreign vessels in order to supply local industries;

3. train Mauritanian sailors.

Since 1962, and in spite of the large investments made in infrastructures, results have not lived up to expectations because although this development policy has brought in a major influx of revenue in currency:

	1974	1975	1976	1977	1978	1979	[illegible]
Fishing fees and taxes	200	300	500	550	1,500	1,080	[illegible]

Source : Ministry of Finance, Department of Studies "Le Secteur des peches et le Developpement Economique et Social" p. 5

Table F. III : Handings and Processing of Fishing Products (tons)

	1973	1975	1977	1979
Handlings at Nouadhibou (tons)	80,000	28,000	62,760	53,633
Exports [1] (tons)	27,213	26,533	29,042	15,333
Value of Exports (UM)	503	692	921	887

1) Figures in National Accounts Aggregates Statistics Department, Sept. 1980, p. 29.

it has not:

allowed for the training of Mauritanian personnel either in the domain of navigation or of management;

permitted the formation of a national fleet, or

improved the interior distribution network, because the fishing industry is mainly export-oriented.

Past Policy

Past policy was to invest in processing facilities so as to benefit from catches made by foreign vessels. In order to obtain the financing for these installations and for development as well, it was thought better to receive fishing fees and taxes rather than to go into debt and to pay interest. Such was the basis of past policy.

Present Policy

In order to help the Mauritanian economy to benefit from its renewable resources, the government instituted a new fisheries policy intended to encourage the creation of a true national fishing fleet.

The report of the 4th Plan Industrial Commission 64) proposed the following investments for 1981-85:

Proposed Investments (millions of UM)	
Port installation	5,044
Boats	15,126
Factories and warehouses	2,593
Supervision	112
Traditional fisheries	600
	23,481

64) Rapport de la Commission du 4 ieme Plan sur le secteur industriel sous-secteur peche, Annex, p. 5

Of these proposed investments, only the port installations, supervision and traditional fishing would be supported by the government, at a cost of 5,762 million UM.

This strategy seems to be one of developing industrial fishing through joint venture fishing companies.

In the area of production, participation by Mauritanian fishermen is desirable. Nevertheless, the development of industrial fishing depends on the prior training of skilled manpower.

Thus if the proposals of the Fisheries Sub-sector 4th Plan Industrial Commission are carried out, more than 3,700 jobs for sailor-fishermen will have to be found by 1985 in order to man the industrial fishing fleet (see table on the costs of creating a job in the fisheries sector).

However, the number of sailors trained at the Mamadou 65) Toure Training Center between 1962 and 1979 was only 970 persons.

This strategy of developing industrial fishing by means of joint venture companies is going to be confronted by the same technical difficulties (manpower, imported materials etc.) and organizational problems that confronted the country in the past decade.

These technical difficulties (employment of foreign manpower, importing of advanced technology) will limit the amount of value added to be obtained. In industrial fishing, value added would only be equal to 40% of production.

Costs of Creating a Fishing Job in Different Types of Fishing[1)]

T_1 (traditional		T_2 improved traditional	T_3 modern
Canoe	motorized canoe	launch Texafier	Trawler
10/20,00	40/80,000	300/400,000	0,9/7 million

Source: RAMS Estimates

65) RAMS report on Evaluation of the Formal Education System in Relation to Development [illegible];

1) 1980 prices. Land installations not included.

Alternatives

An overall strategy to nationally develop the country is fisheries necessities maximizing catches, within given financial investment, manpower, equipment and management constraints. Such as approach would consist of a gradual growth of potential catches by combining traditional with semi-industrial fishing.

It is essentially the government's responsibility to draw up guidelines; the dynamics of the private sector (in traditional fisheries) will do the rest.

The long-term objectives for fishing appear to be:

(1) provision of adequate supplies for domestic and foreign consumption (exports);

(2) building of a traditional fleet by first creating a training facility to prepare qualified personnel capable of organizing traditional and semi-industrial fishing.

Production in traditional river fishing 66) will stagnate as a result of the completion of the Manantali Dam in 1990.

Without an adequate development policy, river fishing will diminish, thereby reducing employment, revenue and consumption.

This sub-sector requires a policy which would:

(1) protect fish reserves and prevent excessive use of the ecosystem, and

(2) develop pisiculture, a form of intermediate technology within the means of fishermen, in order to make up for the ecological deficit.

Successful pisiculture projects have been established in many countries such as Cameroun and Zaire and experiments are being carried out in Senegal and Niger, among other countries.

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66) Inland Fisheries, RAMS, 1980.

It is possible to plan fish ponds around major markets beginning in Boghe, in natural ponds and in irrigated fields. Large scale pisiculture could provide inexpensive protein-rich food and could minimize fluctuations in rural income.

According to the RAMS studies,67) it will be possible to create or improve 9,000 ha. of water for fish production by the year 2000; 4,000 ha. would be in the River region and 5,000 would be in the form of ponds. One could reasonably expect a production level of 1 to 1.5 tons per ha. in irrigated fields and 0.5 to 1 ton per ha. in ponds.

Cost of estimates and investment programs are based on RAMS data.

The possibility of developing traditional and semi-industrial marine fisheries is promising. Even without government support, this sector was able to grow 650% in 15 years with income estimated to be 20.000 UM per person. 68)

This sector has a vast potential in meeting domestic demand, which is rising, as well as foreign demand.

It is first of all a labor-intensive activity (1 job at sea for 2 to 4 jobs on land in ancillary activities such as marketing and processing).

- Local fishermen are able to assimilate techniques.
- Little capital is required and investments are therefore affordable by a larger number of fishermen (problem of income distribution).
- Fishing is still an unorganized sector and has an important growth potential. The sector is to be restructured on 3 levels: the human, the technical and the organizational
- On the human level, reorganization must concentrate on human resource development through training and supervision.

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67) Ibid.

68) Figures provide by Fisheries Service.

- Production is to be increased through improved technology and material.

- The marketing network must also be improved.

- A canoe motorization program is needed.

- In order to prepare for the time when coastal fishing will have been exhausted in areas fished by motorized canoes, a program of construction and training of Mauritanian crews aboard terafier-seiners is necessary.

Potential catches in traditional and semi-industrial fishing will amount to 75,000 tons in the year 2000 and the required manpower will be 5,000 individuals. (see Table F-VIII p.118. Potential development of semi-industrial fishing is based on the estimates of development potential in industrial fishing established by CILSS

The study on industrial fishing is given as an example only and production potential as well as manpower requirements and annual investment costs for 3 possible development strategy scenarios are given in Table VII page 117.

The estimates of cost and the investment programs are based on data from the 4th Economic Development Plan Fisheries Commission Report 69).

Short and Medium-Term Objectives

Traditional inland fisheries has its owned skilled labor and its own dynamic. The objective should be to increase productivity in this sub-sector by up-grading its manpower through training and through incentives (credit, fishermen's organizations, availability of low cost materials, etc.)

Inland fishing

- Training of persons to care for fish ponds;

- Installation of an initial 600 ha. of fish ponds between 1980 and 1990 at the same rate that new rice paddies are created.

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68) FAO DP/MAN/73/007

69) Fisheries Sub-sector, 4th Plan Commission, (Oct. 1980)

Table F.IV : Development Potential in Pisciculture

The development of pisiculture involves:

1) Creation of fish ponds at a cost of 50,000 UM/ha. (1980 prices) following this installation plan:

	1990			2000		
	Potential Useable Area	Area covered by Fish Ponds	Cost	Potential Useable Area	Area covered by Fish Ponds	Cost
Boghe	2,300 ha.	180 ha.	9×10^6	4,000 ha.	320 ha.	16×10^6
Koundi VIII	2,000 ha.	160 ha.	8 "	7,000 "	560 "	28 "
M'Bagne	1,500 "	120 "	6 "	14,000 "	1,120 "	56 "
Koundi III	1,500 "	120 "	6 "	8,500 "	680 "	34 "
Maghama				10,000 "	800 "	40 "
Totals	7,300 "	580 "	29×10^6	43,500	3,480 "	174 "

2) Development of natural ponds[1] :

1990	10×10^6 million UM.
2000	30×10^6 million UM.

1) Inland Fisheries. RAMS, 1981.

Traditional and semi-industrial marine fishing

- Organization of the fisheries sector: national coordinating organization; organization of cooperatives, of a domestic system of internal distribution and storage;

- a motorization program for the canoes;

- opening of fishing villages along the coast (ex. the Arguin Bank, N'Diago) 70)

- Creation of an extension service (for repairs, maintenance, handling of catches . . .)

- creation of a credit system to facilitate the purchase of material and access to funds for fishing expeditions;

- manpower up-grading through training;

- purchase and building of several seiners and terafiers to train fishermen in semi-industrial fishing methods;

- purchase of patrol boats to monitor fishing along the coast in order to protect traditional fishing and to prevent over-fishing.

Production and Consumption

Potential catches are shown in table F. IV , page 114 . The table shows that river will stagnate and decrease. Potential development of pisiculture could follow the installation schedule proposed by the RAMS study 71) and thereby maintain and stabilize production in the river fisheries.

Catches in traditional marine and semi-industrial fisheries could rise to 75,000 tons in the year 2000 if the major technical and organizational constraints were overcome by:

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70) See Agricultural Institutional Framework Option Paper.

71) Inland Fisheries.

- improved coordination of governmental policies;
- up-grading the quality of production and of labor through a good distribution system and improved technology.

The potential of industrial depends upon investing in an industrial fleet and in joint ventures involving government and private capital. If planned investments by the private sector are not made (about 15 billion in 15 years), industrial fishing will continue to be the domain of foreign fleets.

According to the RAMS surveys on consumption patterns 72) the demand for fish will rise, given present consumer preferences and linked with an annual population growth rate of 2.5%. This case will be called D_1 demand.

On the other hand, according to the nutritional norms established by RAMS 73), D_2 demand will result in an individual consumption of 18 kg of fish per year.

D_1 Demand for fish (10^3 tons)

	1980	1985	1990	1995	2000
Rural population	8	9	11	12	14
Urban population[1])	3	4	4	4	10
Total	11	13	17	20	24

However, given the RAMS nutritional standards 74), there will be an annual demand level (D_2) of 18 kg per person.

1) 15 kg annual per capita consumption

72) Rural Consumption

73) See RAMS report Food and Nutritional Situation in Mauritania, 1981.

74) Ibid.

D_2 Demand for fish (10^3 tons)

	1980	1985	1990	1995	2000
Total Demand	11	29	33	37	43

A comparison of consumption and potential catches indicates that fishing is a rural sector activity with a bright future

Fishing will not only provide all of the fish required for domestic consumption but will also generate a surplus for transformation and export industries.

Assuming conditions of D_1 demand (based on a continuation of present consumption patterns), the result is 24,000 tons of fish caught in the year 2000. Assuming D_2 demand conditions (according to nutritional norms) 43,000 tons of fish will be caught in the year 2000. Between 1980 and 1985 there will be a jump in consumption going from 11,000 tons to 29,000 tons. There is a slight deficit in fish during this period under Option F_3 as well under Option F_2. The results of investment in traditional and semi-industrial fishing start becoming evident during the 1985-1990 period and catches under this option increase substantially (doubling).

The Options

The sector has a tremendous potential but the dilemma is one of selecting a sectoral development strategy.

Should investments be channelled into industrial fishing (with its high investment costs, lack of qualified manpower and the constraints of foreign debts, and with the probability of experiencing the same consequences that resulted from the pattern of investment in this industry during the 1970's), or should investments be gradually made in traditional and semi-industrial fishing?

Three options are considered:

Option F_1: development of a national fleet via industrial fisheries;

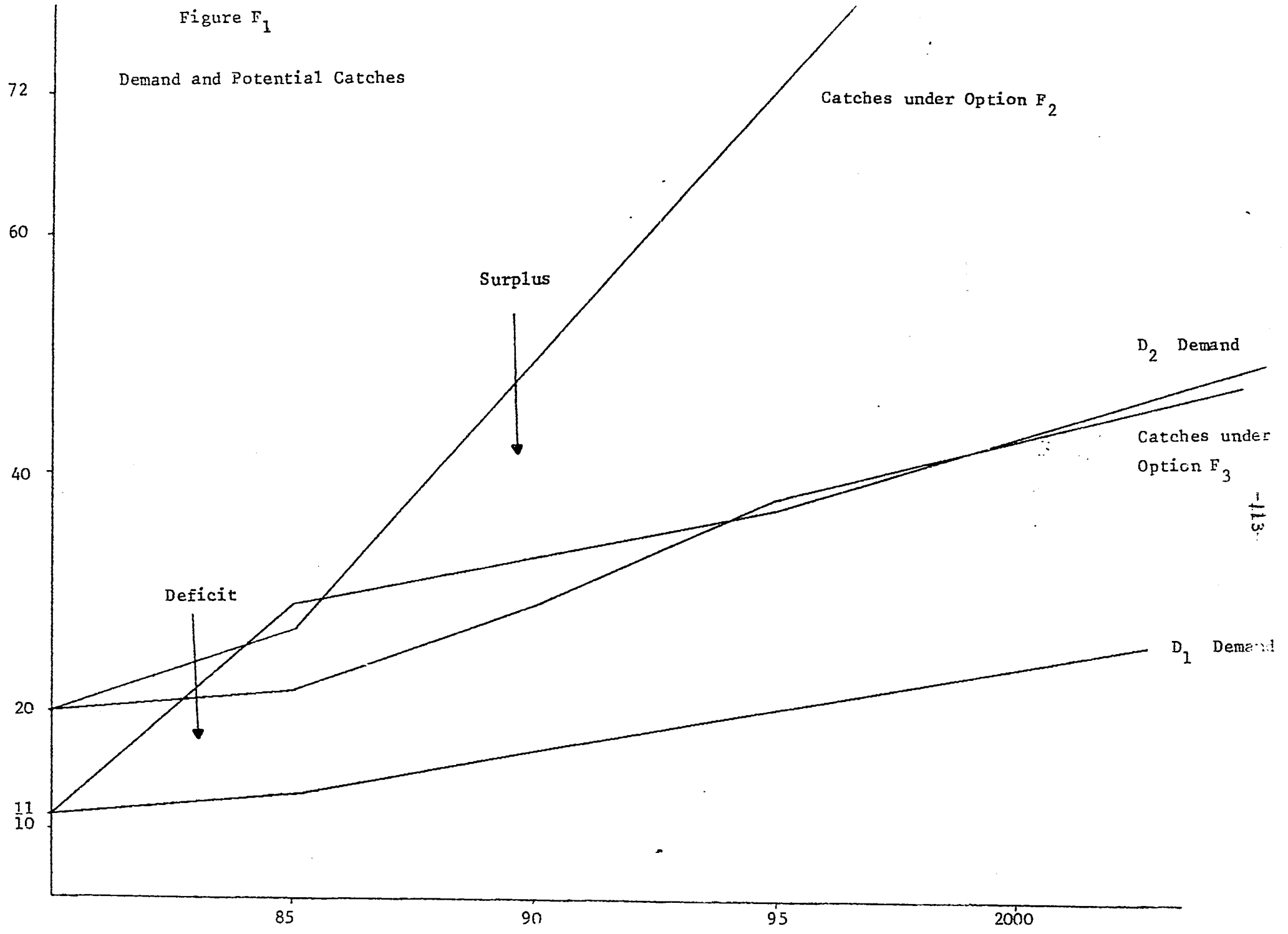
Figure F_1
Demand and Potential Catches
72
60
40
20
11
10
Catches under Option F_2
Surplus
D_2 Demand
Catches under Option F_3
Deficit
D_1 Demand
85
90
95
2000

Table F. V : Fishing

Potential Catches (tons)

	1980	1985	1990	1995	2000
River Fishing					
- traditional 1)	7,000	6,500	9,000	8,000	7,000
- pisiculture 1)		500	1,500	4,500	7,500
Traditional Marine 2)	13,000	15,000	20,000	30,000	36,000
Semi-Industrial 3)		5,000	20,000	30,000	40,000
Total	20,000	27,000	50,000	72,500	90,500
Industrial Fisheries	50,000	100,000	150,000	175,000	200,000
Scenario 1					
Scenario 2		150,000	175,000	200,000	300,000

1) Production in Pisiculture 1.5 tons per hectare
2) Potential catches by an unmotorized canoe : 20 tons a year with a crew of 3 to 4; potential catches with a motorized boat: 40 to 100 with a crew of 6.
3) Potential catches in 200 days of fishing in a terafier: 1,500 tons per year with a crew of 12.

Option F_2 : beginning pisiculture plus development of traditional maritime and of semi-industrial fisheries;

Option F_3 : continuation of present policy.

A comparison of consumption and potential catches indicates that fishing is a rural sector activity of considerable potential.

Option F_1 (Priority Development of Industrial Fishing) allows for high productivity and exports /see Table FVI .) However, it requires the enormous investment of 1,500 M UM annually over a 15 year period. This option will have an impact on the balance of payments and on foreign debt because more than 90% of the required investments must be imported.

Furthermore, this option requires skilled labor (mechanics, master fishermen, etc.) which is unavailable in Mauritania. In order to maintain this industrial fishing fleet, Mauritania would have to rely on foreign crews. For manpower requirements, see Table F-VII, page 117 . Value added would be minimal.

This option also assumes a willingness on the part of the foreign fishing companies to fulfill their contracts properly and in good faith.

Option F_2 would enable Mauritania to satisfy its internal demand while at the same time establishing a national fleet on a firm foundation. The fleet would be a training ground for sailors entering semi-industrial fishing.

Its cost some to about 750 million UM/year.

This option combines the improvement of river fishing through pisiculture and of semi-industrial fishing through the improvement of traditional fishing.

Investments are not as large and or as capital intensive as in Option F_1 and intermediate rechnology is not beyond the means of local fishermne. There would be a more balanced geographical distribution of investments (the river region and inland ponds for pisiculture, Nouakchott, Timiris and Nouadhibou for traditional and semi-industrial fishing). Significant exports will be possible by the year 2000.

Table F. VI : Costs and Production Levels of the Different Options

	1985	1990	1995	2000
Option F_1				
Costs (10^6 UM, 1980)	6,735	3,036	2,776	658
High production (10^3 tons)	1,800	3,150	3,600	5,400
Medium production	1,800	2,700	3,150	3,600
Low production	1,440	2,250	2,700	3,150
Option F_2				
Costs	750	300	400	
Production	500	900	1,300	1,600
Option F_3				
Costs	600	150	70	70
Production	400	500	600	700

Table F. VII : Option F_1 Production/Cost/Jobs (per year)

	1985	1990	1995	2000
Potential Catches (tons)	100,000	175,000	200,000	300,000
High	100,000	175,000	200,000	300,000
Medium	100,000	150,000	175,000	200,000
Low	80,000	125,000	150,000	175,000
Required Investments[1]				
- Infrastructure: Port at Nouakchott	1,006	100[3]	100[3]	100[3]
Equipment for quays	13	13	13	13
Factories and Storage Warehouses	2,593	260[3]	260	260
- Equipment[2]				
ice chests 208 units X 73 million UM	1,022 (14/years)	1,022	1,022	
launches 100 units X 5 million UM	(7/years)	35	35	
Seine gfishing boats 20 units X 64 million UM	128 (2/years)	128	128	
Freezers 50 units X 364 million UM	1,456	1,456	1,456	
Other: Supervision	112	12[3]	12	12
Training	10	10	10	10
Total	6,375	3,036	2,776	395
Number of Fishing Jobs Required each Year:				
Fishermen	565	565	565	
on land[4]	2,260	2,260	2,260	

1) Figures from Rapoort etc.
2) Rounded prices spread over 15 years.
3) Maintenance 10%
4) 1 fishing job = 4 jobs on land.

* Depreciation not included.

Table VIII: Option F_2 Production/Costs/Jobs (per year)

	1985	1990	1995	2000
Potential catches (tons)				
River fishing	7,000	10,500	12,500	14,500
Traditional fishing (marine)	15,000	20,000	30,000	36,000
Semi-industrial fishing	5,000	20,000	30,000	40,000
Total (tons)	27,000	50,500	42,500	90,500
Investments- (millions UM, 1980)				
Infrastructure:				
- Fisheries installation		39		205
- Bay of rest	354	35 1)	35	35
- Boats and transportation	34	3 1)	3	3
- Repair shop	33	3 1)	3	3
- Cold storage unit	95	95 1)	19	19
- Terafier	35	35	35	35
- Supervision	112	11	11	11
- Credit	70	70	70	70
- Training	10	10	10	10
- Reasearch in agriculture	10	10	10	10
Total	753	311	196	385
Required number of fishing jobs needed				
River fishing 2)	3,500	5,250	6,250	7,250
Traditional fishing 3)	2,000	2,600	3,900	4,600
Semi-industrial fishing	40	160	240	320

* Terafiers (100 boats X 5 million) (7 per year)
* Supervision

Maintenance 10%
2 tons per fisherman
Number of fisherman X growth rate
Crew aboard a Terafier = 12 persons.

* See explanation

Table F. IX : Option F_3 Production/Cost/Jobs (per year)

	1985	1990	1995	2000
Potential catches (tons)	6,500	9,000		
River fishing	6,500	9,000	8,000	7,000
Traditional fishing (marine)	15,000	20,000	26,000	30,000
Total	21,500	29,000	34,0000	37,000
Investments (millions of Um, 1980)				
Infrastructure:				
- Bay of Rest	354	35[1)]	35	35[1)]
- Boats and transportation	34	3[1)]	3	3
- Repair shop	33	3[1)]	3	3
- Cold storage unit	95	95	19	19
Other:				
Supervision	122	11[1)]	11	11
Total/per year	628	147	71	71
Required number of fishing jobs needed				
River fisheries[2)]	3,5000	4,5000	4,000	3,5000
Traditional fisheries	2,000	2,6000	3,100	4,000

Calculations: RAMS

Maintenance = 10%
2 tons per fisherman
Number of fishermen X growth rate.

Table F. X : Fisheries: Option F_1 (millions of UM, 1980)

	1985	1990	1995	2000
Potential catches				
High Productivity Scenario				
Production [1]	1,800	3,150	3,600	5,400
Value Added [2]	774	1,354	1,548	2,322
Medium Productivity Scenario				
Production	1,800	2,700	3,150	3,600
Value added:	774	1,161	1,354	1,548
Low Productivity Scenario				
Production	1,440	2,250	2,700	3,150
Value added:	619	967	1,161	1,354

1) Producers' Price 18 UM/kg

2) Value added: 43%, RAMS, 1981.

Table F. XI . Fisheries: Option P_2 (millions of UM, 1980)

	1985	1990	1995	2000
Potential catches				
River fishing				
Production [1]	126	189	225	261
Value added	126	189	225	261
Traditional Fishing (Marine)				
Production [1]	104	157	187	217
Value added	270	360	540	648
Semi-Industrial Fishing:				
Production [1]	189	252	298	454
Value added	90	360	540	720
Production total P_2	63	252	378	504
Value added	486	909	1,305	1,629
	356	661	943	1,175

1) Producers' price 18 UM/kg.
2) Value added in river fisheries : 83%
" " " traditional marine and semi-industrial fisheries: 70%

Table F. XII: Fisheries: Option F_3 (millions of UM, 1980)

	1985	1990	1995	2000
Potential catches				
River fishing	117	162	144	126
Production 1)				
Value added 2)	97	134	119	104
Traditional Fisheries (Marine)				
PRoduction 1)	270	360	468	540
Production 2)	189	252	328	278
Production Total	87	522	62	666
Value added	286	386	447	482

1) Producers' price: 18 UM/kg

2) Value added in river fisheries: 83%
" " " semi-industrial fisheries: 70%

Option F_2 does not prevent the Government from issuing fishing licenses in order to finance investment in this sector, either.

Option F_3 is a continuation of present policy. The stagnation of river fishing is inevitable once the Manantali Dam is finished. Improvements in traditional fishing will allow for a moderate increase in catches which will satisfy domestic demand but will have a minimal impact on the balance of payment (no exports of significance are foreseen).

The Options:

Total potential production in the Agriculture, Livestock and Fisheries sub-sectors under each option is what makes up potential production in the rural sector as a whole.

Since there are three production options for each of the three sub-sectors (agriculture, livestock and fisheries), there are numerous possible combinations. Given the constraints prevailing in Mauritania (tehcnical, human, organization), one of these combinations of potential production will be optimal.

1) Agriculture:

There are A_1, A_2 and A_3.

2) Livestock :

There are L_1, L_2 and L_3.

3) Fisheries :

There are F_1, F_2 and F_3.

Potential production in the rural sector = the sum of potential production in Agriculture, in Livestock and Fisheries.

Potential production in the rural sector lies between the highest potential level of production:

$$A = A_1 + L_1 + F_1$$

and the lowest potential level:

$$C = A_3 + L_3 + F_3.$$

Between these two extremes lie other possibel levels of potential production; 3 broad possibilities will be treated here: A, B and C. B is the middle option.

Outcomes

First of all, two important points must be made:

1) Production depends on prices (either to the farmer or in the market). There is an under-estimation of the different sub-sectors, especically the agricultural sector, since the price per kg. of rice is low relative to that of other grains such as millet, sorghum, etc. There is also an under-estimation problem in the fisheries sub-sector, where the price of fish is estimated at 18 UM/kg/ for all types of fish.

2) The problem of transportation and marketing costs have not been considered. The cost of inputs is calculated with transportation costs included whereas the values of the product is calculated as farmgate value.

3) The links between costs and improvements in the livestock sub-sector are not easily identifiable because the rainfall factor is very important. But in the long-run investments in livestock will lead to improved productivity and a higher off-take rate, growing from 25% to 100%.

Comparisons between costs and production levels in the rural sector are thus made difficult because of the livestock sector.

In order to achieve a better comparison among options A, B and C, considerations of the livestock sub-sector will be separated.

4) It is evident that the ratio between cost and value added is a function of the technologies used, but that in the long run this ration drops with increasing speed as the level of technology rises.

The productivity of investments can be understood by studying capital coefficients in the Input-Output table.

5) In order to overcome the constraints, a multitude of different production possibilities is possible.

Impact of the Options:

Depending upon the choice of economic policy, different possible combinations are possible. The options chosen will impact on the economy in several ways:

through investments

production

employment

1) It is evident, by studying the different medium-and long-term options that in the area of production, there is a change in the make-up of value added in favor of the agricultural sector. In a (see Table 0.1, page129) , the principal components of rural GDP will amount to 15,000 million UM in the year 2000. (1980 prices), or 5 times the 1980 amount. Agriculture will make up 29%, livestock 56%, fishing 15%, instead of their respective percentages in 1980 of 9% 8% and 9% of rural GDP.

Under B (see table 0.II, page 130), the major components of rural sector GDP will be valued at 13,200 million UM in the year 2000, or 4 times their 1980 value. Agriculture will make up 25%, livestock 66% and fishing 9% of rural sector GDP.

Value added in agriculture between 1985 and the year 2000 will be multiplied by

3.3 for A

2.5 for B

1.5 for C

Value added in fisheries between 1985 and the year 200 will be multiplied by

3 for A

3.3 for B

1.6 for C

2) In the area of manpower, agriculture offers the most employment and thus permits the widest distribution of revenues. Livestock is the second largest employer. Option A will provide the most employment in this sector (about 1/3 of the rural sector in the year 2000) whereas options B and C will lead to an out-migration of manpower from the livestock sector.

Employment in the fisheries sector is negligible and is not more than 3% of the total of any option.

3) From the standpoint of capital ration (investment-value added ratio), fishing is highly capital intensive and employs relatively few people.

	1985	1990	1995	2000
		Fisheries		
Option A	8.2	2.2	1.8	0.3
B	2.1	0.5	0.2	0.3
C	2.1	0.4	0.1	
		Agriculture		
Option A	0.7	0.5	0.3	0.2
B	0.5	0.4	0.2	0.2
C	0.3	0.2	0.2	0.1

These two tales show that the capital intensity in fishing is ten times higher than it is in agriculture in Option A and 5 times higher in Option B. This ration drops as time goes by (investments in fisheries are projected for the 1980-1995 period).

The development strategy in inland fishing is a response to ecological problems whereas marine fishing is a means of acquiring foreign exchange.

Given the amount of investment required in industrial fishing in relation to traditional marine and inland fishing, a certain modulation of investments in industrial fisheries will be necessary over time. Priority must be given to traditional and semi-industrial fishing.

The importance of herding in the rural sector will continue through the year 2000. In the livestock sector, a period of 20 years to improve range management nad production is rather short if there is a significant amount of investments. Herding remains the most attractive activity in terms of value added (93%), resource use and existence in marginal areas.

The final choice of combinations of potential production will depend of a system of allocated points. The points will be given in terms of priorities established by the Plan and are higher to the degree that objectives and potential production are close.

Option	Value added	Manpower	Costs	Total
Option A				
Agriculture	+	+	-	
Livestock	+	+	+	3+
Fisheries	+	-	-	
Option B				
Agriculture	+	+	+	3+
Livestock	+	-	+	
Fisheries	+	+	+	3+
Option C				
Agriculture	+/-	-	+	
Herding	+/-	-	+	
Fisheries	-	-	+	

Thus, given value added priorities, manpower and cost goals, the choice of options will depend on a combination of production potentials under Option A for the Livestock sector and Option B for Agriculture and Fisheries.

In our example the choice will be:

$$L_1 + A_2 + F_2$$

Priorities and options can be expanded or changed according to needs.

Table 0.1 Annual Impact of Option A

	1985	1990	1995	2000
Investments (millions of UM, 1980)				
Agriculture [1]	1,007	992	1,428	1,376
Livestock	500	520	532	478
Fisheries	6,375		2,776	658
Total	7,882	4,548	4,737	2,510
Production (millions of UM, 1980)				
Agriculture	1,900	2,900	4,300	6,300
Livestock[2]	9,009	9,482	9,929	9,516
Fisheries	1,800	3,150	3,600	5,400
Total	12,709	15,532	17,825	21,216
Value Added[3] (millions of UM,1980)				
Agriculture	1,368	2,008	3,096	4,536
Livestock	8,288	8,723	9,135	8,755
Fisheries	774	1,354	1,548	2,322
Total	10,430	12,165	14,779	15,613
Manpower (thousands of persons)				
Agriculture	145	180	216	258
Livestock	145	145	145	145
Fisheries	5.5	8	10.4	12.2
Total	305.5	333	371.4	415.2

1) Figures from page _____.
2) Assuming normal rainfall.
3) Value added taken form Table I-E(RAMS).
4) Assuming rising productivity.

Table O.II : Annual Impact of Option B

	1985	1990	1995	2000
Investments[1] (millions of UM, 1980)				
Agriculture	642	642	829	774
Livestock	382	392	401	361
Fisheries	753	311	196	385
Total	1,777	1,365	1,426	1,520
Production (millions of UM, 1980)				
Agriculture	1,800	2,400	3,400	4,600
Livestock[2]	9,009	9,482	9,929	9,516
Fisheries	490	900	1,300	1,600
Total	11,299	12,792	14,629	15,716
Value Added[3] (millions UM, 1980)				
Agriculture	1,296	1,728	2,448	3,312
Livestock	8,288	8,723	9,135	8,755
Fisheries	356	661	943	1,175
Total	9,940	11,192	12,526	13,242
Manpower[4] (thousands of persons)				
Agriculture	141	152	157	167
Livestock	131	124	115	107
Fisheries	5.3	7.1	7.4	7.5
Total	277.5	283.1	279.4	281.5

Excluding recurring costs.
Assuming normal rainfall; RAMS baseline data.
Figures from Table I-E (RAMS). 42% for agriculture, 92% for livestock, 83% for river fishing 43% for industrial fishing, 70% for traditional and semi-industrial fishing.
Figures from Option Paper on Employment Implications of Alternative Development Strategies.

Table O.III: Annual Impact of Option C

	-1985	1990	1995	*2000
Investments[1] (millions of UM, 1980)				
Agriculture	400	350	360	300
Livestock	172	176	181	162
Fisheries	628	177	71	71
Total	1,200	673	612	533
Production (million of UM, 1980)				
Agriculture	1,750	2,000	2,200	2,700
Livestock	9,009	9,482	9,929	9,516
Fisheries	387	522	612	666
Total	11,146	12,004	12,741	12,882
Value Added [3] (Million of UM, 1980)				
Agriculture	1,260	1,440	1,584	1,944
Livestock	8,288	8,723	9,135	8,755
Fisheries	286	386	447	482
Total	9,834	10,549	11,130	11,181
Manpower[4] (thousands of persons)				
Agriculture	135	135	135	135
Livestock	132	119	107	96
Fisheries	4	4.5	4.8	5
Total	271	258.5	246.8	236

1) Figures from page ____.
2) Normal rainfall assumed.
3) Figures on value added come from Table I-E
4) Figures from Option Paper on Employment Implications of Alternative Development Strategies

Intermediate Technology

The most important factors in rain-fed agriculture in the South-East are:

(1) The number of plants per hectare (density of planting). If the number of hills per hectare is too high, yields can drop. If the number of hills is too low, potential yields will be not related. It is obvious that a balance between these 2 cases is needed.

Experiments in agronomy have shown that the optimum number of hills in the Sahel is about 10,000 per hectare. These experiments were carried out in Sahelian dune soils and show that the usual 6,000 hills per hectare in Mauritania is quite different from what the number could be.

Experience has shown that this average number of 6,000 hills is a safety measure because this lower density of hills allows for double cropping.

If each hill contains 3 plants, there is a total population of 18,000 plants per hectare.

The 6,000 hills are the basis on which fertilizer requirements are calculated.

(2) 1 gram of urea per hill is applied when weeding is done and another gram per hill is applied at the beginning of the growth period, which add up to a total of 12 kilograms of urea per hectare.

The method of applying urea depends on the kind of sowing technique used.

TSP (triple super phosphate) is used at the beginning of the planting season at the rate of 1 gram per hole, which means that a total of 6 kg per ha. of TSP are used. Total fertilizer use will amount to 18 kg per hectar.

Fertilizer Requirements

No. of hills/ha.	Kg. of Urea/ha.	Kg.TSP/ha.	Total
6,000	12	6	18
7,000	14	7	21
8,000	18	9	27
9,000	18	9	27
10,000	20	10	30

T_2 Technology is used and consists of:

1) sowing 6,000 hills/ha.

   - placing 1 g of TSP into the hole dug for the seeds;
   - planting 8 to 10 seeds of millet of 5 to 8 seeds of sorghum in the hole.

2) when the first weeding is done

   - weed around the plants
   - reduce the number of plants to 3 per hill
   - add 1 g of urea to each hill.

3) when the third weeding is done

   - add another gram of urea to each hill.

4) double cropping (planting cow-peas) is carried out between the first and the second weeding.

Animal Traction

1) plowing

2) sowing by land - - 1 g TSP per hole

3) first weeding done with the plow - add 1 urea per hole

4) second weeding done with the plow - add 1 g urea per hole cow-peas planted in between the hills.

5) no more weeding done with the plow.

Table No. 1 Average Yields of Certain Crops (Kg/ha)

Soil Type	Oualo	Dieri	Rainfed	Dams (Receesional	
A - Sorghum	330	-	494	460	Dryland Agriculture RAMS, p. 69.
Millet	-	416	395	270	
Cow peas	280	210	210	241	
B - Sorghum Fellah G.	780				
Nienico G.	560				Bradley et al. 1977: Guidimaka War on Want.
Nabane G.	-	1,500			
Millet			610		
C - Sorghum	430				
Millet/Sorghum (B)		416			Gannet et al, 1978 (?): OMVS: Fleuve Senegal, page 31 de Boutilier et al, (1962) (B)
Cow peas (1)	300				
(11)	250				
(111) (B)		300			
Sorghum Early Nienico G.	479				
Fairly late					
Nienico G.	504				Average 41 Years Beaudoin, J.C.
" " G.	524				" "
Fellah Nabane G.		550			" " 1975: Project du
Nabane	899				" " developpement du
White or red G.					" " Sud-Est Mauritanien
Fellah	600				p. 31 -51
Gadiaba G.	673				BDPA.
Manganie G.	712				" "
					" "
					" "
Millet Souna H		344			" "
" H		290			" 55 " S = 176
Sanio H		270			" " S = 176
E - Sorghum IRAT					
Varieties G.	1.378				
CE 67 (CT)					Beaudoin, J.C., 1975 p. 36
CE 90 (CT)	1.185				bdpa.

G. Guidimak.
H. Hodh
CT. raditional Crop

Table No. 2 Average Yield of Certain Crops Kg/Ha.

Soil Type / Nature		Oualo	Dieri	Rainfed	Dams (Recessional)	
Millet	1966 - 67			1,087		(Statistical Service in OMVS: Etude socio-economique du Bassin du Fleuve Senegal, 1980.
	1967 - 68			827		
	1968 - 69			790		
	1969 - 70			817		
Sorghum						
	1966 - 67	1,215				
	1967 - 68	969				
	1968 - 69	990				Upper Valley
	1969 - 70	1,171				
Millet	*			568		Mme Keita (R.N'Diaye) Kayes et le Haut Senegal: Vol.2 p. 107 - 108 in OMVS. Etude socio-economique du Bassin du Fleuve Senegal, 1980. (Ministry of Rural Development)
Kayes				600		
Bafoulabe				600		
Keniabe				600		
Kita				-		
Nioro				522		
Yelimane						
Sorghum durra					1,213	Grain Yields (Tamourten-Naaj, Bouraga, Boumdeid)
Sorghum caffra					956	
Pennisetum typh. (millet)					658	Rural Development in the Tagant Region (As rainfall = 249 mm) (S = 124 mm)
Sorghum		1,600				Senegal River Valley: Irat, 1970 op. cit. Brown, RAMS, 1981; 100 kg/ha.
Millet				1,400		
Cow peas				1,300		
Sorghum from Mali				557		Growth rate with 100 kg./ha. of IRAT fertilizer, 1970. op. cit. Brown, RAMS, 1981
Millet from Upper Volta				596		

* Administrative regions in Mali.

Table No.3 Average Yields for Certain Crops in Kg/ha.

Soil Type		Oualo	Dieri	Rain-fed	Dams (Recessional)
Nature		Millet density/ha.			
Millet = CIVT* Treatment No.*					
	N2	10,000 hills		2,590	with nitrogenous fertilizer
NCP.CA. 1/80	N4	" "		2,448	20 kg/ha. Urea, 10 kg/ha. TSP
	NF	" "		2,441	40 kg/ha. Urea, 10 kg/ha. TSP
				2,021	10 tons/ha; farm yard manure
Millet = CIVT		Population: Millet/cow-peas/ha.			
Treatment	(1)	4,444/33,335		CP	
	A	8,888/33,335		1,250 + (480)	13 kg/ha Urea, 75 kg/ha. STP
NCP.CA. 2/80	B	4,444/33,335		2,229 + (625)	22 kg/ha " " " "
	AB	8,888/33,335		1,588 + (855)	18 kg/ha " " " "
	C	4,444/66,670		1,933 + (570)	27 kg/ha " " " "
	AC	8,888/66,670		1,529 + (939)	13 kg/ha " " " "
	BC	4,444/66,670		1,800 + (726)	22 kg/ha " " " "
	ABC	8,888/66,670		1,270 + (903)	18 kg/ha " " " "
				2,138 + (845)	27 kg/ha " " " "
Millet		Population per hectare		CP	
CIVT Varieries		10,000 hills/ha		1,776 + (737) CI	20 kg/ha Urea; 10 kg/ha. TSP
NCP.CA 3/4 HK		15,723 " "		1,715 + (319) C2	31 kg/ha " ; 16 kg/ha. TSP
ICRISAT WC - CX - 75		15,723 " "		957	31 kg/ha " ; 16 kg/ha "
Millet = CIVT		Population per hectare			
Treatment	a	10,000 hills/ha.		1,640	N4 40 kg/ha of urea
	b	" " "		1,422	N2 20 kg/ha of urea
NCP.CA. 5/80	ac	" " "		1,351	NF 10 tons/ha of urea, farm yard manure
	abc	" " "		1,337	NO = without urea
Millet		Population per ha.			
NCP.CA. 7/80	A	10,000 hills/ha.		1,077	without manure (residual value)
" " 7/80	B	" " "		946	" " " "

The experiment were carried out at the INRA, Tarna, Republic of Niger, 1979 - 80 or "dune soil".

Source: Cunard, A.C. Annual Technical Report CID: REDSO/WA 76-84 NCP: USAID Project.

500 - 550 mm. rainfall zone

* These technical terms are used in the French version of this table.

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