SENEGAL AGRICULTURAL SECTOR ANALYSIS

SENEGAL: ADMINISTRATIVE REGIONS

USAID/SENEGAL/ADO September, 1990.

Agricultural Sector Analysis

The Agricultural Sector Analysis will be presented in three parts reflecting the iterative strategic planning process being undertaken by the Mission in preparation of its CPSP:

Part I will deal with the sector in broad terms and will provide the basic materials necessary to develop the broad strategy framework;

Part II will deal with second generation issues: production, marketing, processing, institutions, consumption and trade.

Part III will consist of a detailed analysis (discussion) of three main geographic/ecological regions. This is where such specific agriculture related issues as WID, health, education etc. will be presented.

When it is all completed, some material from one part may be repeated in other parts. The idea is that each major part of the Analysis be complete and independent.

Part I Sectoral Issues (attached)

Chapter 1 .. Agriculture in the Economy
Development Policy

Chapter 2 .. Resources and Constraints

Chapter 3 .. Farm Technology

Part II Commodity Systems and Institutions (to be developed following initial CPSP planning)

Chapter 1 .. Food Crops

Chapter 2 .. Export Crops

Chapter 3 .. Forestry

Chapter 4 .. Institutions

Part III Regional Analyses

Chapter 1 .. River Valley (attached)

Chapter 2 .. Groundnut Basin

Chapter 3 .. Casamance and Southeastern Senegal

As noted above, portions of the three parts are in various stages of completion. All of the existing work is subject to revision or extension, as time and new information permits.

Agricultural Sector Analysis

Part I Sectoral Issues

Chapter 1 .. Agriculture in the Economy
Development Policy ..... Attached

Chapter 2 .. Resources and Constraints ..... Attached

Chapter 3 .. Farm Technology ..... Attached

CHAPTER 1
AGRICULTURE IN THE ECONOMY

Senegal's economy passed through several distinct phases between independence in 1960 and the end of 1989. These phases are usually specified according to movements in macro-economic indicators of output, consumption and trade such as gross domestic product, final consumption, savings rates, investment and the balance of payments, and vary slightly, depending of the analytic focus. For the purposes of this Analysis major economic policy and/or program changes (generally these are related to the agricultural sector) have been used to separate movements in the economy into four periods. An overview of the four periods along with some general performance indicators is shown in Figure 1.

Figure 1.

MAJOR PHASES IN THE SENEGAL ECONOMY
(1960-1989)

PERIOD			
I	II	III	IV
1960-1966	1967-1980	1981-1984	1985-present
Stability	Instability	Transition	Structural Adjustment
Overall stability with strong growth in all sectors. French provide preferential treatment for exports.	Low average but widely variable growth. Preferential treatment removed.	Relatively strong average but still highly variable growth. First structural adjustment attempted. State disengagement begins.	Return to relatively low but generally stable growth. Second and third structural adjustment facilities. Active state disengagement. Extensive liberalization.
Weather:	Weather:	Weather:	Weather:
Change in real GDP Average ..... 3.3% Highest ..... 4.5% Lowest 2.1%	Change in real GDP Average ..... 1.8% Highest ..... 8.9% Lowest 8.8%	Change in real GDP Average ..... 3.1% Highest ..... 15.2% Lowest ..... -4.8%	Growth in real GDP Average ..... 2.8% Highest ..... 4.5% Lowest 2.7%
No. years < 0 : 0 % years < 0 : 0%	No. years < 0 : 7 % years < 0 : 54%	No. years < 0 : 2 % years < 0 : 50%	No. years < 0 : 1 % years < 0 : 20%
Per capita 0.2%	Per capita 1.0%	Per capita 0.4%	Per capita 0.1%
PROGRAM AGRICOLE		AGRICULTURAL CREDIT SUSPENDED	NEW AGRICULTURAL POLICY

The economy's performance has been dominated by the usual external, (generally uncontrollable) and internal factors. The main external factors have been nature, world markets and external economic policy. The main internal factors have been general economic and political philosophy and several specific economic policies and programs. This chapter of the report will trace the major patterns in the economy, as influenced by major events,

with the purpose of describing linkages and impacts to and from the primary sector (agriculture, livestock, fishing and forestry) and to some extent the secondary sector (manufacturing and mining). The focus is on economic growth in general and the contribution(s) of the primary sector.

MAJOR PHASES

Senegal was one of the african states which opted for "African Socialism" at independence in 1960. The over-riding philosophy was that the State, and especially an enlightened bureaucracy, would manage the economy for the benefit of all its citizens. This philosophy translated into extensive price controls, subsidies and State owned and managed industry. This general philosophy was in effect from 1960 through 1984, when the first real attempts at structural adjustment began. The period following 1984 is characterized by extensive state disengagement and general economic liberalization.

The economy underwent a series of sever shocks between 1960 and 1984. Some of the shocks were created by policies and politics outside Senegal, for example the French suspension of preferential treatment in 1966 and OPEC policy. Some of the shocks were created by nature - average rainfall in the peanut basin declined from 635 cm for 1960-1966 to 376 cm over the period 1981-84, and there were sever insect infestations in several years. Some of the shocks were the result of policy, program and sometimes management problems: in the agricultural sector the Program Agricole, under ONCAD, generated 142 billion CFA in deficits; agricultural credit was forgiven four times and even suspended for four years between 1981 and 1984; the State undertook a series of nonproductive investments as part of the Senegalization process, as it purchased previously french owned businesses and began to create numerous parastaitals (the number of public enterprises increased from 21 in 1962 to 83 in 1977). The result, as shown in Figure 1 and Tables 1 and 2, was an economy which was subject to considerable instability; in per capita

terms growth was marginal (and often negative) with the result that on the average real per capita income declined 0.3 percent over the 1960-1989 period.

Table 1

REAL GROSS DOMESTIC PRODUCT
(PERCENT OF TOTAL BY SECTOR AND PERIOD)

SECTOR	1960-1966	1967-1980	1981-1984	1985-1989
YEARS	7	14	4	5
	(percent of total)			
PRIMARY	26.5	25.9	21.6	21.5
SECONDARY	17.8	21.3	24.7	25.4
TERTIARY	42.1	40.3	38.4	38.7
SALARIES	13.7	12.5	15.3	14.4
ADMIN.	12.6	11.6	14.1	12.9
WORKERS	1.1	0.9	1.2	1.5

SOURCE: ANNEX I.__.

Table 2

PERCENT CHANGE IN REAL GROSS DOMESTIC PRODUCT
(AVERAGE PERCENT CHANGE BY SECTOR WITHIN PERIOD)

SECTOR	1960-1966	1967-1980	1981-1984	1985-1989	1960-1989
YEARS	7	14	4	5	30
	(percent change)				
PRIMARY	3.4	2.1	1.6	4.3	2.7
SECONDARY	4.4	3.6	5.3	3.1	3.9
TERTIARY	3.9	1.4	2.1	3.0	2.4
SALARIES	2.5	3.0	5.2	0.4	2.8
TOTAL GDP	3.3	1.8	3.1	2.8	2.5
POPULATION	3.0	2.9	2.7	2.7	2.9
PER CAPITA GDP	0.3	-1.0	0.4	0.1	-0.3

SOURCE: ANNEX I.__

THE PRIMARY SECTOR: PATTERNS AND TRENDS

Growth in primary sector gross domestic product has also passed through four distinct periods. These periods, along with the major policies and programs are shown in Figures 2-A and 2-B.[1].

I. (1960-1966): Seven years of stable growth in a range of 2.5 to 4.5 percent per year.

This period begins with independence and is marked by good weather, the initiation of the 20 year "Programme Agricole", and preferential treatment for exports (especially peanuts) by the French.

An extensive cooperative system was created, almost exclusively concentrated on providing credit and inputs to the peanut producing regions and peanut marketing. By 1963 about 80% of the cooperatives had been established. They were controlled, and managed, by State agents. Even at the outset loan repayment rates were low (68%).

[1] The data shown in the Figures are two year moving averages and are thus "smoothed" to compensate for year-to-year fluctuations. This is done to adjust for farmers' tendency to alternate between millet and groundnuts.

II. (1967-1980): Thirteen years of widely fluctuating output and building sector deficits.

This period begins with the loss the french preferential treatment for groundnut exports in 1967 and ends with the termination of the "Programme Agricole" in 1980. It encompasses the creation, growth and eventual dissolution of ONCAD, the creation of 83 regional development authorities and other State owned and operated agencies, Senegalisation of the economy, several bad weather years - including forgiveness of agricultural credit ~~three (4) times~~, growth and eventual discrediting of State controlled cooperatives, and the world wide commodity crisis.

The cooperatives were under the control of ONCAD, which was also responsible for the purchase and sale of agricultural commodities, determination of cooperative credit and input needs and their pass-through to cooperatives. By 1970 there were 1870 cooperatives with 1060 specific to groundnuts.

ONCAD staff increased from an initial level of about 450 to over 2900 in 1979, when personnel costs account for about half of the ONCAD budget. Credit repayment rates fell to 48% in 1970. (in fact, agricultural credit was forgiven three times in the 1970's and again in 1980 when ONCAD was dissolved).

ONCAD debit was estimated at 75 billion CFA by 1980 (142.4 billion by 1983).

III. (1981-1984): Transitory stage and the beginning of structural adjustment - crisis.

SONAR was created to replace ONCAD, all agricultural credit was suspended, deficits, partly from ONCAD and now from SONAR build to crisis levels and SONAR was dissolved.

SONAR's main function was the provision of seed and fertilizer to the groundnut sector. SONAR deficits accumulated to 27.4 billion CFA between 1981 and 1984.

The World Bank's first Structural Adjustment Loan (SAL-I) was approved in December 1980. The SAL-I program was aimed at improving parastatal efficiency, increasing producer and exporter incentives, raising productivity of investments, containing urban consumption and a wide range of institutional and policy reforms in the agricultural sector.[2] SAL-I was considered a failure because of two bad weather years (1979/80 and 1980/81); because it was based on inaccurate and incomplete information (debit and arrears were much higher than originally thought); because of excessively optimistic forecasts; and because of GOS action (or inaction). Virtually no progress was made in agricultural policy reform. High world groundnut prices led the GOS to increase the producer price 43% in 1981, when world prices fell in 1982 the deficit exploded. The second tranche of SAL-I was postponed and the outstanding balance was canceled in June, 1983).

[2]The specifics of the various structurel adjustment programs are discussed in detail in, The World Bank and Senegal, 1960-1987, World Bank, August 31, 1989, pg 21.

IV. (1984-1989): Structural adjustment period.

The New Agricultural Policy was formulated and initiated in 1984-85; the Cereals Policy was formulated in 1986; State disengagement began; weather returned to near "normal"; an emphasis was placed on privatization, elimination of subsidies and price controls and sectoral growth began to recover. As part of the NAP fertilizer subsidies were reduced and then eliminated in 1988 and price controls on cereal grains (except rice) were eliminated.

V. Present:

In 1989 the GOS and four of the major donors began discussions which are expected to lead to a structural adjustment loan for agriculture (PASA). The government of Senegal produced its newest statement of development policy (DPDA - "Declaration de la Politique de Developpemment Agricole"). This statement, combined with the conditionality under SAL-IV, will complete the privatization/liberalization process. The DPDA and the donor/GOS dialogue will discussed in more detail in the concluding section of this chapter.

Figure 2-A

Real Primary Sector Gross Domestic Product
(1977 FCFA and Qudratic Trend)

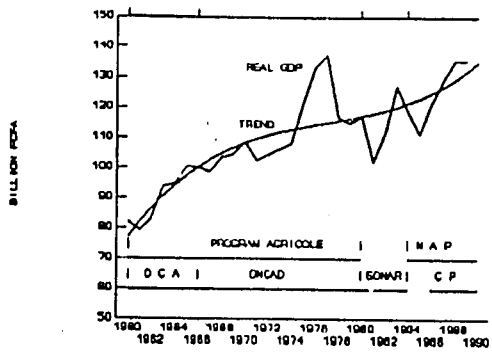
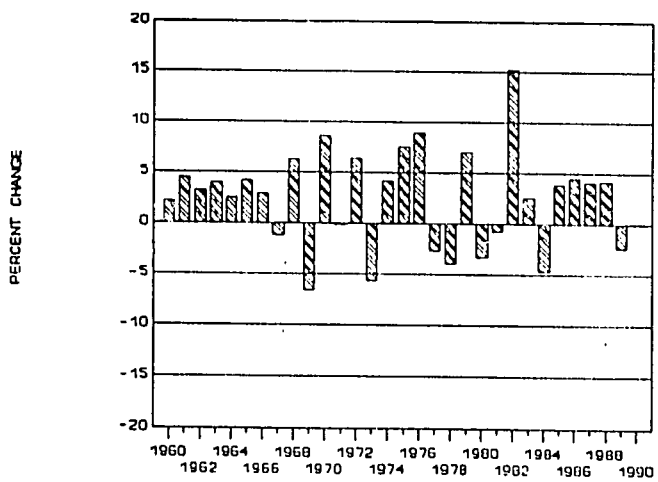


Figure 2-B

Percent Change in Primary Sector GDP
(Constant 1977 CFA)



SECTORAL SHIFTS AND THE IMPORTANCE OF THE PRIMARY SECTOR

Although the primary sector has declined in importance relative to the other sectors (from 26.5 percent of real GDP during 1960-66 to 21.5 percent over 1985-89), it continues to generate much of the variation in economic growth, most of which can be attributed to rainfall variation.

Dakar and the nearby areas dominate economic activity in Senegal, largely because of the concentration of administrative, secondary and tertiary activity. Recent data are not available, but for the 1981-84 period this area accounted for 55 percent of national GDP [MDR, 1986, pg 8]. Although the primary sector only accounts for about 20 percent of total GDP, 44 percent of GDP generated outside the Dakar area is attributed to the primary sector. Given this highly skewed economy, it is not surprising that over one-third (37%) of the permanent markets are located in Dakar, or that Dakar has over 80 percent of the registered merchants [Ministry of Plan, 1989, pg 35].

A part of the development "problem" for Senegal is that, despite the dominance of the major urban center in overall economic activity, the greater portion of its people are employed in its least productive and most volatile sector - agriculture. The rural sector accounts for two-thirds of Senegal's total active population and 60 percent of Senegal's active population lists agriculture/transformation as their profession (Table 3). Even among the urban population agriculture ranks relative high (11% of the total active urban population, the fourth highest ranked profession). While the Census data with respect to women probably has some definitional problems, it still helps to establish a perspective. According to the 1988 Census, 26 percent of the active population was female and 63 percent of the active female population had "agriculture" as a profession.

Table 3

Professions of Senegal's Active Rural and Urban Population (1988)
(Thousands and Percent by Profession)

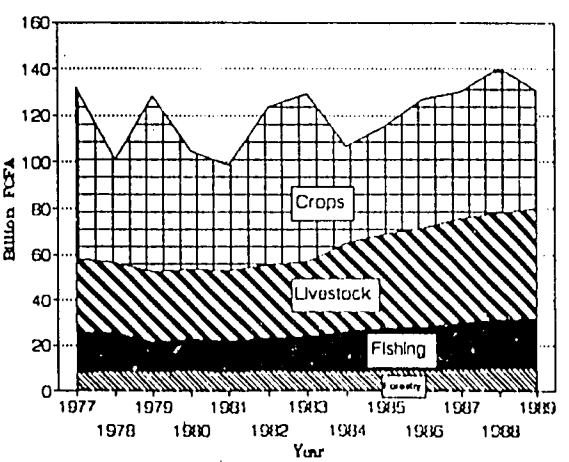
Profession	Number (000)			Percent		
	Total	Rural	Urban	Total	Rural	Urban
Management	16.0	1.3	14.7	0.7	0.1	1.8
Education	23.9	1.9	22.0	1.0	0.1	2.7
Technician	103.4	18.5	84.9	4.4	1.2	10.5
Commerce	119.7	40.2	79.5	5.1	2.6	9.8
Agriculture	1,438.3	1,346.8	91.4	60.7	86.4	11.3
Production	260.9	58.2	202.8	11.0	3.7	25.0
Labor	79.4	24.1	55.3	3.4	1.5	6.8
Sales/Service	326.7	67.0	259.7	13.8	4.3	32.0
Total	2,368.3	1,558.0	810.3	100.0	100.0	100.0

Source: 1988 Population Census, Table 5.06

The larger part of GDP generated in the primary sector comes from crop based agriculture and livestock; the two together accounted for over 75 percent of primary sector GDP in 1989. The shares of the four sub-sectors in the primary sector (agriculture, livestock, fishing and forestry) vary considerable over time, depending on rainfall and crop production.

Figure 3

Real GDP in the Primary Sector, by Sub-Sector
(Billion 1977 FCFA)



However, as shown in Figure 3, there has been a tendency for the livestock sub-sector to gain share while the fishing and forestry sub-sectors remain relatively stable. Also, although there has been a slight positive trend in total primary sector output (in real terms), the total in 1989 was only a little above the total in 1977. This points to the major focus of this analysis, the potential for improving the rate of growth in the primary sector, with the emphasis on crop based agriculture. This does not mean that the other sub-sectors have less potential nor that they are unimportant. The Mission decided from the beginning that livestock and fishing would not constitute a part of this analysis.

Structural Adjustment and the Policy Dialogue

The earlier discussion summarized some of the history of policy and economic adjustment activity in Senegal. Given the relative stagnation of the sector, in terms of real GDP, these interventions can be judged to have been moderately successful. Current GOS policy, as defined by the 1984 "New Agricultural Policy" and more recently by the DPDA and the donor/GOS dialogue in preparation for the Agricultural Sector Adjustment Loan (PASA), is aimed at relieving many of the constraints which have contributed to the present status of the sector.

Structural Adjustment: the Impact

[this will summarize Erickson material]

Investment Priorities:

[more from Erickson material]

Policy Dialogue: PASA

[summary of the GOS/donor discussion]

CHAPTER
POPULATION, LAND AND WATER RESOURCES

Senegal covers 196,722 square kilometers (19,672,200 hectares) with maximum dimensions of 700 km east/west and 500 km north/south. Senegal has 700 km of atlantic coastline, 2/3 of its land mass is below 50 meters and 90 percent is below 100 meters. The highest point (in the south-east of the country) is 500 meters.

The national territory is divided into ten administrative regions, each with three departments - which are in turn divided into arrondissements. The population is further organized into urban commune and rural communities; there are 314 rural communities and 33 urban commune. The 1988 Census of the Population counted 6.9 million people, 39 percent of whom live in urban areas.

LAND CLASSIFICATION: USE AND POTENTIAL

A classification of Senegal's 19.7 million hectares according to use and/or potential use (Table r3) puts almost 81 percent of the land in parks, reserves, classified and unclassified forests, and other, non-agricultural, uses. Only about 19 percent (3.8 million hectares) of the total land mass is classified as arable. About 63 percent of the arable area is cultivated each year. The use or potential use of the arable land is largely for rainfed agriculture (91% of the total) with about 8 percent suitable for irrigation.[1] About 23,000 hectares of the 300,000 hectares classified as suitable for irrigation have been developed (in the Senegal River Valley) and about 62 percent of the total rainfed potential is planted. In fact, counting fallow

[1]Estimates of arable land, especially land potentially irrigable, vary considerably. These data, for the larger part, depend on 1976 FAO estimates. A recent estimate of potential irrigation in the River Valley (GERSAR, 1990) estimates irrigable land in the River Valley at 642,000 hectares. Practically, and in the light of experience in developing irrigation systems in the Valley, 250,000 hectares seems more realistic. The remaining 50,000 hectares are potential developments on the Gambia and Kayanga Rivers and the Cayor Canal - all extremely long-term prospects.

land (1.4 million hectares according to the 1986 Cereals Plan) as active use, 86 percent of the total rainfed potential is being used. Data on the use of recessional land are not collected, but a rough estimate, used by the National Food Needs Committee, is 25,000 hectares.[2]

Table r3

Senegal: Land Classification by Use and Potential

Land Classification	Total Area (Mil. ha.)	Percent Total
Arable	3.8	19.3%
National Parks and reserves	1.3	6.6%
Other forest (limited use)	4.9	24.9%
Forest unclassified	7.0	35.5%
Other	2.7	13.7%
Total	19.7	100.0%
Arable	3.800	100.0%
Suitable for irrigation	0.300	7.9%
Rainfed	3.460	91.1%
Recessional	.040	1.0%
Total Cultivated Area *	3.009	79.3%
Rainfed (cultivated)	2.146	62.0%
(fallow reserve)	.840	24.3%
Irrigated	.023	7.7%

Source: National Cereals Plan, 1986, page 16.
*1985-89 average in major crops. The percentages are percent of potential for this type of land.

Fallow reserve is calculated according to information in the 1986 National Cereals Plan (1.4 million hectares, including marginal lands with 560,000 hectares of "good" fallow. Area planted has declined and fallow has increased.

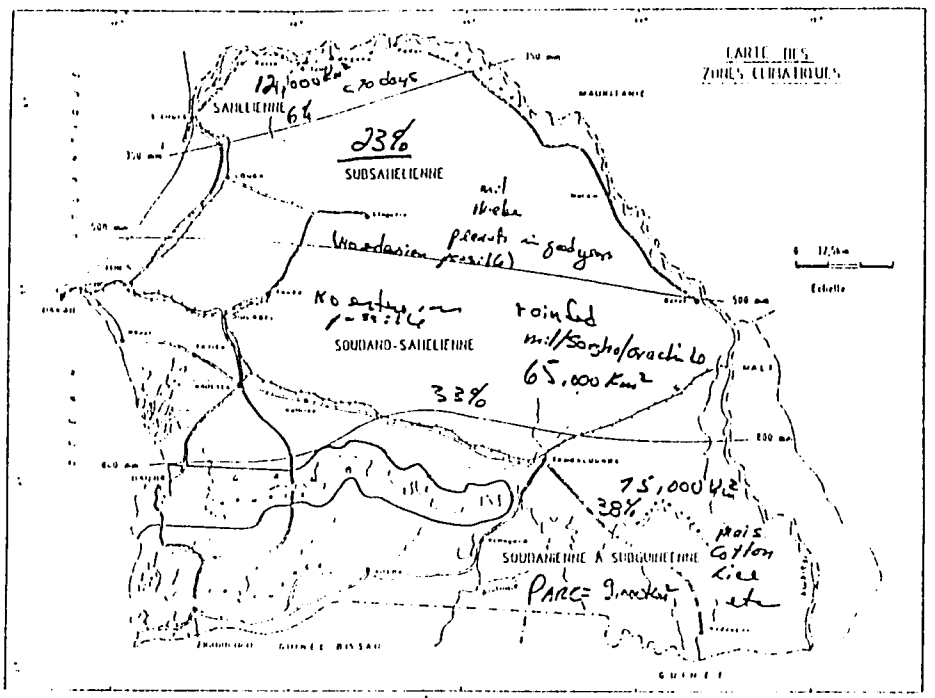
[2]The National Food Needs Committee is composed of GOS and donor representatives who meet to develop Senegal's food needs and food aid requirements.

Discussions of Senegal's land use and land potential usually divide the national territory into either agro-ecological zones or climatic zones. There are six standard agro-ecological zones and four climatic zones. The agro-ecological zones are fairly standard but the climatic zones vary depending on the historical period used to define the rainfall boundaries (isoyets). Maps r1 and r2 show the two types of partitioning and some related information.

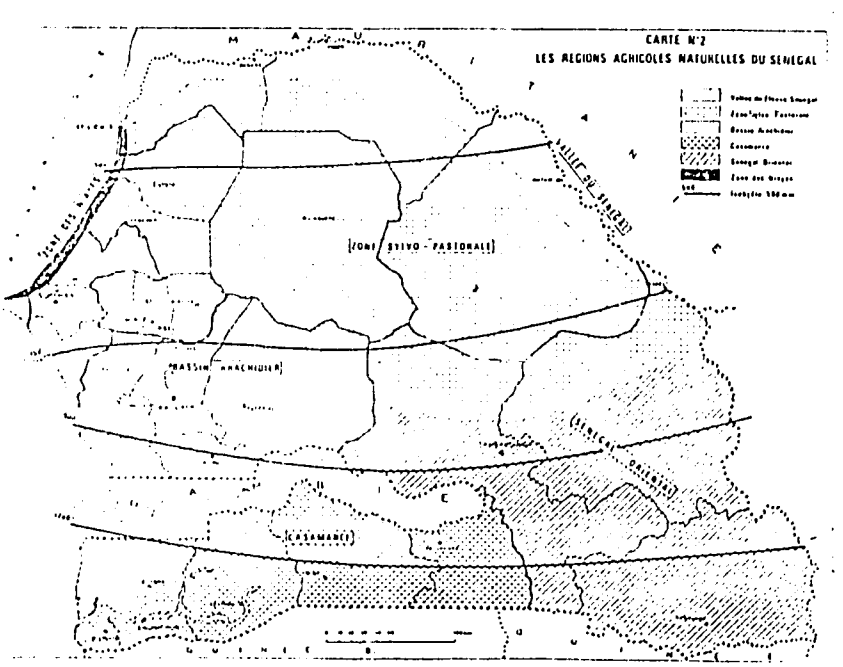
The two maps show one of the problems associated with land and land use classification in Senegal, particularly those related to rainfall zones; most notable is the location of the 500 mm zone on the two maps (just north of Dakar on Map 1 and just south of St. Louis on Map 2). Map 1 is from [MDR, May, 1986, page 6] and is based on 1951-1980 rainfall data. Map 2 is from the Natural Resources Assessment [USAID/Senegal, July, 1990, page 11] with no source or time period indicated. The difference between the two maps is important because rainfed agriculture is considered impractical north of the 400 mm zone. The associated problem in attributing land potential is apparent, especially since most of the data necessary to evaluate population/production issues are reported for administrative zones.

Rainfall, both its level and distribution over the growing period, is a well appreciated constraint and it will be treated in some detail later in the chapter. Map 3 is included here to show the magnitude of the problem and how it has changed over time. Most notable is the southward shift in the 400 mm rainfall zone between 1960 and 1976. In 1976 nearly 2/3 of the country would be considered unsuitable for rainfed agriculture. The variability of this critical rainfall zone has important implications for crop types, crop mixes and the farming system (crop/livestock choices) and related development strategies.

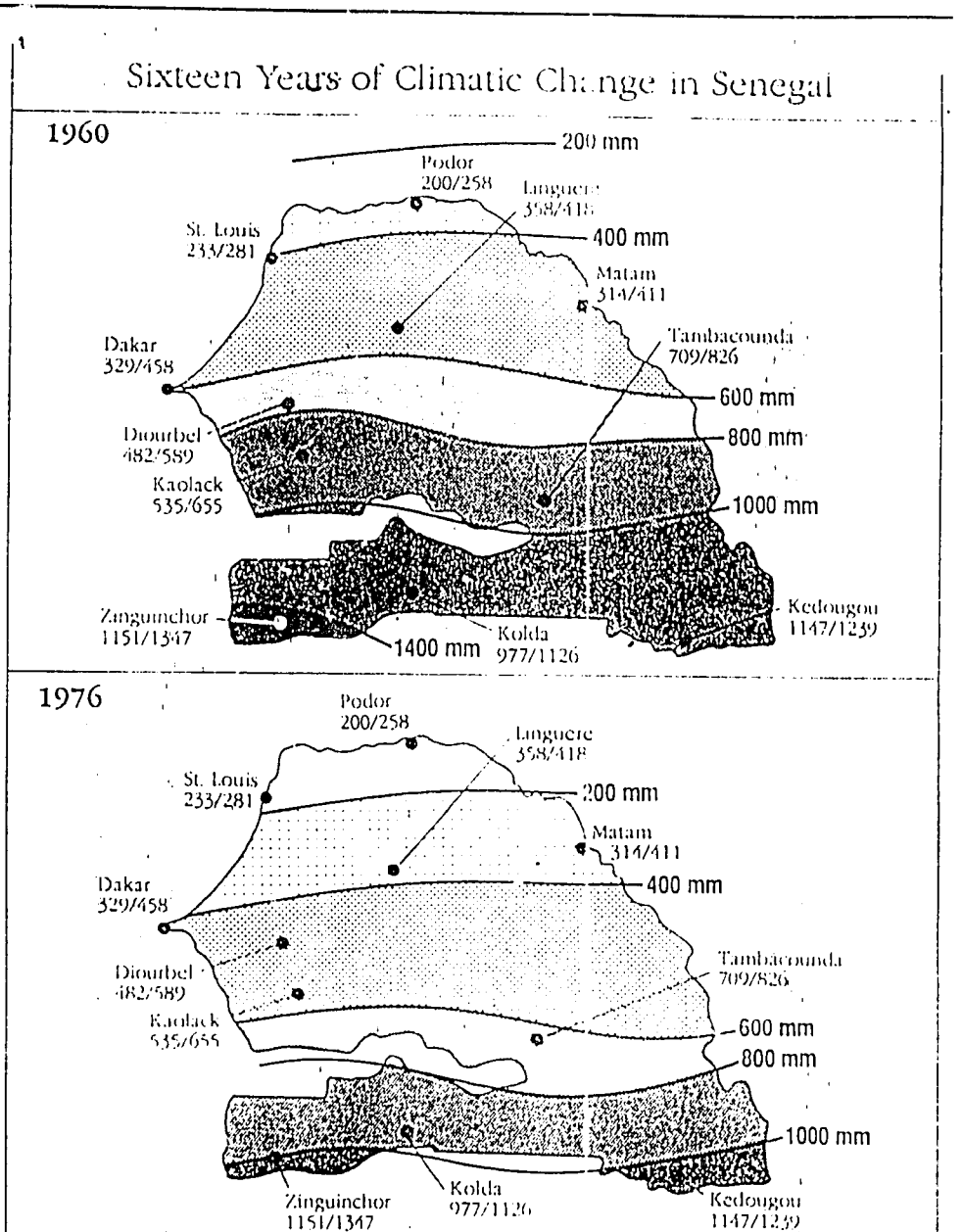
Map 1


CARTE DES
ZONES CLIMATIQUES
SAHELIENNE
SUBSAHELIENNE
SOUDANO-SAHELIENNE
SOUDANIENNE A SUBGUINEENNE
MAURITANIE
MALI
GUINEE BISSAU
GUINEE
Echelle

Map 2


CARTE N°2
LES REGIONS AGRICOLES NATURELLES DU SENEGAL
(ZONE SYLVO - PASTORALE)
(MASSIF ARACHIDIER)
(CASAMANCE)

Map 3



Isohyets of mean annual rainfall in 1960 and 1976 showing southward migration of drought by 113 km. Each city shows the mean amount of rainfall for the last 16 and the last 30 years. The last 16 years show reduced mean rainfall at all stations.

FORESTRY AND FOREST RESERVES

Domestic fuelwood demand constitutes the major use of Senegal's forest resources. While Senegal does export some wood, its overall importance is small (tons/year) and, in total, forestry contributes about 1.5 percent of GDP (7% of total primary sector GDP). However, despite its relatively small "weight" in the macro statistics, forestry, as defined by fuelwood, contributes about 63 percent of Senegal's total energy (the remainder is imported oil). It provides virtually 100 percent of all energy used by rural households and 89 percent of all energy used by urban households, which use over 50 percent of all wood consumed in Senegal. Given the high rate of growth in the urban population, and the urban population's importance as a wood consumer, growth in fuelwood consumption is expected to equal the urban population growth rate of 3.8%/year. [Natural Resources Assessment, page 93]. It is clear that considerable demands are and will continue to be made on Senegal's forestry resources.

Table r2 shows the estimated areas in various types of forest land in 1978 and a projection for the year 2000.[3] An overall reduction of 17.8 percent in available forest land is expected by the year 2000, with the majority of the reduction in the fragile bush dominated lands. Projections of wood use to the year 2016 indicate that Senegal will be deficit in nearly all categories of wood products; deficit to the degree that it will have to import, for fuelwood alone, 2.3 billion m^3 of wood.[4] Forest wood output varies by climatic and forest type, but an average of between one-half and one m^3 per hectare indicates a deficit equivalent to the output from between 2.5

[3]The data on forests and forest land is old but is currently being updated. Indications are that the new data will show a situation which is even more critical.

[4]Senegal Natural Resources Management Assessment, page 92

and 5 million hectares. This helps to explain the importance which the donors attach to the forestry sector and the 27 different forestry projects now operating in Senegal. On the other hand, an indication of the relative priority given to the woodlands is reflected by its relatively small share (8%) in the primary sector portion of the 1990/93 investment budget.[5]

Table r2

Forest Lands, by Type 1978 and 2000
(000 hectares)

Forest Land Type	1978	2000	Percent Change
Forests	226	220	-2.7
Dense Gallery	58	58	0.0
Mangrove	168	162	-3.7
Forest Grasslands	10,906	9,626	-13.3
Forest Dominated	2,850	2,210	-29.0
Grass Dominated	8,056	7,416	-8.6
Bush (Shrub) Forests	2,630	1,835	-43.3
Total	13,762	11,681	-17.8

Source: Natural Resources Assessment, USAID/Senegal, July, 1990, page 89, 90.

The reduction in forest area, since it is primarily from grassland sources, cannot be expected to contribute to the amount of land available for crop based agriculture, nor does it portend any benefit for grazing. For livestock in particular the removal of shrubs and trees also removes the source of fodder during the long dry season. An additional, and significant, burden is also placed on rural families (especially women and children) because of the increasing amount of time needed to search for firewood. It is reported [Jennefer report] that women now spend up to 3 hours/day

[5] See Chapter __ for more information of donor programs and investment priorities.

collecting firewood. Increasing pressure from human and animal populations, especially in the Groundnut Basin, suggests that the problem will only increase.

From a strategic point of view, the "problem" also suggests certain opportunities for the rural community. Increasing demand and diminishing supplies of wood for fuel and other uses argues that agro-forestry should be an important element in a national rural development strategy. While the need to generate wood for home use is critical in much of rural Senegal, and while the potential for income generation is high, appropriately managed agro-forestry can also make a considerable contribution in other ways. The pods from the much appreciated Acacia Albida, for example, are a high protein animal feed (on a par with barley), through nitrogen fixation and its contribution to soil organic matter it helps improve soil productivity and it produces significant quantities of animal fodder and firewood. On the other hand, and it should be emphasized, the loss of forest land, and soil degradation in general, has occurred over long periods of time and corrective measures are also a long-term process. For example, overgrazed grassland can require as much as 30 years to regenerate and Syler [,page] estimates that it will take 10 years before the benefits from a program to integrate Acacia Albida into the farming system will start to appear. Thus, while forestry and agro-forestry are clearly important considerations for long-term development, shorter term strategies are necessary. The remainder of this chapter concentrates on identifying some of the major resource related constraints and potentials which will have to be considered in developing an intermediate-term agricultural sector strategy. The analysis concentrates on the relationships between cropland, population and water.

AGRICULTURAL POTENTIAL

Because it is important to confront land capability with population and production data, this report will use a classification which follows, as closely as possible, administrative boundaries. This will also facilitate subsequent impact monitoring, as required by the DFA legislation. The one exception is the area identified as Dakar/Niayes, which includes parts of the Regions of Thies, Louga, and St. Louis. This region is treated separately because of its importance as a horticultural zone. Table r3 shows the basic data for land types and land use for each of the regions.

Table r3

Senegal: Total Land Area, Land Zoned Non-Agricultural, and Arable Land
(Thousand Hectares)

Region	Total Land Area	Zoned for non-Agric. Uses	Total Other Area	Arable Land *				Rural Population (000's)
				Cropped	Fallow	Available	Total	
Dakar	35	6	41	2	0	6	8	53
St. Louis	4,412	1,769	2,389	40	0	214	254	472
Louga	2,919	1,084	1,335	264	147	89	500	417
Thies	660	98	193	233	90	47	370	618
Diourbel	436	0	86	247	96	7	350	483
Sine Saloum	2,395	341	904	848	300	2	1,150	1079
Casamance	2,835	477	1,608	326	126	297	750	780
Tambacounda	5,960	2,331	3,229	208	80	112	400	322
Total	19,671	6,105	9,786	2,169	840	773	3,782	4,224
Dakar/Niayes	280	179	65	23		13	36	
Irrigable				6		7	13	
Rainfed				17		6	23	

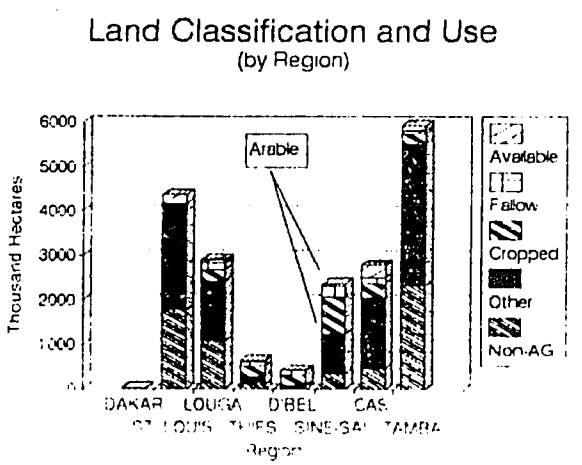
Source: Senegal Agricultural Policy, 1985, page 179 with areas corrected, the 1986 Cereals Plan, pages 16 and 17 and [MDR, 1986, page 60].

* Area cropped is 1985-1989 average in major crops (peanuts, sorghum/millet, maize, cowpeas and cotton) - except Dakar/Niayes area planted is 1984 and includes horticulture.

Figure r1 shows the distribution of land by region and by broad land type. It emphasizes, particularly, the relatively small supply of arable land in each region and the even smaller amount of unused arable land, especially in the main part of the groundnut basin (Thies, Diourbel and Sine-Saloum - Kaolack and Fatick). This fact is of particular importance to the formulation

of a development strategy because 42 percent of the total and 52 percent of the rural population lives in these regions. (Including Louga, this area accounts for 49% of the total and 62% of the rural population.) Another factor, not show so clearly in the Figure, is that the majority of the land available for expansion is in the River Valley, Casamance and Tambacounda Regions. This and some of the implications is discussed in greater detail below.

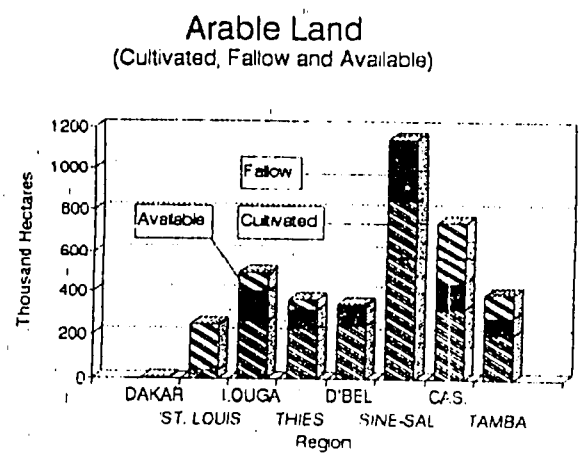
Figure r1



One of the central issues which must be addressed in a national rural development strategy is demonstrated in Figure r2, which shows arable land by region and by its present use (cropped, fallow reserve and available). As mentioned above, the Groundnut Basin (Louga, Thies, Diourbel, Fatick and

Kaolack) has virtually no land available for expansion and a large and growing rural population. Any expansion would mean use of the fallow reserve, which under any circumstances should not (and in the intermediate-term probably cannot) be brought into production.[6]

Figure r2



Of the four regions which do have some land available, Louga should be discounted because of rainfall shortages and sub-soil water salanization problems, and the land available in the St. Louis Region is irrigation potential - highly expensive to develop and unlikely to be realized in the near future. In the absence of a serious program to improve productivity on existing land and without a serious resettlement program to the Casamance and Tambacounda, growth in the rural sector is questionable. In order to establish some parameters within which to measure the severity of the existing "problem", to outline the impacts of contributing factors, and to point to the resource/population factors which may contribute to articulation of an

[6]The Senegal Natural Resources Management Assessment [USAID/Senegal, July, 1990, page 78] lists soil management problems in the Groundnut Basin (acidification - upland soils, salinization - Sine-Saloum, soil degradation - general) which suggest that most of the fallow is marginal land. Syler [1990] has also observed that farmers are placing more land into fallow in an attempt to recapture lost fertility.

agricultural development strategy for Senegal, the remainder of this chapter will develop a more detailed analysis of the resource/population issues. This discussion is intended to establish the "outer" boundaries of the "problem". The other chapters of the report will deal with specific alternatives and options.

POPULATION DISTRIBUTION AND LAND USE

Like many developing nations, Senegal has had high population growth accompanied by increasing urbanization. In 1976 about 34 percent of the national population lived in urban areas and by 1988 (the last population census) 39 percent of the population lived in urban centers. The urban population is concentrated in a few major cities. About 22 percent of the Senegal's people live in Dakar which had a population density of 2,728 people/km2 in 1988. In 1988 the Dakar area (Dakar proper, Pikine, Rufisque) accounted for 54 percent of the total urban population and almost 22 percent of the national total.

Considered together, Thies and Dakar account for 66 percent of all urban and 35 percent of the total population. Outside the Dakar and Thies Regions (which also dominate the trade and industrial sectors) the population is unevenly distributed, varying between 142 persons/km2 in Diourbel (9% of the population and 2.2% of land area) and 6 persons/km2 in Tambacounda (30% of the land area and 5.6% of the population). Overall, including Dakar, Senegal has 35 persons per Km2 (Figure r3 and Table r4).

Figure r3

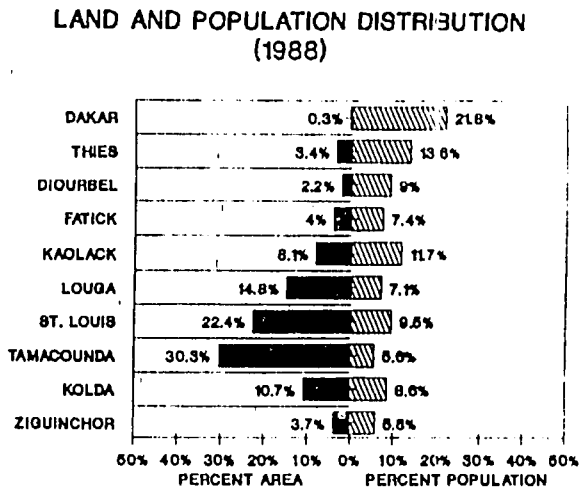


Table r4

SENEGAL: POPULATION AND SURFACE AREA DISTRIBUTION - 1988

REGION	PERCENT OF AREA		% POPULATION BY REGION			% POPULATION IN REGION			DENSITY/Km2	
	TOTAL	ARABLE	RURAL	URBAN	TOTAL	RURAL	URBAN	TOTAL	TOTAL	ARABLE
DAKAR	0.3	0.2	1.1	53.5	18.8	3.5	96.5	100.0	2,728	18,756
THIES	3.4	9.8	14.5	11.6	13.5	65.9	34.1	100.0	142	253
DIOURBEL	2.2	9.3	10.1	5.2	8.5	78.3	21.7	100.0	141	176
SINE-SALOUM	12.2	30.4	25.6	9.5	20.1	82.2	17.8	100.0	55	114
FATICK	4.0		11.3	2.2	8.2	89.6	10.4	100.0	64	
KAOLACK	8.1		14.3	7.3	12.0	77.6	22.4	100.0	50	
LOUGA	14.8	13.2	11.1	3.1	8.4	85.2	14.8	100.0	17	98
ST. LOUIS	22.4	6.7	11.8	7.4	10.3	72.5	27.5	100.0	15	256
TAMBACOUNDA	30.3	10.6	7.5	2.4	5.7	84.1	15.9	100.0	6	96
CASAMANCE	14.4	19.8	18.4	7.3	14.6	78.6	21.4	100.0	35	132
KOLDA	10.7		12.2	2.2	8.8	89.6	10.4	100.0	28	
ZIGUINCHOR	3.7		6.2	5.1	5.8	62.2	37.8	100.0	54	
SENEGAL	100	100	100	100	100	61.4	38.6	100.0	35	182

SOURCE: ENDERS (1976 AND 1988 CENSUS) 100*[(P1/P0)^(1/12)-1]

A better perspective on land/population pressure is provided by the population density relative to arable land (last column, Table r4). To be

meaningful both of these measures need to be related to a standard to determine whether or not they indicate a development constraint or potential. That is, a density of 182 persons per square kilometer of arable land (or inversely 0.55 ha/person) becomes meaningful only when combined with actual and potential production. To establish a broad perspective: since Senegal imports about 60% of its cereal grain needs, its apparent demands on the land are more than double its present productive ability.[7] It is clear, given population growth and increasing urbanization, that any development strategy must address these issues.

Senegal's population increased at 2.7 percent per year between 1976 and 1988 (rural growth was 2.07% and urban growth was 3.83%). At this rate of growth Senegal's population will total 9.6 million by the year 2000 with nearly 44 percent of the population living in urban areas (25% in Dakar). The pressure which this has, and will continue to exert, on Senegal's land and water resources is enormous. For example, Senegalese farmers use over 63 percent of the nation's total arable land each year. Compared with FAO norms, which specify a 5:1 fallow/cultivation cycle for 'traditional' agriculture (about 17% of cultivable land per year), the Senegalese numbers amount to an extremely intense cultivation schedule. To provide a perspective, at current technology, land under cultivation would have to increase 30 percent in the next ten years to provide food and income to Senegal's population. Since Senegal presently cultivates 63 percent of its arable land, farmers would have to bring all possible land into use, just to maintain the status quo.

[7]This is a highly gross, and extremely limited, measure of carrying capacity. This measure, and many existing measures of carrying capacity are focused on food self-sufficiency as opposed to food security because they concentrate on food crops only. In the later part of this report, when alternative strategies are proposed and analyzed, a much broader view of carrying capacity will be employed.

In view of the increasing population pressure one would expect a continuous expansion in cropped area. However, much of this expected expansion has not occurred because the land/water population distribution pattern in Senegal limits the country's ability to meet near and intermediate-term food and cash crop needs by simply expanding area planted. If anything, one of Senegal's major constraints is that the major portion of its rural population is separated from the available exploitable land and water resources. This helps to explain why, in aggregate, the area planted to major crops has remained relatively stable over the past 30 years, and why, especially for the last 20 years, there has been a general shift from cash crop (groundnuts) to food crop production (Table r5).

Table r5

Area Planted to Major Crops (000 ha)
(Ten Year Averages 1970, 1980, 1990)

Crop	Average Over Crop Years			Change 1970-1980	
	1960-69	1970-79	1980-89	Hectares	Percent
Cash Crops	1,073.2	1,154.6	966.5	-188.0	-16.3
Groundnut	1,070.1	1,122.0	932.6	-189.4	-16.9
Cotton	3.1	32.6	34.0	1.4	4.3
Food Crops	1,165.9	1,191.6	1,295.2	103.6	8.7
Millet/Sgm	977.1	999.9	1,063.6	63.7	6.4
Rice	82.4	79.2	70.8	-8.4	-10.6
Maize	44.6	49.6	89.4	39.8	80.2
Cowpeas	61.9	62.9	71.5	8.6	13.7
Total	2,239.1	2,346.2	2,261.8	-84.4	-3.6

Source: Derived from data in Annex _.

The average area planted over the ten years between 1980 and 1989 was 3.6 percent below the 1970-79 average, with cash crop areas down 16.3 percent

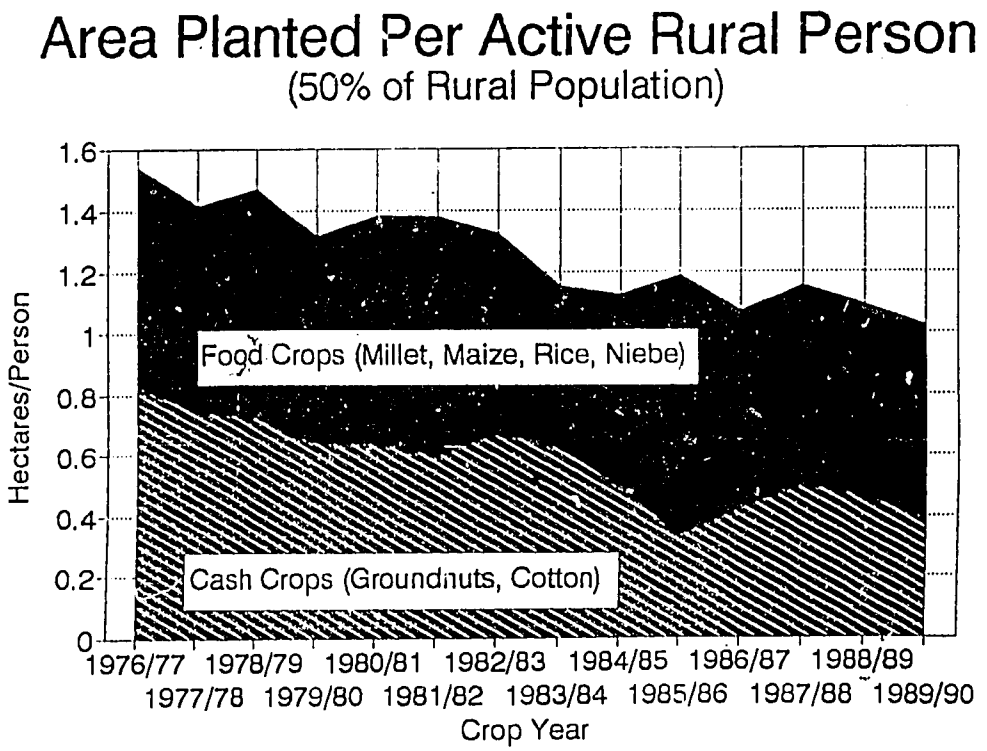
and food crop areas up by 8.7 percent (an average increase of about 0.8% per year). Since the rural population has been increasing at about 2.1 percent per year, the consequences are clear - the food crop area planted per rural person will have decreased by about 1.2 percent per year, with, in the absence of increases in productivity, an attendant decline in income generation and food production. Although there are a number of interrelated factors which have contributed to the shift in the commodity mix (notably relative prices, credit, access to certain inputs such as peanut seed, and policy in general) one of the major factors behind this change must be the relative distribution of the rural population and the land/water balance.[8]

Figure r3 demonstrated that there is a wide dispersion in population density, and showed, in broad terms, the population/land relationship. A more specific relationship between the land and the rural population was presented in Figure r2, which showed that the majority of the rural population had little space for expansion. Figure r4 shows the land use consequences - generally diminishing areas planted per person, as more and more people attempt to farm a relatively fixed quantity of land. Thus, while on an aggregate basis (as was shown in Table r5) there has been a substitution from land in cash producing crops to food crops, on a per capita basis (i.e. per active agricultural person) there has been a decline in areas planted to both types of crops. And, this is true of all of the regions under discussion, except Tambacounda. As the figure shows, since 1976 the area in food crops has diminished from about 0.8 ha/active to 0.6 ha/active and the area in cash crops has declined by 50%. The only circumstances under which such a situation can be considered desirable is if there have been compensating increases in productivity for food crops and price increases for cash crops.

[8]The other factors will be discussed in a later section of the report.

In the aggregate, neither is true.

Figure r4

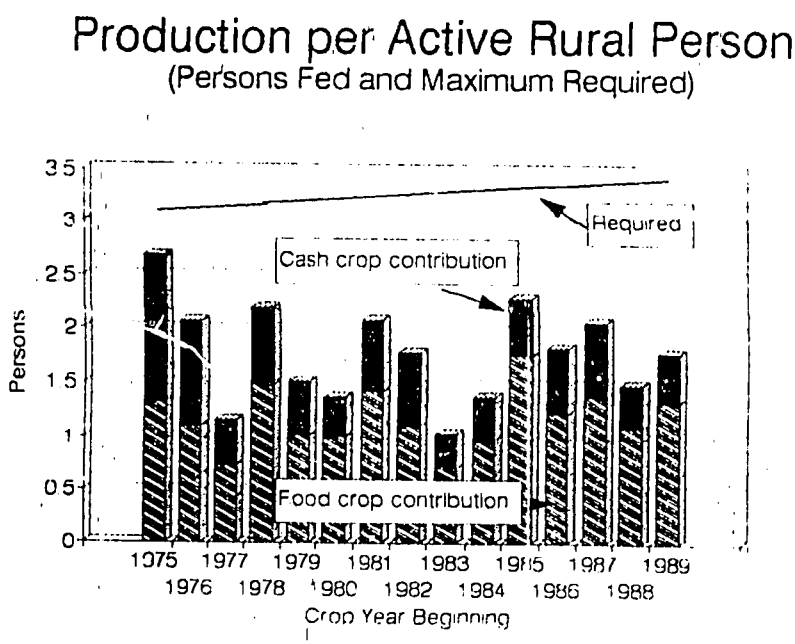


A measure of the carrying capacity of the existing system, one which accounts at least approximately for the cash crop contribution, is shown in Figure r5. The data shown in the figure combine population growth and distribution (urban/rural), the shift between cash and food crop production, and relative cash crop/food crop prices to show the number of people fed per active rural worker (the height of the bars).[9] The solid line in the graph

[9]See Annex __ for details of how the data for Figure r5 were generated.

indicates the number of persons each active worker would have to feed to achieve full food security for the nation. The subdivisions of each bar show the individual contributions of food and cash crops. The horizontal line at two persons per active worker indicates complete provisioning of the rural population.

Figure r5



The figure shows a number of trends: diminishing ability to produce enough cash and food crops to feed the population (all of the bars are below the "required" line); a widening of the gap between number of persons who can be fed and the number who must be fed (because of population growth and declining areas, output for the last four years has been below or just at the level required to feed just the rural population); and there has been extreme variation in output of both food and cash crops, with considerably more variation in food crop output than in cash crop output.

It must be emphasized that the graph presents an extreme view of the demands placed on crop based agriculture because it shows crop output relative to total nutritional (calory) requirements. Even so, it indicates an increasing need either to improve crop production and productivity for the traditional crops, as well as for that part of agriculture outside the major food and cash crops. It is clearly not reasonable that crop based agriculture should be expected to generate enough output to support the entire nation. But, the accelerating "gap" raises questions about the ability of the remainder of the economy to meet Senegal's food (and revenue) needs. Knowledgeable observers say no, that growth in general is dependent on solid growth in agriculture and especially crop based agriculture.[10]

WATER RESOURCES AND DEVELOPMENT POTENTIAL

In the Sahel, questions of land capacity, capacity limits and exploitation of available capacity lead inevitable to water. Some areas in Senegal, especially those areas north of Dakar and largely those areas north of Gambia, face a highly variable climate which places serious restrictions on the kinds of crops which can be grown. There are three sources of water: the Senegal River, sub-surface and surface. According to the Ministry of Rural Development and Hydrology these waters are distributed as follows [MDRH, 1986, page 4]:

75% Senegal River Valley,

10% sub-surface, and

15% surface.

RIVER SYSTEMS

There are six primary surface water systems in Senegal, each with its own potentials and problems.

[10] Lele and Rensen.....

1. Senegal River and Faleme Rivers. Jointly, with control by the Mantali Dam, these two rivers produce a potential annual exploitable volume of 400 billion m^3 per year, sufficient to irrigate about 3-400,000 hectares. The development of this potential has proven expensive, because of high development, maintenance, and operations costs. To date only about 23,000 hectares of the total potential has been developed.

2. Gambia River. Limited agricultural potential.

3. Casamance River. Extends for 300 kilometers. Because it has a low gradient, salanization caused by salt water intrusion during low-flow periods is a problem. This is being addressed by the USAID Southern Zone Water Management Project.

4. Anambe River. 1000 hectares of irrigated land is under development.

5. Lac de Guiers. A natural lake, connected to the Senegal River. About 300 million m^3/year and the main source of water for Dakar.

SUB-SURFACE WATER

Senegal possesses a number of potentially exploitable aquifers (See the Natural Resources Assessment [USAID/Senegal, 1990, pages 21-31]). Explicit information on the exploitable, agricultural, potential of many of these aquifers is not available. The MDR has estimated that these water sources can provide a renewable supply of 176 million m3/year. Senegal has established priority uses for this water as 1) human, 2) animal, and 3) irrigation.

Some of this potential is being exploited, particularly in the Niayes for irrigation, and for water in the Dakar and Louga areas. There are already some problems with lowering water tables and saltwater intrusion in the Niayes area, which raises some question about the further expansion in this area.

The exploitation of the deeper aquifers (some 60 meters or more) raises cost and management questions. The first concern is, and ought to be, better water supplies for the rural population. Thus, consideration of sub-surface water for agriculture is to be discounted.

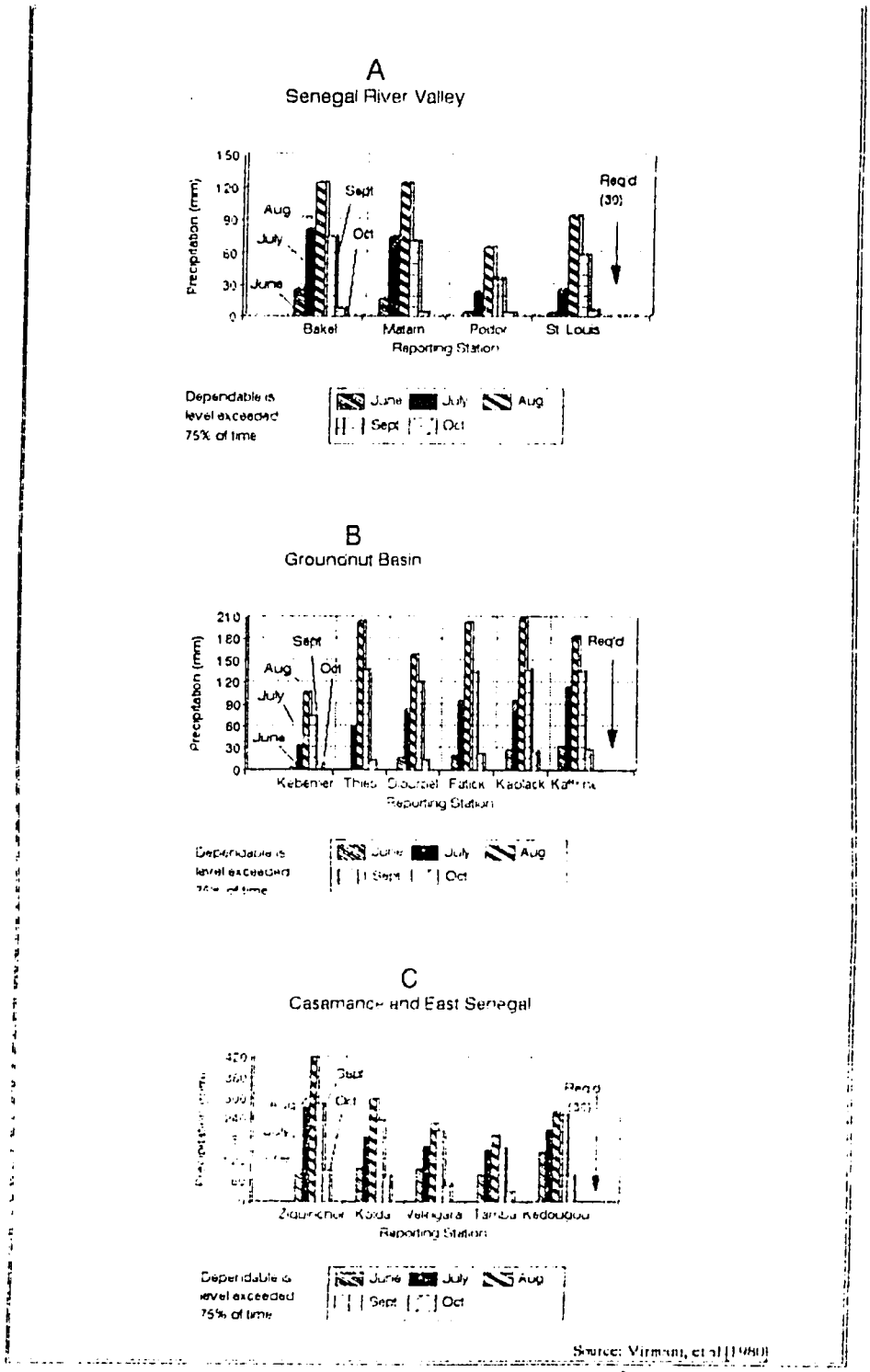
RAINFALL

Rainfall and its distribution during the growing season remains the primary determining factor in Senegalese agriculture. It established the limits to cultivation as well as defining the potentials. Earlier in this chapter figure r2 (page 11) demonstrated that there are essentially three land potential zones: the Senegal River Valley with considerable potential for irrigation; the groundnut basin with very little potential for expansion; and South and Eastern Senegal, with considerable potential for expanded rainfed agriculture. Rainfall and its distribution further emphasizes these constraints and potentials.

Figure r6 shows the level of dependable rainfall at reporting stations in each of the major regions. Dependable rainfall is defined as the level exceeded at least 75% of the time over successive 10 day periods; a minimum of 30 mm of dependable rainfall is considered necessary for rainfed crops. The data establish the outer limits on what crops and crop systems can be applied during the growing season. Part A show data for the River Valley, part B for the groundnut basin, and part C for the Casamance and Tambacounda. Three facts from the figure: 90 day crops are required in the Groundnut Basin; in Louga (Kebemer in the graph) 60 day crops are required; and in the south, 120-150 day crops are possible.

Figure r6

Dependable Precipitation, River Valley, Groundnut Basin, Casamance and East Senegal



Source: Virmani, et al (1980)

CONCLUSION - RESOURCES

The information presented in this chapter suggests certain elements which have to be considered when developing a sector strategy. They do not suggest what the strategy should be, nor do they point to particular regions or crops, per se. This chapter has shown that there has been a general decline in productivity in both food and cash crops and that increasing demands have and will continue to be made on limited natural resources.

The portion of the country with the majority of the rural population has little room for expansion and highly variable rainfall and, thus, highly variable production. A strategy aimed at this region (the Groundnut Basin) would have to concentrate on farm level natural resource management to stabilize, then improve production.

That portion of the country with the greatest potential for expanded rainfed agriculture is the least populated. This suggests a wide range of alternatives, but suggests, as well some marketing/transportation constraints.

The next chapter deals with these questions as related to productivity, production and crop mix potentials and regional comparative advantage. The chapter will investigate, in particular, existing and potential farming systems (technology) and alternative crops on a more detailed geographic basis so that both physical and institutional constraints and opportunities can be identified.

CHAPTER __

FARM TECHNOLOGY
TECHNOLOGY CHOICES, CROP PRODUCTION
AND
PRODUCTION POTENTIAL

CHAPTER _

FARM TECHNOLOGY: TECHNOLOGY CHOICES, CROP PRODUCTION AND PRODUCTION POTENTIAL

Chapter __ outlined some basic environmental factors which act to limit (or expand) crop production potentials in Senegal. This chapter extends that discussion to include human intervention to investigate the degree to which restrictions have been, or may be, overcome and/or potentials exploited. It is clear at the outset that land quality and water supply are the two dominant physical factors in Senegalese agriculture and that these two factors severely restrict crop alternatives for much of the rural population. It is the blend of the physical and human factors which determines the degree to which the physical factors will be limiting, given the crop alternatives available. There are two principal issues: the availability of appropriate technology and its eventual implementation.[1] The remainder of this chapter will deal with these issues as follows: first, a brief discussion of the locations and the importance of various crops in national production; second, a discussion of available technology and incentives for or against adoption; third, a discussion of the implications for national production and food and export balances; and fourth, a brief discussion of comparative advantage for existing

[1]Much of the discussion in this chapter is from the data in Annex TA1., most of which is based the crop budgets in [Martin, 1988], with revisions to reflect changes in prices and practices. Martin developed crop budgets for major crops in each of 12 regions. The budgets reflect a combination of station and on farm research and the judgment of researchers and experienced field staff. The detailed budgets are included in the Annex so they will be available for evaluation and revision as better information is available; they are about the only source of internally consistent, nationwide, budgets for Senegal. The specific technologies are generally defined as high, medium, and low, with additional information for late planting and fields located near the farm residence. In each case, the yield information represents an "average" year. The late planting and "home fields" reflect the lowest available technology, with the exception that the small "home fields" receive substantial amounts of organic fertilizer. A comparison of the costs and output from these fields with the others is useful because they represent the potentially most productive land and an indication of what might be attained from better soil management. There is a considerable regional difference in what constitutes high and medium technology. For example, most technologies in the Senegal River delta represent highly mechanized (tractor) land preparation, whereas high technology in the other areas, especially in the Groundnut Basin and the cotton producing regions, may be mechanized, but is usually animal traction. In general, the medium technology is the same as the high technology but with reduced purchased inputs (fertilizer). The low technology and "home field" information is most often based on manual operations. The reader should be careful when comparing technologies across regions.

crops and the potential for introducing new and/or alternative crops.

Crop Production: Location and Importance

In terms of area planted and gross production, millet/sogrhum and groundnuts are the most important crops produced in Senegal; over the last five years these crops accounted for 85% of total area planted (Table T1 and Figure TF1).

Table T1

Senegal; Area planted, Production and Yields - Major Crops
(Five Year Average, 1985-1989)

Crop	Saint-Louis	Louga	Thies	Diourbel	Sine-Saloum			Casamance			Tamba-counda	Total Senegal
					Fatick	Kaolack	Total	Zig'chor	Kolda	Total		
Area (1000 ha)												
Millet/Sgm	21.1	153.3	131.3	146.2	149.1	301.5	450.6	12.9	86.0	98.9	100.3	1,102
Maize	2.9	--	--	--	3.7	26.4	30.0	4.1	36.1	40.2	28.4	102
Paddy	15.5	--	--	--	0.3	0.2	0.5	24.9	29.6	56.5	3.8	76
Cowpea	4.4	38.8	19.1	19.6	4.3	0.9	5.2	1.2	0.4	1.6	1.4	90
Manioc	--	--	11.8	0.4	1.3	0.2	1.6	0.8	1.0	1.[illegible]	0.0	16
Oil Nuts	1.5	71.9	82.3	81.3	95.7	263.2	358.9	25.5	85.9	111.4	65.2	772
Table Nuts	--	--	--	--	1.8	13.0	14.9	--	2.4	2.4	0.8	16
Cotton	--	--	--	--	0.5	2.6	3.0	--	17.8	17.8	10.3	31
Total	45.5	264.0	244.5	247.4	256.	608.0	864.6	69.4	259.3	330.6	210.2	2,205
Production (1000 mt)												
Millet/Sgm	11.7	62.5	74.5	88.1	97.2	239.6	336.8	9.9	79.1	89.0	85.4	748.0
Maize	6.3	--	0.1	--	4.8	37.5	42.4	4.1	45.7	48.9	30.9	128.4
Paddy	71.7	--	--	--	0.8	0.2	1.0	32.6	34.7	67.2	7.6	147.6
Cowpea	1.0	18.5	8.0	9.7	2.0	0.4	2.4	0.7	0.2	0.9	0.6	41.0
Manioc	--	--	37.1	0.0	4.1	1.2	5.3	4.5	6.9	11.4	0.4	54.2
Oil Nuts	0.8	60.6	60.4	63.6	98.9	288.0	386.8	28.5	106.8	135.3	71.0	778.5
Table Nuts	--	--	--	--	2.3	14.9	17.2	--	2.6	2.6	0.8	18.2
Cotton	--	--	--	--	0.4	2.4	2.8	--	20.7	20.7	10.8	34.4
Yield (kg/ha)												
Millet/Sgm	555	408	567	603	652	795	747	769	920	900	851	679
Maize	2,158	--	--	--	1,312	1,424	1,410	1,000	1,265	1,217	1,085	1,284
Paddy	4,622	--	--	--	2,517	1,046	2,021	1,306	1,170	1,19[illegible]	2,010	1,935
Cowpea	226	478	417	493	461	456	460	571	447	541	449	456
Manioc	--	--	3,140	0	3,081	5,431	3,414	5,484	6,911	6,266	--	3,489
Oil Nuts	551	842	734	783	1,033	1,094	1,078	1,118	1,243	1,214	1,090	1,008
Table Nuts	--	--	--	--	1,267	1,144	1,159	--	1,100	1,100	1,000	1,153
Cotton	--	--	--	--	922	944	941	--	1,162	1,162	1,047	1,102

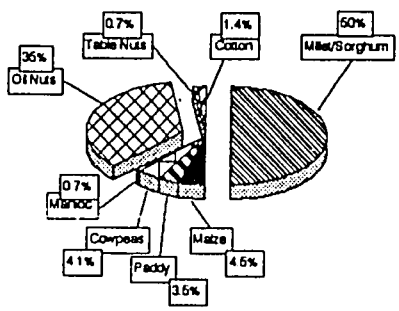
Source: Dervied from data in Annex

Millet is by far the most important in terms of area planted (50%), followed by groundnuts for oil (35%). Among the food crops, after millet, maize accounts for 4.5% of planted area, followed by cowpeas (4.1%) and paddy (3.5%). Cotton accounts for 1.4% of area planted and manioc and confectionery groundnuts each account for 0.7% of area.

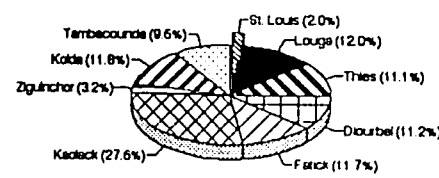
Figure TF1

Area Planted to Major Crops (Percent of 1985/89 average)

Percent by Crop



Percent by Region



Source: Derived from Table T1.

Regionally, Kaolack accounts for the largest portion of area planted (almost 28%), Fatick, Diourbel, Thies, Louga and Kolda each account for between 11 and 12 percent, farmers in Tambacounda plant 9.5% of the national total and the St. Louis region accounts for the smallest portion (2%).

The previous chapter pointed out that the regions which now account for 75 percent of the cultivated area (the Groundnut Basin) have little potential for expansion. In addition, because of rainfall patterns, crop choices in these regions are restricted to short season, drought tolerant varieties. It is apparent that growth in crop based agriculture in these regions is dependent on relieving the basic soil and water constraints. It is also apparent that, in absolute terms and at present consumption patterns, increased productivity in millet (ie, improved input/output ratios through

different technologies and farming systems) would make a relatively larger contribution than it would for such crops as maize. What remains at question is wether or cost effective technologies exist and will be employed. A related, basic, development issue is the social benefits and cost related to a shift in basic production/consumption patterns. For example, the following analysis will show that at current prices and costs there is little incentive for Groundnut Basin farmers to move to higher technologies but that there is considerable potential in the south. The relative benefit from a location-of-production facilitating shift in consumption from millet to maize could be considerable. For example, on the basis of relative yields and caloric values, one hectare of maize could replace about two hectares of millet. The replacement rate could actually be as high as 3 to 1, if relative calory production per day of labor and selected technology is applied. The following sections consider this question in more detail.

Available Technology and Its Use

The availability and the eventual use of a technology depends on environmental, economic, institutional, and political elements. In Senegal all of these factors combine to generate a system which generally uses low to intermediate technology. The data in Tables T2 and T3 demonstrate (broadly) where, and for which of six major crops, various levels of technology are employed. The information can be summarized as follows:

Crop Type	Technology
Rainfed crops (average)	low to medium
Irrigated crops	medium to high
Cash crops	medium to high
Non-irrigated crops	
North Senegal	low
Central Senegal	low to medium
South Senegal	medium to high

Table T2.

Cowpeas, Groundnuts and Cotton, Yields Under Low, Medium and High Technologies

Region	Millet/Sorghum Yield (kg/ha)					Maize Yield (kg/ha)					Paddy Yield (kg/ha)				
	Technology				5 Year	Technology				5 Year	Technology				5 Year
	Low	Medium	High	Note	Average	Low	Medium	High	Note	Average	Low	Medium	High	Note	Average
Dakar	--	--	--			--	--	--			--	--	--		
St. Louis *	400	550	700	rainfed	555	--	1700	--	irrigated	1628	--	5000	5500	irrigated	4622
Louga	250	400	450	rainfed	408	--	--	--			--	--	--		
Thies	400	550	700	rainfed	567	--	--	--			--	--	--		
Diourbel	400	550	700	rainfed	603	--	--	--			--	--	--		
Fatick	500	700	900	rainfed	652	--	--	--		1312	--	--	--		2517
Kaolack	500	700	1100	rainfed	795	1400	1700	2000	rainfed	1424	--	--	--		1046
Ziguinchor	600	800	1200	rainfed	769	--	1200	1500	rainfed	1000	1200	--	2500	transplant	1306
											1000	1500	2000	upland	(all)
Kolda	600	800	1200	rainfed	920	--	1200	1500	rainfed	1265	1000	1500	2000	swamp	1170
											--	1200	1500	upland	(all)
Tambacounda	600	800	1200	rainfed	851	--	1600	2200	rainfed	1035	--	--	--		2010

Table T3.

Cowpeas, Groundnuts and Cotton, Yields Under Low, Medium and High Technologies

Region	Cowpea Yield (kg/ha)					Groundnut Yield (kg/ha)					Cotton Yield (kg/ha)				
	Technology				5 Year	Technology				5 Year	Technology				5 Year
	Low	Medium	High	Note	Average	Low	Medium	High	Note	Average	Low	Medium	High	Note	Average
Dakar	--	--	--			--	--	--			--	--	--		
St. Louis	--	--	--		226	--	--	--		551	--	--	--		
Louga	--	400	500		478	--	--	--		842	--	--	--		
Thies	--	500	700		417	800	850	950	rainfed	734	--	--	--		
Diourbel	--	500	700		493	800	850	950	rainfed	783	--	--	--		
Fatick	--	--	--		461	900	1000	1100	rainfed	1035	--	--	--		922
Kaolack	--	--	--		456	900	1000	1100	rainfed	1094	--	--	--		944
Ziguinchor	--	--	--		571	800	1000	1200	rainfed	1118	--	--	--		
Kolda	--	--	--		447	900	1000	1200	rainfed	1243	700	1300	1500	rainfed	1162
Tambacounda	--	500	700	Bakel	449	900	1000	1100	rainfed	1090	550	1000	1200	rainfed	1047

Source: Table . and Table ; Technologies, [Martin, 1988], average yields, MDRH/DS various reports. (tech1)

Although it may be somewhat over-simplified, a generalization of technology use can be made: low technology in areas with low rainfall and poorer soils; medium and high technology in areas with higher rainfall and relatively better soil. Overall, however, the level of technology employed by Senegalese farmers can be classed as low to medium. It should be noted, however, that in most cases (especially the Groundnut Basin) this includes the use of animal traction.

Beginning in the mid-1960's the Government of Senegal made a concerted effort to introduce "modern" technology, particularly in the Groundnut Basin, and more recently in the River Valley and in the cotton producing areas of Tambacounda and eastern Kolda. The primary intervention was subsidies and/or minimum cost (to the farmer) distribution of inputs (via cooperatives) and guaranteed prices implimented by a series of regional development agencies. The "Programme Agricole", the primary vehicle for this intervention, was initiated in 1966 and was finally abandoned in 1980. In 1984 the "Programme Agricole" was replaced by the "New Agricultural Policy", as further defined by the "National Cereals Policy" of 1986. The history of the "Programme Agricole" and the various development agencies has been well covered in previous analyses and will not be repeated. However, it has left a legacy which is relevant to the present analysis. Several points are worth mentioning:

1) Enormous amounts of highly subsidized fertilizer, groundnut seed and equipment were distributed on credit. In the mid-1970's the fertilizer subsidy rate was often as high as 70% and always in the 50-60% range. In the late 1970's about 100,000 tons of fertilizer were distributed annually.

2) By 1980 (the end of the PA) there were 45 thousand pairs of oxen, 222 thousand horses and 207 thousand donkeys. The Sine-Saloum (Kaolack and Fatick) had, by far the largest numbers.

3) Credit repayment rates were low and in especially bad years debits were forgiven (four times).

4) Large numbers of farmers had access to or experience with fertilizer, improved groundnut seeds, and animal traction "packages".

The Programme Agricole was abandoned in 1980, largely because it had generated enormous deficits. The New Agricultural Policy was initiated in 1984 and made fully operational following the development of the National Cereals Plan in 1986. The new policy centered on state disengagement and privatization. It in particular eliminated floor pricing for cereals (except rice) and led to the elimination of fertilizer and pesticide subsidies at the end of the 1988 season (with the exception of cotton), and farmers have been made responsible for storing their own groundnut seed. The NAP also included a reorganization of the cooperatives and the agricultural credit system (see Chapter on institutions for further discussion of both). What is important about these measures is that the input delivery and a large part of the pricing systems have changed radically. Farmers are now required to make input decisions on a full cost/productivity basis. The restructuring and "privatization" of CNCAS has led to more careful control of credit. As a result, entire regions where repayment rates are a problem are denied credit. Private input distributors are seldom, if ever, willing to extend credit to farmers, further restricting access to inputs, even for those crops and areas where higher input levels are justified. The implications are, thus, that farmers will demand lower quantities of "modern" inputs such as fertilizer and crop protection chemicals. The impact of these changes is well demonstrated by the lowered fertilizer consumption (around 25,000 tons annually vs. the 100,000 used under the old programs). The largest drops by far were for the kinds of fertilizer used on cowpeas and groundnuts. Table T4 shows fertilizer consumption, by crop type for 1980/81 (the end of the Programme Agricole and suspension of agricultural credit, 1985/86 (beginning of the Cereals Plan and beginning of CNCAS operations), and 1989/90 (the first year with no subsidy).

There was a substantial drop in fertilizer consumption between 1980 and 1985, from 74 thousand tons to 27 thousand tons. Most of the change is accounted for by suspension of the program and agricultural credit, and the

substantial increase in the farm price; fertilizer of the type for groundnuts and cowpeas dropped by 86 percent and fertilizer for cereals declined by 57 percent. We can assume that in 1985 and 1989 most of the fertilizer of the type used for groundnuts/cowpeas was used for edible nuts and groundnut seed production.

Table T4

Fertilizer Consumption, 1980/81, 1985/86, and 1989/90
(Thousand Metric Tons)

Crop (Fertilizer Type)	1980/81	1985/86	1989/90
Millet/Sorghum/Maize	26.820	8.582	3.119
Irrigated Rice	8.290	6.400	2.365
Urea			9.763
Total Cereals	35.110	14.982	15.247
Groundnuts/Cowpeas	29.600	4.200	2.966
Cotton	5.100	7.900	4.536
Other			2.425
Total	74.680	27.082	26.345
Farm Price FCFA/kg	25	105	80
Subsidy FCFA/kg	39.4	20	--
Percent Subsidy	61%	16%*	--

Source: Annex
*Cotton is subsidized at about 40%

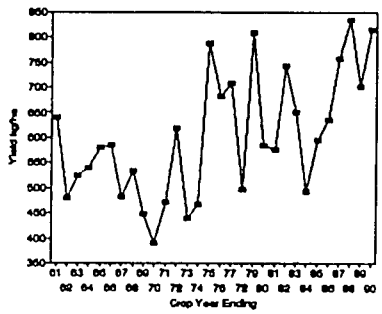
It is interesting to note that changes in yields for millet and groundnuts did not reflect the reduced fertilizer consumption. In the Sine-Saloum (Kaolack and Fatick) yields for groundnuts, millet and maize show no evidence at all that changes in the fertilizer program had any appreciable impact (Figure TF2)[2]. Maize yields in Tambacounda, where SODEFITEX has been active in promoting maize, with steady input supplies and marketing support, have been somewhat less eratic. In all areas and for all crops the dominate feature is the enormous year-to-year variation, which suggests that a more appropriate "intervention" could have been considered.

[2]Note that what appears to be a positive trend in millet yields actually reflects a sudden upward shift in 1975 (this is true for all of the crops). It is unclear wether this represents anything significant or wether it merely represents an adjustment in the data.

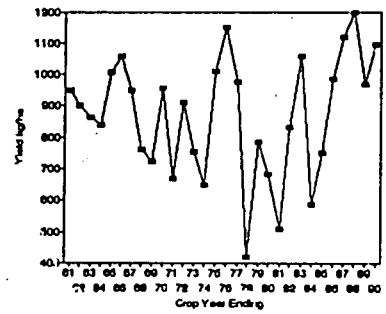
Figure TF2

Millet, Maize and Groundnut Yields for the Sine-Saloum, Maize Yields for Tambacounda
(Kg/ha)

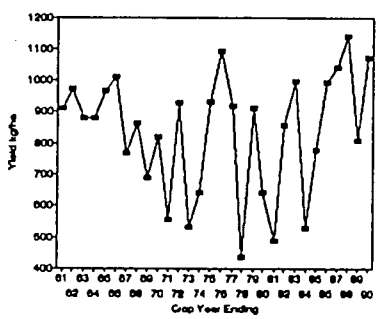
Millet: Kaolack and Fatick



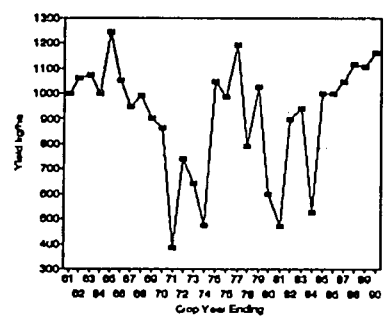
Maize: Kaolack and Fatick



Groundnuts: Kaolack and Fatick



Maize: Tambacounda



Technology Choices and Farmer Attitudes

A great deal of the analysis of actual and potential technology depends on an assumption about farmers' objectives and options. It is common to use benefit/cost ratios to evaluate alternative technologies (both within and between crops) on the assumption that the farmer's objective is to maximize net revenue. This is clearly not the case, since Senegalese farmers seldom elect to use the crop/technology combinations with the highest BC ratios for

a number of reasons: agricultural policy in general, legal and institutional restrictions, lack of credit, inadequate extension, absence of input and output marketing systems, risk aversion, resource limitations, and a whole range of cultural patterns. On the other hand, these analyses can help us to identify the possibilities for improvement in output and incomes, etc.

Take, for example, BC ratios for Kaolack (southern, Nioro - more humid and northern, Boulel-dry) shown in Table T5. In the dryer north (Boulel) the BC ratios for groundnuts and a cereal crop were both 2, while in the more humid south they were 5 for groundnuts and 2 for the cereal crop.

Table T5.

Benefit/Cost Ratios
Returns to Fertilizer - Kaolack

Crop/days to mature	Nioro (South)	Boulel (north)
Groundnuts (120 day)	5.0	2.2
Sorghum (135 day)	3.5	
Millet (90 day)		2.0

Source: [Kelly, 1987, pg 29]
Calculations include the value of hay, average yields 1965-82 and 1987 prices.

Since a general rule of thumb is that the BC ratio needs to be at least 2 for a farmer to consider the new investment, there is little to no reason to expect adoption in the dryer area (north) but clearly some incentive for higher technology on groundnuts in the south.

BC ratios for maize, millet and sorghum, calculated on the basis of farmers expectations about yields based on 1987 rainfall for farms in the extreme east of Kaolack, the southwest part of Tambacounda, and the south central part of Kolda show a similar pattern in that the ratios are low, but increase toward the south and the southeast of the country (Table T6). The ratios are all relatively low, especially for millet and sorghum (less than or just above 2 in four of the five cases). They are considerable higher for

maize (over 3), which confirms its relatively high potential in southern and southeast Senegal.

Table T6

Benefit/Cost Ratios
Returns to Fertilizer - South and Southeast Senegal

Village	Location	Millet	Sorghum	Maize
Koungheul	extreme east Kaolack	1.3		
Maka	southwest Tambacounda	1.7	2.2	3.7
Dioulacolon	south central Kolda	2.7	1.9	3.5

Source: [Goetz, 1990, pg 235]
Based on farmer expectations and 1987 rainfall

The information provided by the BC ratios is reinforced by farmer responses to questions about their investment priorities. Both Kelly and Goetz asked groundnut basin farmers about their investment priorities. Kelly's data are for the central and southern Basin (90 farmers) and Goetz's data (198 farmers) are for the southern Basin and Kolda. Results showing farmers' priorities (either first or second) are summarized in Table T7. In all cases the farmers indicated an extremely low priority for fertilizer but a fairly high priority for groundnut seed and food. Overall, only between eight and nine percent of the farmers would purchase fertilizer as a first or second choice as a way to use an additional 15,000 FCFA. In fact, even as a third choice, only about 10 percent indicated they would choose fertilizer as an investment. Food and groundnut seed purchases were the highest priorities, reaffirming to some degree the relative importance of cash and food crops in the farm economy.

According to Kelly's data, most of the farmers who would purchase groundnut seeds would purchase equipment next, then fertilizer; and those who

would first purchase food would then purchase seeds, followed by equipment and fertilizer.

Table T7

Farmers' Investment Choices: How They Would Spend 15,000 FCFA
(Percent who would purchase according to priority)

First or Second Choice	Kelly	Goetz	Note
Buy food	67.8%	75.3%	Kelly collected data in 1985/86.
Buy seed	82.2%	47.5%	
Buy/repair equipment	16.7%	25.3%	
Hire labor	(*)	20.2%	Goetz collected data in 1987.
Buy Fertilizer	7.8%	9.1%	
Livestock	8.9%	(*)	
Other	11.1%	37.9%	(*) included in other.
Number of Observations	90	198	

Source: [Kelly, 1988 pg 33], [Goetz, 1990 pg 84]

Thus, it is clear that on the basis of benefit/cost ratios from historical yields or from farmers expectations about yields, or on farmers' stated investment priorities, there is a strong trend toward lower and medium level technology in most of Senegalese agriculture. The information so far indicates what the trend is but not precisely why it exists. It is axiomatic that farmers are rational in their own environment, so there must be good and sufficient reasons for this behavior.

Technology and Selection of Crops and Cropping Patterns

Because the range of potential crops and cropping patterns varies, depending on the geographic region, this section of the Analysis will deal with crops in four major geographic areas: the River Valley, the Groundnut Basin, Southern and Southeastern Senegal, and the Niayes. The primary focus will be on technologies and production potential (between and within crops) in each broad region.

The Senegal River Valley

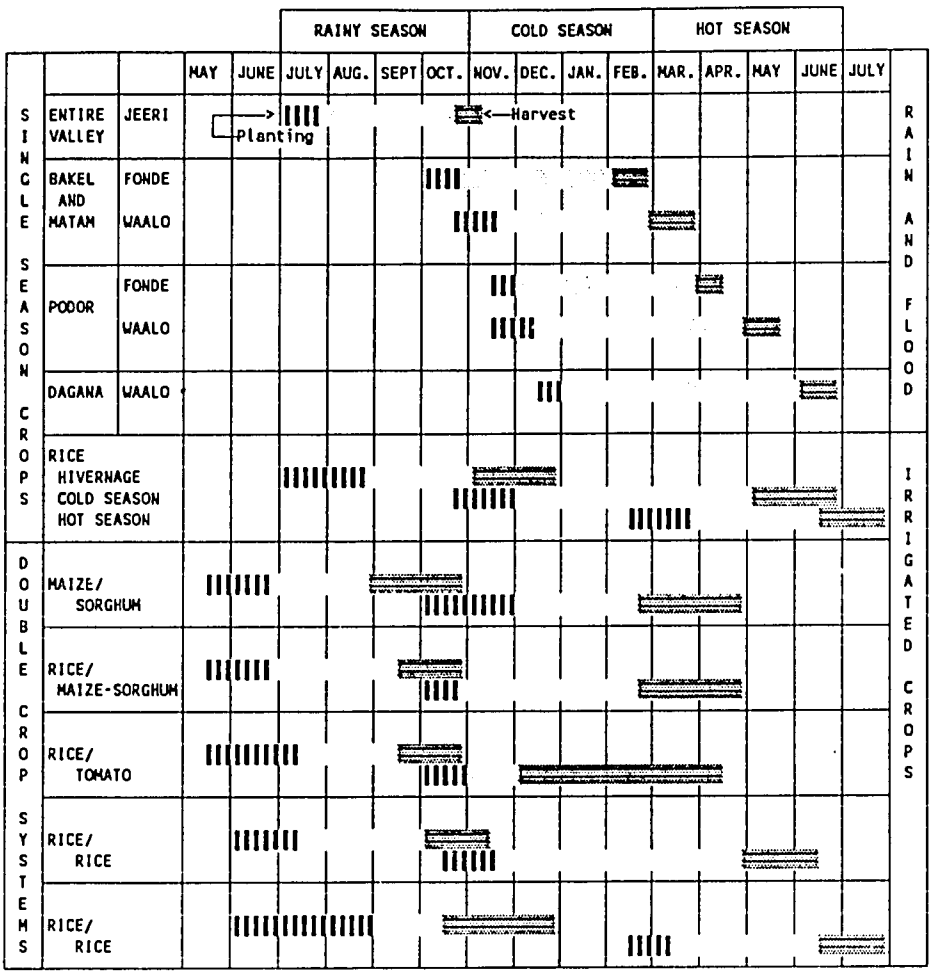
Driven by a national policy to achieve maximum food self-sufficiency and the water control made possible by the Manantali Dam, the region has been

accorded the highest development priority. Accordingly, irrigation system development in the St. Louis Region has received the larger share of Senegal's investment in the agricultural sector (See [Erikson, 1990]).

The development of irrigated agriculture in the Valley has opened the region to a potentially wide range of crops and introduced the possibility for as many as three cropping cycles per year: the rainy season (hivernage), a "cold" season, and a "hot" season. For a variety of reasons (largely labor, credit, land preparation and water management problems) cropping intensity is low. A goal of 1.3 - 1.5 was set, but it seldom exceeds even one. Figure TF3 demonstrates part of why there are cropping pattern/crop intensity conflicts. The top portion of Figure TF3 shows planting and harvesting periods for rainfed and flood "decru" crops and the bottom portion is for irrigated crops. In all cases, land preparation and harvest for non-irrigated crops conflicts with planting and/or harvesting of irrigated crops. In addition, there is a conflict between planting and harvesting all 1st and 2nd season crops except hivernage and hot season rice. Even though it may be technically feasible to produce two crops on the irrigated land in the Valley, operationally it appears unlikely that this will occur unless significant changes are made in land management and how water is charged to the farmer. This is important because if double cropping was to become a standard practice, then the high fixed costs of the irrigation systems could be spread over a larger volume of land to reduce water costs. The gains could be considerable, especially for the large perimeters in the Delta, Podor and Matam where the annual cost/ha/year is estimated to be about 213,000 FCFA/ha or 47 FCFA/kg of rice - over 50% of the official rice price. Since the State subsidizes much of the cost, farmers in the large perimeters are charged 73,000 FCFA/ha, so for rice the actual water cost is about 16 FCFA/kg.

Figure TF3

CROPPING SYSTEMS IN THE SENEGAL RIVER VALLEY



SOURCE: [JAMIN, DEC. 1987], [LeBloas, Juin 1986], [NDIAYE, JAN.1989]

The importance of this cost differential will become increasingly important as more and more of the responsibility for the irrigation systems is transferred to the farmers. This issue will be discussed in more detail later in the report (in the chapter dealing with policy and the current policy dialogue). There are two other types of irrigation systems operating in the Valley, Irrigated Village Perimeters (PIV) and private fields. The PIV have also been subsidized (about 40%) but the private operators pay the full cost

because they operate privately owned pumping systems.[3]

Given the emphasis on irrigation, government policy and donor support has had a significant influence on technology in the Valley. In order to look at the relative attractiveness of alternative crops and technologies and to provide information for subsequent analysis, the budgets in Annex TA1 have been used to calculate production costs and returns to labor for the various crops and seasons in the three main sectors of the Valley. The returns to labor are calculated as FCFA/day and thousand calories/day of labor. The cost of production is calculated as FCFA/kg (both including and excluding labor). This approach is used because the supply of irrigated land is limited so a producer will make crop and crop technology choices based on labor productivity; cash value if the producer is interested in income, and food value under subsistence conditions. Certainly, actual decisions will be made on the basis of some combination of these two factors. These same calculations are done for each of the main national geographic regions. The data for the River Valley are shown in Tables T8 and T9.

Ignoring such limiting factors as market availability, and on the basis of present costs and returns, hivernage rice and cold season tomatoes (in all parts of the Valley) clearly dominate the other crops in terms of value per day of labor. Irrigated maize and sorghum would not seem to be reasonable alternatives to rice since they return 300-500 FCFA/day of labor while the return for rice is generally 5 to 10 times higher.

Depending on the daily wage rate, maize and sorghum (especially maize) would be marginal under any circumstances. Note that rainfed millet and groundnuts in the Bakel area provide a better return then both irrigated maize and sorghum, possibly accounting for the observed shift in that area.

[3]The budgets included in Annex TA1 include costs actually paid by farmers and are per hectare per year.

Given the substantial difference in labor requirements between irrigated and rainfed cereals, farmers in the Bakel area can cultivate nearly three times as much millet as irrigated maize with the same amount of labor. This would amount to 1200 kg of millet vs. 2000 kg of maize, the difference would be absorbed by the higher non-labor cost to produce maize. There are other considerations, especially the risk associated with rainfall levels in Bakel (rainfed agriculture is not a real option in the other parts of the Valley).

Overall, the argument is for a lower technology in this area. The strategic implications point to improving marketing systems for such crops as tomatoes and onions. There are also important marketing considerations such as the size and location of the market for these products and competition with outside suppliers. These issues will be discussed in a later chapter dealing with marketing and processing agricultural commodities.

Table 8

Technology Options in the Senegal River Valley: Returns to Labor (FCFA/Day and 1000 Calories/Day) 1990

Area	Crop	Return to Labor (FCFA/Day)					Return to Labor (1000 Calories/Day)				
		Technology				Home	Technology				Home
		High	Medium	Low	Late	Field	High	Medium	Low	Late	Field
River Valley-Delta	Rice-Hivernage	2270	2081		1852		67	62		55	
	Rice-Hot Season	2283	2138		2213		68	63		66	
	Maize-Hivernage		564		-58			28		-3	
	Maize Cold Season		478		-52			23		-3	
	Sorghum-Hivernage		732		561			33		25	
	Sorghum-Cold Seaso		634		389			29		18	
	Tomato-Cold Season		2590		1347			18		9	
River Valley-Matam	Rice-Hivernage		1147		1011			35		31	
	Rice-Hot Season		967		818			29		25	
	Maize-Hivernage		338		250			17		12	
	Maize-Cold Season		312		125			15		6	
	Sorghum-Hivernage		525		412			24		19	
	Sorghum-Cold Seaso		358		262			16		12	
	Sorghum-Decru			335	293				17	15	
	Tomato-Cold Season		2066		1227			14		9	
River Valley-Bakel	Rice-Hivernage		1141		1005			35		31	
	Rice-Hot Season		959		811			29		25	
	Maize-Hivernage		214		139			12		8	
	Maize-Cold Season		251		170			14		9	
	Sorghum-Hivernage		392		296			21		16	
	Sorghum-Cold Seaso		251		170			14		9	
	Tomato-Cold Season		2001		1154			14		8	
	RAINFED										
	Millet/Sorghum	541	465	546	381	711	27	24	28	19	36
	Cowpeas	-68	5				-3	0			
	Groundnuts	542	552	681	495						

Technology:						
Land Preparation						
Delta	machine	machine		machine	manual	Rainfed crops in Bakel: high and medium
Matam		manual		manual	manual	technology use animal traction for
Bakel		manual		manual	manual	land preparation and weeding.
Seeding	manual	manual	manual	manual	manual	For low technology and late planting
Weeding	manual	manual	manual	manual	manual	all operations are manual.
Chemical Fertilizer	X	X				
Plant Protection	X	X				
Organic Fertilizer					X	
Harvest						
Delta	machine	machine	machine	machine		
Matam		manual		manual		
Bakel		manual		manual	manual	

Table 9

Technology Options in the Senegal River Valley: Production Cost Including and Excluding Labor (FCFA/Kg) 1990

Area	Crop	Including Labor (FCFA/kg)					Excluding Labor (FCFA/Kg)				
		Technology				Home	Technology				Home
		High	Medium	Low	Late	Field	High	Medium	Low	Late	Field
River Valley-Delta	Rice-Hivernage	48	46		50		38	35		38	
	Rice-Hot Season	45	43		43		35	32		32	
	Maize-Hivernage		73		106			53		78	
	Maize-Cold Season		76		110			53		78	
	Sorghum-Hivernage		64		70			44		49	
	Sorghum-Cold Seaso		67		79			44		53	
	Tomato-Cold Season		16		23			13		19	
River Valley-Matam	Rice-Hivernage		50		54			27		29	
	Rice-Hot Season		57		63			33		36	
	Maize-Hivernage		91		102			42		48	
	Maize-Cold Season		94		123			44		59	
	Sorghum-Hivernage		71		82			26		31	
	Sorghum-Cold Seaso		88		103			34		40	
	Sorghum-Decru			105	118				8	9	
	Tomato-Cold Season		14		21			9		14	
River Valley-Bakel	Rice-Hivernage		50		54			27		29	
	Rice-Hot Season		58		63			33		36	
	Maize-Hivernage		91		102			42		48	
	Maize-Cold Season		88		102			34		40	
	Sorghum-Hivernage		71		82			26		31	
	Sorghum-Cold Seaso		88		102			34		40	
	Tomato-Cold Season		15		22			10		15	
	RAINFED										
	Millet/Sorghum	62	68	61	80	48	30	29	14	18	7
	Cowpeas	93	91				46	39			
	Groundnuts	34	34	30	36		22	19	16	20	

Technology:						
Land Preparation						
Delta	machine	machine	(See	machine	manual	Rainfed crops in Bakel: high and medium
Matam		manual	note)	manual	manual	technology use animal traction for
Bakel		manual		manual	manual	land preparation and weeding.
Seeding	manual	manual	manual	manual	manual	For low technology and late planting
Weeding	manual	manual	manual	manual	manual	all operations are manual.
Chemical Fertilizer	X	X				
Plant Protection	X	X				Decru is all manual
Organic Fertilizer					X	
Harvest						
Delta	machine	machine	machine	machine		
Matam		manual		manual		
Bakel		manual		manual	manual	

Groundnut Basin

The benefit/cost ratios already discussed (Tables T5 and T6) pointed to a general tendency for Groundnut Basin farmers to employ lower technology. That data also indicated that there was some incentive for higher technology for maize and groundnuts in the southern part of the Basin. Data calculated on the basis of returns to labor reinforce this conclusion, but point to an even lower technology. See Table T10 (returns to labor) and T11 (cost of production). The returns to labor for groundnuts is highest for the low technology option in each of the four sub-regions of the Basin. This is a little different that was shown by the BC ratios because: (1) the groundnut price has since been reduced from 90 to 70 FCFA; (2) farmers are now required to store their own seeds (previously SONACOS stored and distributed seed); (3) although the BC ratios were calculated without the fertilizer subsidy which was then in effect, that sector has been privatized so farmers are forced to make decisions under a different set of rules. The results reinforce farmer attitudes, which rank fertilizer very low as an investment. The reasons are clear - the returns to increasing inputs do not justify the additional cost and labor.

The Northern Groundnut Basin has no advantage in groundnut production relative to the rest of the this region, although the returns to labor help to explain why farmers continue to try to produce. The highest potential for this region rests with cowpeas, which have serious insect related storage and production problems. Researchers under the Bean/Cowpea CRSP report hugh yield increases, if improved varieties and technology are used [Schwartz, 1990, pg 12]. Yields improvements as high as 250 percent have been reported, with yields of over 800 kg/ha (vs a long term average of below 300) with 200 mm of rainfall. The potential for this crop is high, provided appropriate systems are used. When the variety CB5 was introduced in the mid-1980's production jumped enourmously. It has since fallen because there was no market for the

output and storage problems made it impossible to carry the crop forward.

One issue which is pertinent to the development strategy issue is shown under the column heading "Home Field". These are low technology operations on very small fields near the farm houses. They differ from the other fields in that because of their location, they receive more organic fertilizer from farm animals held near the houses. The difference between these fields and the others are substantial in that returns from them exceed even the high technology option. The chapter on resources pointed out the general soil degradation which has taken place in the Basin, this result helps to quantify the consequences. In terms of calories produced, these fields will consistently produce 25% more per day of labor - a substantial benefit with minimal cash cost. There is little information available on crop response to fertilizer on these fields, but it can be expected to be substantial. As it stands, one of the obvious considerations is the water retentiveness of these soils. As has been pointed out (Table R7, chapter _, page _) water requirements for crops may be reduced by as much as 50% on water retentive soils - organic matter is a requirement. Thus, from both the point of view of stabilizing and of increasing productivity of Senegalese agriculture, an effort to improve the quality of the soil would appear to be essential. The difference between returns to the high technology option and the "home fields" does not support a contention that chemical fertilizer is the answer.

Table 10

Technology Options in the Groundnut Basin - Senegal: Returns to Labor (FCFA/Day and 000 Calories/day)

Area	Crop	Return to Labor (FCFA/Day)					Return to Labor (1000 Calories/Day)				
		Technology				Home	Technology				Home
		High	Medium	Low	Late	Field	High	Medium	Low	Late	Field
Northern Basin	Groundnuts	599	686	889	602						
(Louga)	Millet/Sorghum	551	561	526		748	23	24	22		32
	Cowpeas	200	300				9	13			
Central Basin	Groundnuts	2166	2237	2850	2483						
(Thies, Diourbel,	Millet/Sorghum	697	620	735	535	850	34	30	36	26	41
No. Kaolack, Fatick	Cowpeas	354	402				15	17			
Southeast Basin	Groundnuts	1877	1965	2336	2118						
(Southern Kaolack)	Millet/Sorghum	604	635	727	478	835	34	36	41	27	47
	Maize	1797	2037			2499	105	119			146
Southwest Basin	Groundnuts	1641	1683	2039	1806						
(Southern Fatick)	Millet/Sorghum	677	623	688	498	620	37	34	37	27	44
Technology:											
Land Preparation		animal	animal	animal	animal	animal	Groundnuts in the Southwest use fongicides in all technologies.				
Seeding		animal	animal	animal	animal	animal					
Weeding		animal	animal	animal	animal	animal					
Chemical Fertilizer		X	X								
Plant Protection		X									
Organic Fertilizer						X					
Harvesting		manual	manual	manual	manual	manual					

Table 11

Technology Options in the Groundnut Basin - Senegal: Production Cost Including and Excluding Labor (FCFA/Kg)

Area	Crop	Including Labor (FCFA/kg)					Excluding Labor (FCFA/Kg)				
		Technology				Home	Technology				Home
		High	Medium	Low	Late	Field	High	Medium	Low	Late	Field
Northern Basin	Groundnuts	28	59	51	63		16	16	12	16	
(Louga)	Millet/Sorghum	74	72	75		54	34	27	13		7
	Cowpeas	198	180				100	77			
Central Basin	Groundnuts	28	28	23	27		17	17	13	17	
(Thies, Diourbel,	Millet/Sorghum	55	59	49	64	42	22	21	9	12	5
No. Kaolack, Fatick	Cowpeas	164	158				78	63			
Southeast Basin	Groundnuts	31	30	25	29		17	17	13	17	
(Southern Kaolack)	Millet/Sorghum	54	50	43	61	37	27	16	7	10	3
	Maize	37	28			15	27	16			3
Southwest Basin	Groundnuts	34	33	28	32		19	18	15	19	
(Southern Fatick)	Millet/Sorghum	50	52	46	61	39	18	16	7	11	4

The Casamance and Southeastern Senegal

The Casamance (Ziguinchor and Kolda Regions) and Southeastern Senegal (central Tambacounda) provide an environment under which a wider variety of crops can grown than in the Groundnut Basin. As was pointed out in the previous chapter, this part of Senegal contains most of the currently unused, arable land. The major disadvantages in these regions is distance (in the case of Tambacounda) and physical separation from the rest of the country (by Gambia for the Casamance). These areas also differ from the GB in that higher agricultural technology would seem to be appropriate, which is consistent with the better rainfall and soils in these regions. Because of these relatively greater potentials, south and southeastern Senegal have (along with the River Valley) been selected as priority development areas with an emphasis on expanding maize production.

The potential, both for increased use of higher technology and for the production of maize is supported by the data in Tables T12 and T13. Unlike the Groundnut Basin, returns to labor are higher for the high and medium level technologies for most crops grown in these regions. Also unlike the Groundnut Basin, the "home fields" do not dominate the other technologies.

There are three things worth noting; first, the high and medium technologies for rice are "potential", not actually used by farmers; second, very little rice produced in the Casamance is marketed; and third, the supply of land available for lowland rice is limited and has been severely degraded by salt intrusion. Thus, the yields used in the budgets may be above actual farmer experience. Both of these factors would push farmers toward a lower technology. Reclaiming these soils, if done in a cost effective way, will increase the return to labor applied to lowland rice by between 25 and 50 percent. Since women are the main producers of lowland rice, there is a definite gender related advantage.

The data in Table T12 also indicates a distinct advantage to maize and groundnuts vs other crops. There are clearly market related problems with maize as a cash crop but the potential is substantial. Groundnuts are clearly superior to cotton as a cash crop. In fact, given the low rates of return to cotton and the present push to eliminate subsidies to cotton producers, there is a definite likelihood that producers will shift to maize and groundnuts. Confectinary groundnuts are, or ought to be, the most likely cash crop candidate (aflatoxin levels will have to be resolved - a storage and marketing problem). Thus, marketing problems will have to be resolved in the Casamance and in Southeastern Senegal before these high potential crops can be effectively exploited.

Fruits and vegetables are important crops in the Casamance. At issue here are questions about appropriate water supplies and water cost for vegetables and markets for both. These issues are discussed in the following section, which deals with the Niayes and fruits and vegetables in general.

Table 12

Technology Options in South and Southeastern Senegal: Returns to Labor (FCFA/Day and 1000 Calories/Day)

Area	Crop	Return to Labor (FCFA/Day)					Return to Labor (1000 Calories/Day)				
		Technology				Home	Technology				Home
		High	Medium	Low	Late	Field	High	Medium	Low	Late	Field
Lower Casamance	Millet/Sorghum	611	505	564	381	487	25	21	23	16	20
(Ziguinchor)	Maize	459	974	612		787	24	51	32		41
	Rice - Lowland	652	365	416	334		19	11	12	10	
	Rice - Transplant	818		552			24		16		
	Groundnuts	668	499	482	619						
Middle Casamance	Millet/Sorghum	316	547	543	361	603	13	22	22	14	24
(West Kolda)	Maize	524	786			790	28	41			42
	Rice - Lowland	531	328	412	335		16	10	12	10	
	Rice - Rainfed	335	577	230			10	17	7		
	Groundnuts	865	624	435	546						
	Cotton	517	461	319	164						
Upper Casamance	Millet/Sorghum	645	489	797	417	583	27	21	34	18	25
(East Kolda)	Maize	687	973			792	36	51			42
	Rice - Lowland	557	350	416	338		16	10	12	10	
	Rice - Rainfed	298	524	217			9	15	6		
	Groundnuts	943	782	948	556						
	Cotton	601	553	323	220						
Mid-East Senegal	Millet/Sorghum	445	367	646	575	575	23	19	33	29	29
(Central Tamba.)	Maize	1422	1352			1303	83	79			76
	Groundnuts	1212	1083	1302	944						
	Cotton	369	287	178	116						

Technology:					
Land Preparation	animal	animal	manual	manual	manual
Seeding	animal	manual	manual	manual	manual
Weeding	animal	manual	manual	manual	manual
Chemical Fertilizer	X	X			
Plant Protection	X				
Organic Fertilizer					X
Harvesting	manual	manual	manual	manual	manual

Insecticides applied on all cotton technologies.
High and medium technologies for rainfed rice are "potential".

Table 13

Technology Options in South and Southeastern Senegal: Production Cost Including and Excluding Labor (FCFA/Kg)

Area	Crop	Including Labor (FCFA/kg)					Excluding Labor (FCFA/Kg)				
		Technology				Home	Technology				Home
		High	Medium	Low	Late	Field	High	Medium	Low	Late	Field
Lower Casamance	Millet/Sorghum	73	79	71	104	82	42	12	2	3	1
(Ziguinchor)	Maize	71	45	61		45	54	20	21		2
	Rice - Lowland	73	98	97	117		39	44	12	15	
	Rice - Transplant	54		76			9		6		
	Groundnuts	59	68	70	59		30	21	19	22	
Middle Casamance	Millet/Sorghum	94	79	77	111	69	64	32	8	10	3
(West Kolda)	Maize	69	55			45	55	28			2
	Rice - Lowland	81	105	98	116		48	41	15	16	
	Rice - Rainfed	93	75	152			63	20	24		
	Groundnuts	52	59	75	65		29	24	24	27	
	Cotton	99	103	125	166		64	66	56	68	
Upper Casamance	Millet/Sorghum	69	79	54	92	67	40	36	13	9	3
(East Kolda)	Maize	65	50			45	51	28			2
	Rice - Lowland	79	101	97	115		46	41	14	16	
	Rice - Rainfed	99	81	101			59	33	23		
	Groundnuts	50	53	52	64		29	27	26	26	
	Cotton	93	96	124	155		58	60	55	57	
Mid-East Senegal	Millet/Sorghum	68	76	53	71	71	39	35	12	4	4
(Central Tamba.)	Maize	45	37			25	35	22			2
	Groundnuts	49	53	52	57		29	27	25	26	
	Cotton	110	117	152	193		72	77	71	72	

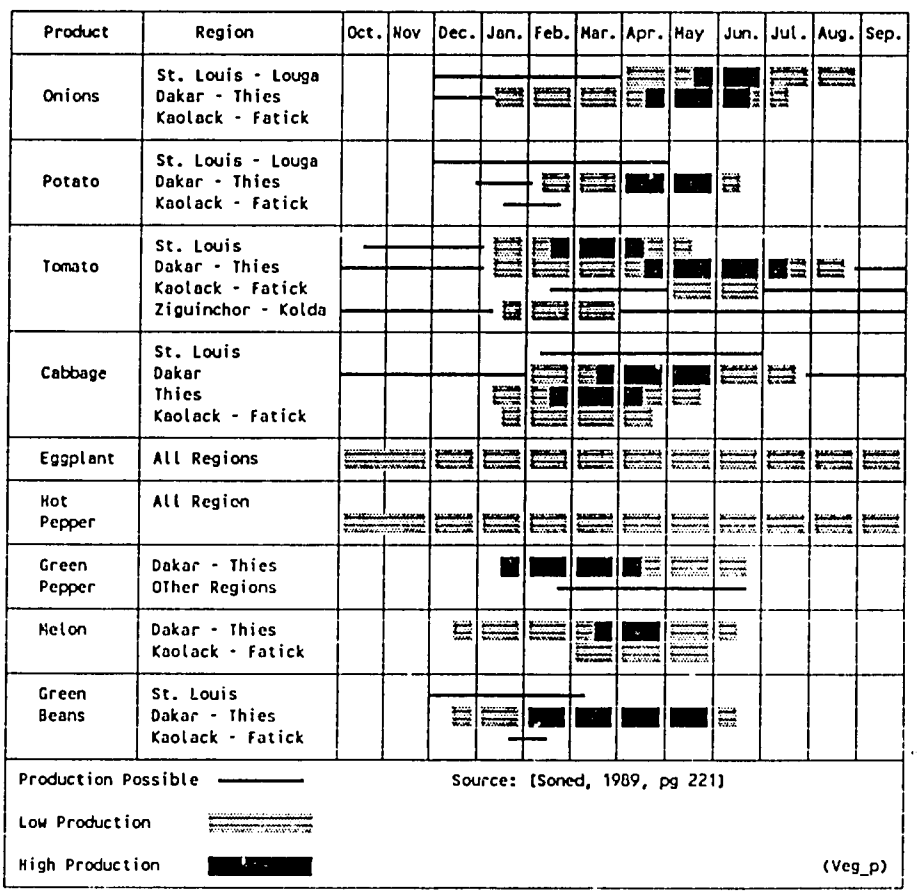
Technology:						
Land Preparation	animal	animal	manual	manual	manual	Insecticides applied on all cotton
Seeding	animal	manual	manual	manual	manual	technologies.
Weeding	animal	manual	manual	manual	manual	High and medium technologies for
Chemical Fertilizer	X	X				rainfed rice are "potential".
Plant Protection	X					
Organic Fertilizer					X	
Harvesting	manual	manual	manual	manual	manual	

The Niayes and Horticultural Crops

Vegetable production is concentrated in the River Valley (tomatoes and onions), in the Niayes (for a range of crops), and in the Casamance (mainly fruits). There are some fruit producing operations in Thies - mostly mangos for the Dakar market. Crop budgets for several vegetable crops are include in Annex TA1 for the Valley and the Niayes. Crop budgets for fruits and vegetables in the Casamance were not available.

Figure TF4.

Possible, Low, and High Vegetable Production Periods, by Region and Product



CDH has identified, by product and region, periods during the year when vegetables are produced (high production periods, low production periods, and

periods when production would be possible if water and related problems were resolved. This information is shown in Figure TF4.

The heaviest periods of vegetable production are between February and June, with some production beginning in January and carrying into July and August. Senegal produces between 120 and 125 thousand metric tons of vegetables each year, with most of the production (71%) in the Niayes area. (Table T14). The Dakar/Thies portion of the Niayes accounts for over 60 percent of all vegetable production and account for the larger share of the production of all individual vegetables, except onions. St. Louis and the Louga portion of the Niayes are the largest onion producing areas (almost 70% of the total). Production arrangements vary, depending on the eventual destination of the crop. Crops meant for export (green beans) are usually produced under contract and some tomato producers in the St. Louis Region receive assistance (credit, advise, inputs) from one of the tomato processing plant (SNTI). The others are sold on the open market.

Table 14

Vegetable Production 1987/88 Season, by Product and Region
(Percent of Production)

Crop	Percent Production of Crop in Region					Percent of All Crops
	Niayes				Other	
	Dakar	Thies	Louga	St. Louis	Regions	
Potatoes	28.4	60.7	6.0	4.4	0.5	10.8
Onions	7.7	13.4	30.7	38.8	9.4	18.7
Cabbage	37.4	41.2	6.6	5.6	9.1	18.4
Tomato	34.0	38.0	2.2	11.3	14.5	17.6
Green Beans	35.7	63.5	0.8	--	--	4.5
Melons	31.6	40.4	4.7	--	23.3	5.1
Hot Pepper	58.0	31.6	9.3	--	1.1	2.1
Eggplant	30.3	24.3	6.6	--	38.7	5.0
Other Veg	27.7	18.4	8.3	26.5	19.1	17.6
Total	28.3	33.4	10.3	15.4	12.6	100.0

Source: [Abt Associates, 1989, pg 15] (MDRH data)

Onions, cabbage, and tomatoes are the most important crops (each accounts for about 18% of total vegetable output), followed by potatoes

(10% of total production). The cost of producing tomatoes and onions in the Niayes is considerably higher than it is in the River Valley. There are two main reasons:

(1) Irrigation in the Niayes is considerably more labor intensive and costs about twice as much as in the River Valley. The difference is about 100 days/hectare, which adds an incremental 5 FCFA/kg.

(2) Producers in the Niayes apply about 20 tons/ha of organic material (groundnut meal), which is not applied by producers in the River Valley adds about 6 FCFA/kg to the cost of production.

Table T15 summarizes production cost and farm-gate price information for the Niayes and the River Valley. Caution: comparing the prices for tomatoes between the River Valley and the Niayes is not appropriate because the tomatoes in the River Valley are for tomato paste production and the tomatoes in the Niayes are for fresh consumption. Onions, however, are comparable products.

Table T15

Production Costs, Farmgate and Dakar Retail Prices
(Selected Vegetables, FCFA/kg, 1990)

Vegetable		Niayes	River Valley			Dakar
			Podor	Matam	Bakel	Retail
Tomato						
Production	H	46.0	15.0	15.0	15.0	
	T	54.0				
Farm-Gate		70	30	30	30	
Margin (high)		362	15	15	15	
Onion						
Production	H	79.0		17.0	17.0	
	T	91				149.2
Farm-Gate		150		50	50	
Margin(high)		71		33	33	
Potato						
Production	H	86.0				
	T	95				180
Farm-Gate		150				
Margin(high)		64				
Green Beans						
Production	H	93.0				
	T	118				
Farm-Gate		150				
Margin		57				

Source: Crop budgets Annex TA1.
H = high (modern) technology. T = low (traditional) technology).

The data in Table T15 suggest that there is a potential for increasing farmer incomes by improving production technology and marketing of onions and tomatoes. Although the cost-of-production data for the Niayes is based on recommendations (that is producers probably are not using all of the inputs or getting the stated yields), it shows that considerable improvement in productivity can be achieved by introducing labor saving equipment. Additionally, observation suggests that women (and to some degree, children) are heavily involved in water lifting; relieving their work load by up to 100 days/hectre would have a considerable impact. Given the potentials, and considering the possible environmental impact of increased well based irrigation in the Niayes, more analysis of farming practices, labor distribution and water supply and quality should be undertaken. There are certainly marketing problems to be resolved (transportation, storage). These are addressed in the following chapter.

Implications: Crop Production

Horticultural Crops

Niayes

According to the data in Table R3 of Chapter R? the Niayes has an additional 6,000 hectares of potentially irrigable land. The main problem with exploiting this resource is the impact the additional wells would have on the water table and water quality. Water quality is already beginning to deteriorate and the water table is beginning to drop. We conclude that although there will probably be some increase in area, it will not be significant. The Cavor Canal (to transfer water from the River Valley to Dakar) has been proposed as a way of bringing the land into production. This is a long term, extremely expensive project unlikely to be initiated any time in the near future. Thus, from a purely production point of view, we conclude that the production potential is now nearly fully exhausted, and that labor

and cost savings on existing operations ought to be the primary consideration.

River Valley

There is a considerable advantage for the production of onions and tomatoes in the River Valley and this area has, by far, the greatest potential for expanded production of both commodities, especially if based on a double cropping system. The main problems here are marketing for onions and extension and land management for both crops. Double cropping will have to be expanded, expecially in the delta region, if the high cost of the irrigation system is to be justified. It is particularly important that better land/farm management practices be introduced to facilitate the production of tomatoes, because there is an existing market for nearly twice as many tomatoes as are now being produced (This will be discussed in more detail in the next chapter).

Groundnut Basin

The majority of the rural population lives in the Groundnut Basin, and it accounts for the majority of the cultivated land and cash crop production. This region also has the greatest constraints to increased productivity and production. There are, however, possibilities for improvement. The large difference between output from the small, low input, fields suggests that with proper management productivity could be improved by as much as 75 percent if the organic content of the soils can be improved. A combination of preditors (insects, birds and weeds), causes enormous year-to-year variations in yields. Reducing this variation through land and water management and improved stress tolerant varieties could add between 25 and 50 percent to output, with existing technology.

Casamance and the Southeast

The Casamance has an environmental advantage for fruit production, an area about which there is little cost and marketing information. The major problem will be transportation and quality control. Research into vegetable

and fruit production and marketing systems and market potentials should be undertaken before large investments are considered. Existing production systems, especially lowland rice, can be much more productive. Current efforts at land reclaimation are addressing this problem.

Confectionary groundnuts and cashews are high potential cash crops. Cotton production, while it will probably continue, is likely to be replaced by groundnuts and maize, unless there is a substantial and sustained increase in world prices for cotton. Marketing and processing of cashews and quality and health considerations for table nuts will present the greatest obstacles for these crops.

This region has the potential to expand cereal grain production, expecially maize. Long-term storage, marketing in general and basic consumption patterns are the major obstacles to realizing this potential. There is some potential for use in animal feeding, but the magnitude of this oportunity is not known. While there are some local opportunities, in general, societies need to be cereals surplus and relatively wealthy before fattened animals can become a significant factor ... this is not the case in Senegal.

Prospects

The majority of the conclusions drawn from the analysis in this chapter relate to land and water resource management (existing sytsems in the River Valley and improving resources in the Groundnut Basin) and improved marketing and marketing information (for fruits, vegetables and maize).

The overall impacts of the existing and the likely expansion of output are summarized in Figure TF5, which shows import needs for major food crops (historical 1976/77-1989/90 and projected to 2010. These data have been developed using the general framework employed to prepare the annual food needs assessment, the related parameters are shown in Table T16.

Table T16

Historical and Projected Growth in Output - Per Capita Consumption for Major Food Crops

Food Crop	Per Capita Consumption			Historical 1976-89 Growth *	Growth Scenarios		
	Urban	Rural	Total		Low	Medium	High
	Un-milled (kg/capita)			(%/year)		(%/year)	
Millet/Sorghum	27.7	123.2	87.1	2.7	2.0	3.0	3.0
Maize	11.4	18.9	16.0	5.8	2.0	3.0	7.0
Paddy	143.6	63.6	93.9	4.2	2.0	3.0	4.0
Cowpea	1.0	5.0	3.5	2.4	2.0	3.0	4.0
Total	144.2	194.9	175.7	3.3			

* Growth rates are calculated by regressing output (semi-log function output=f(time)) over the 1976/77-1989/90 crop years. With the exception of maize, the regression functions explained only a small portion of the variation in output (millet 16%, maize 85%, paddy 34%, cowpeas 17%). In other words, random variation in output account for much more of the variation in output than is accounted for by trend.

Three output growth scenarios are given, low, medium, and high. These scenarios are relatively conservative in that the high growth scenario is only slightly higher than historical trends. The reasoning behind these numbers is as follows:

Millet/sorghum - the geographic locations where most of the production takes place have high population densities, with low prospects for expansion of land area. Climatic and soil constraints limit prospects for immediate yield increases. Expansion of production to and in the south is set at about the rate of rural population growth.

Maize - maize output has been increasing at a rate of almost six percent per year. Producers are beginning to encounter marketing problems, unless these problems are resolved producer incentives will be greatly reduced. Thus, the low scenario provides for no change and stabilized production at rural family needs, the medium scenario at a slightly higher growth and the high option assumes that marketing, storage arrangements and consumption patterns adjust to facilitate growth at one percent above the historical growth rate (compounded this amounts to a 97% increase in production in 10 years).

Paddy - paddy production has been increasing at about four percent per year, largely because of development of irrigation perimeters in the River Valley. Development of large irrigation works is being drastically slowed, with a shift to small, private fields.

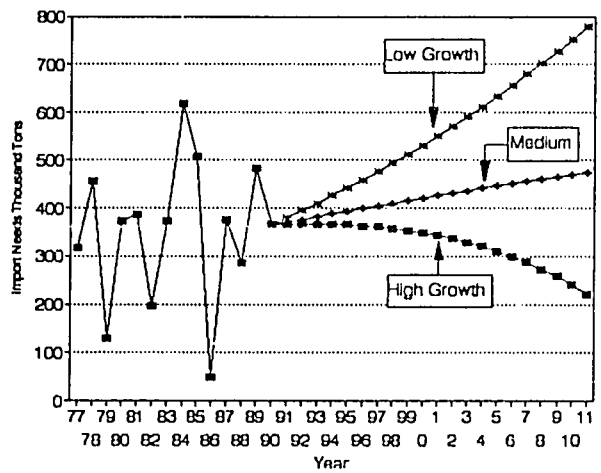
Cowpeas - excluding the temporary impact of introduction of CB5 in 1985, cowpea output has increased at 2.4 percent per year (essentially the rate of growth of the rural population. If protection from insects (both during growth and during storage) and better technology is adopted, then there is potential for considerable growth in output,

especially in the northern Groundnut Basin. This is a relatively minor part of total food crop consumption and is set at 2, 3, and 4 percent for the low, medium and high options.

Applying these parameters to production levels beginning in 1990/91 and accounting for population growth produces an import needs picture as shown in Figure TF5. Unless trading patterns between Senegal and its neighbors changes dramatically, these import needs would be met by imported rice.

Figure TF5

Food Needs Under Three Growth Scenarios



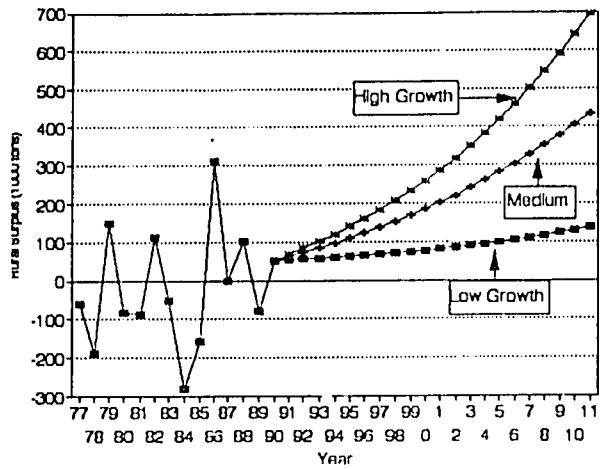
The differences between the three scenarios are considerable but, considering normal year-to-year variation in output, would fall within the bounds of historical import needs for a considerable length of time. Food self-sufficiency is clearly not an attainable goal. In fact, at the high option extended 20 years, Senegal would still import over 50% of its food needs (from the food crops). As the data show, stabilizing the year-to-year variation in output could make a larger contribution to domestic food supplies than even a relatively high rate of growth in output.

To look at the opposite side of what is implied by the food import needs shown in Figure TF5, the associated rural surplus (production less rural

consumption) is shown in Figure TF6. This shows, to some degree, the prospects for food crop marketing implied by the three scenarios.

Figure TF6

Rural Surplus Under Three Growth Scenarios



With the exception of rice and tomatoes in the lower Senegal River Valley and vegetables in the Niayes, a small portion of locally produced food crops enter commercial channels. Part of the reason why so little is marketed and why imported rice has penetrated so far into rural markets is demonstrated by the large variation in the rural surplus; it was deficit in 9 of the last 14 years Even under the "high" growth scenario the rural surplus does not exceed the historical range of variation until it is maintained for about 15 years. Unless higher output levels are stabilized and maintained, farmers would likely retain a large part of any increase to assure family food security. <u>This suggests that on farm storage should be a part of any production increasing or stabilizing strategy.</u> Farm marketing, particularly that which now takes place outside commercial channels would be influenced because within the farm community there is a broad range of surplus/deficit families. This, along with the other marketing and processing activities, is discussed in the next chapter.

Agricultural Sector Analysis

Part II Commodity Systems and Institutions

Chapter 1 .. Food Crops

Chapter 2 .. Export Crops

Chapter 3 .. Forestry

Chapter 4 .. Institutions

(To be completed after the initital CPSP process.

Agricultural Sector Analysis

Part III Regional Analyses

Chapter 1 .. River Valley ..... attached

Chapter 2 .. Groundnut Basin

Chapter 3 .. Casamance and Southeastern Senegal

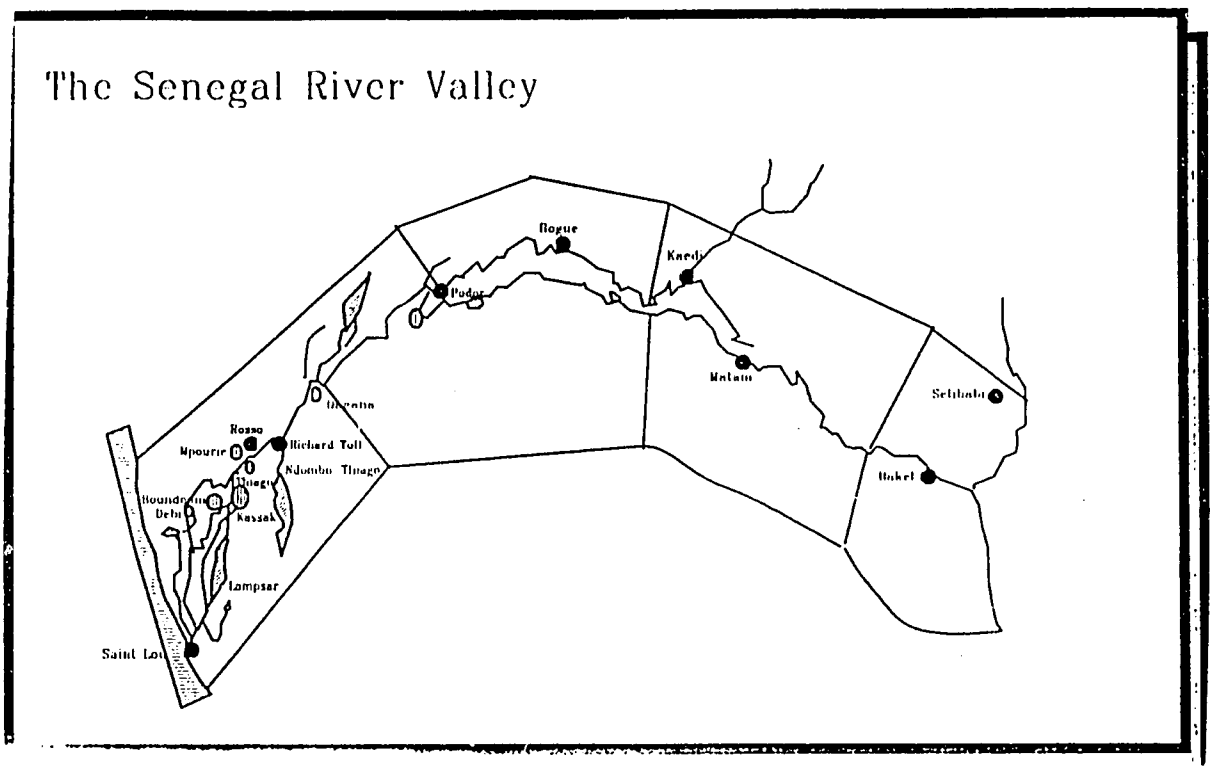
CHAPTER _

THE SENEGAL RIVER VALLEY

æ = CHAPTER NUMBER (145) Æ = ANNEX NUMBER (146)

MAP 1

THE SENEGAL RIVER VALLEY



SOURCE: [SECK, 1987]

CHAPTER
SENEGAL RIVER VALLEY

INTRODUCTION

The Senegal River defines the border between Senegal and Mauritania in the north, and Senegal and Mali in the east. The Senegal River Basin covers an area of approximately one million hectares, including land in Mauritania, Mali and Senegal and travels 900 kilometers from its mouth at St. Louis to Kayes in Mali. Since the River accounts for nearly 90 percent of Senegal's potential supply of fresh water for human, agricultural and industrial use, it has been the focus of considerable GOS and donor investment, especially the development of general infrastructure and irrigation systems; the Manantali Dam (in Mali) and the salt water control dam (Diama) in the south have, to date, cost approximately 200 million dollars.

While the climate, structure of the river banks, and the quality of the surrounding land has restricted the types of agriculture which can be practiced in the river basin, it has still supported a diverse agriculture, ranging from extensive-rainfed to intensive-flood and irrigation based crop production, as well as livestock herding and fishing. However, despite the diversity, the dominant feature of the Valley is, and will likely remain, its basic physical structure. There are three general land types in the River Valley -each linked to ownership and use by its relationship to the River and the availability of water. The relationship between the various land types and the river are shown in Figure 1 and some related information is shown in Table 1.

FIGURE 1

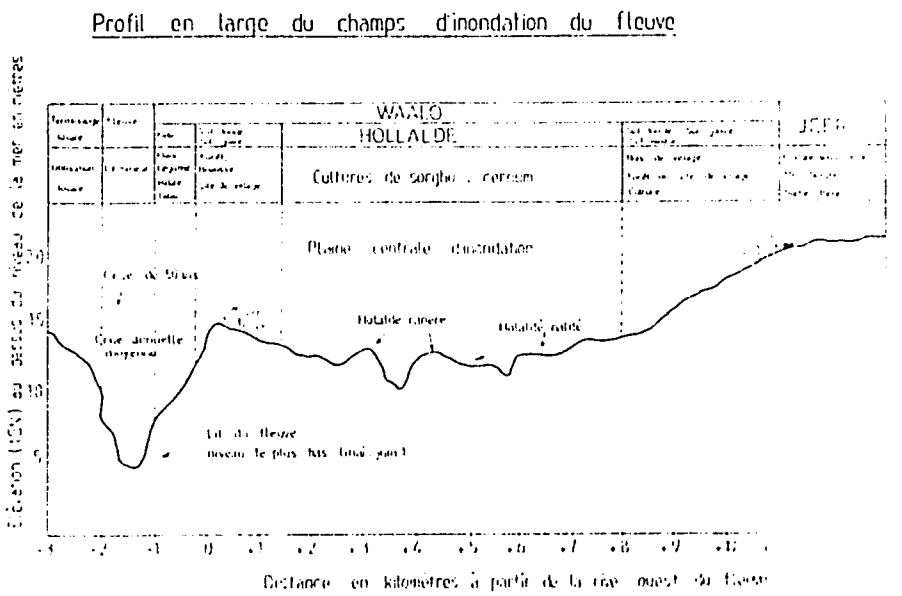


TABLE 2.1

SENEGAL RIVER VALLEY: BASIC LAND TYPES.

NAME	LOCATION	ESTIMATED LAND AREA (000 HA)	CHARACTERISTICS AND POTENTIAL
WAALO	FLOOD PLAIN		COLLECTIVE PROPERTY OF THE VILLAGE ALLOCATED ON A MORE OR LESS PERMANENT BASIS.
FONDE	BANKS OF THE FLOOD PLAIN	400	POROUS SOIL REQUIRES ABOUT 1.5 MORE WATER THAN HOLLALDE SOIL, MOST SUITED FOR CEREALS AND VEGETABLES BUT IS FARMED IN RICE BY SMALL VILLAGE IRRIGATION SYSTEMS.
HOLLALDE	LOW FLOOD PLAIN	300	HEAVY, HARD TO WORK SOIL BEST SUITED FOR RICE PRODUCTION. THE TRADITIONAL CROP IS SORGHUM.
FALO	STEEP INNER RIVER BANK		VEGETABLES, CORN.
JEERI	HIGHER, DRYLAND (USE)	10-80	ESSENTIALLY UNLIMITED SUPPLY. LIGHT, SANDY SOILS DEPENDENT ON RAINFALL, SUITED FOR CEREALS (MAIZE, MILLET) AND NIEBE, AVAILABLE TO THOSE WHO CLEAR AND WOFK THE LAND.
DELTA	RIVER DELTA	250	HEAVY, SALTY SOIL GENERALLY SUITED TO RICE ONLY.
TOTAL		1,000	

SOURCE: [JAMIN, 1987]

About one-fourth of the one million hectares in the Valley could be developed for irrigation without significant problems, about one-half could be developed, but with problems, and one-fourth is judged not to be suitable for irrigation development. Planning for such development is the responsibility of OMVS (..., composed of representatives from Senegal, Mauritania and Mali). SAED (...) has been responsible for planning and execution for Senegal.

The Valley has three distinct seasons which, with some constraints, allow two production seasons and some double cropping. The periods for the three seasons and their average temperatures are shown in Table æ-2.

TABLE æ-2.

SENEGAL RIVER VALLEY: THREE SEASONS

SEASON	PERIOD	TEMPERATURE
Rainy Season	July - mid-November	29 (Oct.)
Flood Peak		
Bakel	early September	
Matam	mid-September	
Podor	late October	
Dagana	early November	
Cold Dry Season	mid-November - mid-February	10-16 (Dec.-Jan)
Hot Dry Season	mid-February - June	39 (May-June)

Production systems in the Valley are linked to the annual flood following the rainy season. As was shown in Table æ-1, a potential of about 750,000 hectares are involved (250,000 in the Delta and 700,000 of waalo land) Because of environmental, infrastructure, labor and water constraints, only a small portion of the total area is used in any given year. In a "normal" year, and before the Mantalli Dam, the annual flood peaked in Bakel (upper valley) in early September, about mid September in Matam (upper-middle valley), late October in Podor (lower-middle valley), and early November in

Dagana (delta). The Mantalli Dam now permits an artificial flood, which is seen a an intermediate stage while irrigation systems are completed. To date, controlled flooding has been somewhat erratic; there was no water release in 1987, in 1988 the flood peaked in Bakel at the normal time, and in 1989 there were two, somewhat low releases. The artificial flood and its impact is discussed in more detail below.

IRRIGATION DEVELOPMENT AND PRODUCTION SYSTEMS

Irrigation development

Development of irrigation systems in the Valley began as early as 1936, at Richard-Toll (Guédé aand Diorbivol). After World War II a 6,000 hectare perimeter was developed at Richard-Toll[1]; in 1970 it was ceded to CSS (..). SAED was created in 1965 and was given the responsibility for irrigation development, input distribution, credit, and rice assembly and processing. Serious development began in the 1970's, especially after the 1973 drought, when development of small perimeters began at Matam (FAO). In 1976 the large perimeters at Dagana and Podor were completed. The EEC began development of perimeters in the late 1970's. USAID began work on irrigated perimeters in Bakel in 1977.

Policy: Development of irrigation systems count heavily in Senegal's food security policy and ambitious plans have made for their development. The New Agricultural Policy of 1984 and the more precise Cereals Policy of 1986 established specific food security goals (70-80 percent self-sufficiency) to be attained by the year 2000:

- increase irrigated area by 72,000 hectares to a total of 95,000 hectares. Recessional agriculture was to be replaced by these irrigated lands. The original goal to develop 5,000 hectares per year has been revised downward, to 3,000 hectares per year.

[1] Richard-Toll takes its name from a "garden" which was started in 1822. The garden was essentially a research station which tested an early type of irrigation. It is interesting that an evaluation of the experiment concluded that it had failed because of deficiencies in the irrigation system, soil salinity, and labor and organizational problems. [O.M.V.S., 1980]

- irrigated cereals (maize, rice, sorghum) to account for 38 percent of total cereals production vs. the current 5 percent. Part of this increase was to be gained from double cropping (rice/rice, rice/maize).

- 3-4,000 hectares in irrigated fruit.

- double production of vegetables, from 150,000 tons to 300,000 tons per year.

Performance: The rate of development of irrigated land has fallen far short of the goals. There are several reasons: (1) the way in which the goals were established; (2) farmer attitudes and labor and financial resources; (3) the cost of system development; (4) land tenure, extension, credit availability etc.

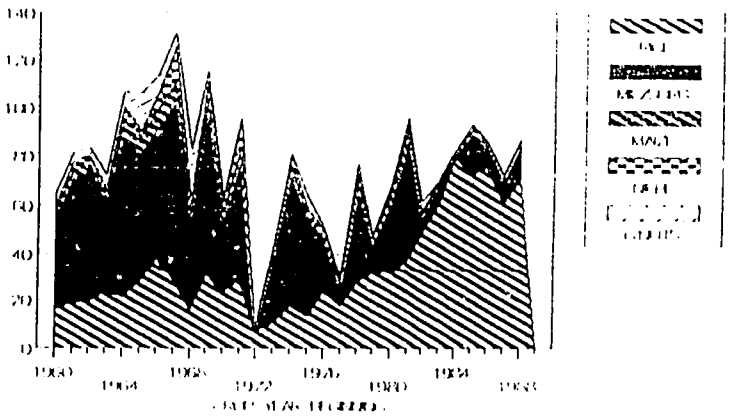
The goals for development of irrigated land were established on the basis of needs to meet production and food security goals.[2] The goals have been established on the basis of area required to replace land now cultivated following the annual flood, with very little consideration of management and financial constraints, or alternatives. Thus, since 1980, only an average of about 1,500 hectares/year has been achieved [Annex Æ-5].

Production Impact: Even though the rate of achievement of new irrigated land has been lower than planned, there has been a significant increase in production and in the relative composition of production in the River Valley. As shown in Figure æ-2, there have been two outstanding developments: the share of rice in total production has increased enormously, yet total production is still below pre-drought levels.

[2] Policy statements discuss both food security and food self-sufficiency. It should be noted that Operationally they are the same, because Senegal has never expected to produce more than 70-80 percent of its food needs from cereals.

FIGURE æ-2

SAINT LOUIS REGION: CROP PRODUCTION



SOURCE: ANNEX Æ-1

Causes and Consequences

The Senegal River Valley has undergone extensive socio-economic and environmental changes, perhaps more so than any other region of the country. These changes have resulted in shifts in cultural practices, land use patterns and male/female roles. Through this process, the Delta (Dagana) has passed from an essentially livestock/fishing/flood based recessional crop economy to one which is heavily dependent on irrigation; this is also true, but to a lessor degree in the lower-middle Valley (Podor) and even to some degree in Matam and Bakel. While it is tempting to blame many of the changes which have, and which will certainly continue, on irrigation, this is not strictly appropriate. In fact, while it is true that the development of the various irrigation schemes has led to many significant changes, the irrigation development was, itself, imposed by external forces - specifically drought.

Drought

Before the 1970's the Valley was the granary of Senegal, producing large surpluses of millet on jeeri lands and sorghum on the waalo. A combination of factors, especially the droughts of 1968, 1970, 1972, 1974, 1977 and the prolonged drought of 1982-1984, led to near destruction of the traditional production systems. For example, from a normal 100-150 thousand hectares of land surface flooded and cultivated, 10,000 hectares were flooded in 1972 and in 1984 there was virtually no production from recessional or rainfed crops. [Ba and Crousse, 1985].

Stimulated by the sever drought in 1972 and a continuous decline in rainfall, permanent shifts in cropping patterns began to take place: (1) the surplus, largely millet and sorghum, disappeared; (2) the composition of output shifted from recessional sorghum and rainfed millet to irrigated rice. As shown in Table æ-3, these changes have been very large; the share of millet and sorghum in total production fell from and average of 54% over 1960-71 to about 37% for 1972-84, and only about 13% over the 1985-89 period. The share of rice in total production increased from an average of about 26% for 1960-71 to over 78% for the 1985-89 period.

TABLE æ-3.

SAINT LOUIS: RAINFALL, SHARE OF PRODUCTION BY CROP, PER CAPITA PRODUCTION (SELECTED YEARS)

YEARS	AVERAGE RAINFALL (MM)	PERCENT OF TOTAL CROP PRODUCTION						PRODUCTION PER CAPITA MILLET EQUIVALENT (KG)
		RICE (%)	MILLET SORGHUM (%)	MAIZE (%)	NIEBE (%)	GROUND-NUTS (%)	TOTAL (%)	
1960-71	349	25.8	54.4	6.0	6.2	7.5	100	242
1972-84	192	51.0	37.0	5.5	3.6	3.0	100	118
1985-89	265	78.8	12.5	6.7	1.1	0.9	100	167

SOURCE: ANNEX A-1 PRODA

* Data do not include Bakel.

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The extreme drought of 1972 allowed production of only about 10,000 mt of the five major crops, less than 20kg per person in the Saint Louis Region. Considering that estimated requirements for the Region are about 220 kg/year it is clear why the GOS has developed such a preoccupation with irrigation in the Valley. This has clearly been reinforced by production performance after the rains returned to more 'normal' levels in 1985. Despite increasing production, output has reached levels sufficient to supply only about seventy-five percent of the area's cereals needs.

The data presented above include the urban and rural population in the region, and smooths out some important differences within the Region, especially between the Delta and the rest of the Valley. A more detailed analysis is presented in a later section of this chapter.

Although population growth and weather changes are responsible for part of the food gap, there are other contributing factors: migration from the region and the rate of development and use of irrigated lands.

Migration and the Role of Women and the Young

The Senegal River Valley has a long tradition of male migration, especially from the middle and upper valley. In some ways this migration has helped in the development of intensive agriculture by providing a source of investment funds, as well as providing funds for food purchases during the bad years.[3] On the other hand, it has also limited the availability of labor and forced fundamental changes in the role of the family.

Migration is, first, a fundamental cultural characteristic of the Toucouleur society (they are the dominant peoples in the middle valley) and is closely associated with adulthood and the generation of revenue for acquisition of livestock. There are two types of migration: local as wage

[3] A linear regression on data collected in the village of Houdery (Bakel) in 1987 shows a significant positive relationship between hectares of irrigated land and the number of migrant family members as well as for the participation of women in irrigated perimeters [Bloch, 1989, pg 23, 28].

earners in agricultural related work; and external to other african countries and to europe. Thus, early migration was supportive of traditional roles in the family. Beginning in the 1950's the relative roles began to change, especially following the severe drought years in the 1970's [Fieloux, 1985]. According to Fieloux, in 1978 between 42 and 47 percent of middle valley men were migrant and 35-40 percent of family income was dependent on remittances. Recent USAID financed research in the middle valley (the village of Thiemping in Matam) indicates that 56 percent of the males between the ages of 20 and 50 had migrated [IDA, 1989]. Similar information is shown by research in the Bakel area wghere a survey of 83 families showed a substantial increase in the part of family income generated from remittances and internal migration [Sella, 1987, pg 16]. In the Delta region, which is dominantly Wolof, migration is less prevalent; land availability and land quality are the larger problems.

Factors: Other than the traditional-cultural reasons for male migration there are at least four primary factors which have led to more and more permanent migration: (1) development of the railroad; (2) development of the groundnut basin; (3) elimination of markets for traditional cash crops (gomme arabic and cotton); and (4) the drought of the 1970's. A fifth factor, population/land pressure, is sometimes mentioned but is less likely to have been a strong influence since much of the arable land in the middle valley is still available [IDA/Kane, 1989]. This is, however, a factor in the Delta region, where fragmentation of available land and reduction in the availability of falo lands could seriously limit womens' traditional income generating agriculture (because of higher water levels through controlled release from Manantali).

Consequences: Clearly, access to external income contributes to family food security. Also, as clearly, the absence of large number of active males constrains production and productivity and forces a realignment of labor tasks

and economic activity. The direct impact of male migration ranges from alienation of women from traditional roles to limiting access to traditional land and income generating activities, and dependence on the departed males' fathers or brothers [Fieloux, 1985]. The impact on labor and the division of labor may be the most significant.

A comparison of male/female and adult/youth labor shares for 1978 and 1988 indicates a dramatic shift from adults to youths as the main source of labor for irrigated rice (Table æ-4). The data in Table æ-4 must be interpreted with caution because the age ranges used to definite adults and youth are different (10-15 for 1978 and 5-14 for 1988). Despite these definitional problems, the data indicate a considerable shift, especially from female labor to young males.

TABLE æ-4

LABOR SHARES FOR CULTIVATION:
IRRIGATED RICE AND WAALO LANDS BY SEX AND AGE
(PERCENT OF TOTAL PER HECTARE - MATAM 1978 AND 1988)

LABOR SOURCE	IRRIGATED RICE		WAALO (SORGHUM)	
	1978/79	1988/89	1978/79	1988/89
MALE	58%	81%	74%	53%
FEMALE	42	19	26	47
YOUTH	15%	49%	12%	46%
ADULT	85	51	88	54

SOURCE: ANNEX A-2, 3 AND 4.

The labor used on waalo lands, mainly for sorghum production, also shows a significant shift in primary labor source, with considerably less male and much more female labor. Since both irrigated and waalo production are traditional male activities, the internal adjustments are clearly aimed at maintaining production on the most productive lands. It is evident that this internal shift in the use of family labor resources is made at the expense of women's traditional income generating activities associated with farming the

jeeri and falo lands. It isn't necessarily true that this reduces food security, but it does reduce diversity and probably adversely affects womens' status. To the degree that migration is a permanent part of the culture and is likely to continue in the future, appropriate development strategies and programs must consider such factors as the division of labor, labor requirements and productivity. The shift in labor from adults to the young has implications for education of future generations, especially in the middle and upper valleys.

THE NEW ERA - APRES BARRAGE

Land Development Potential - The Dams and Irrigation Systems

The Manantali Dam in Mali and the Diama anti-salt dam (about 23 km from the mouth of the Senegal River) are intended to assure water supplies and water control sufficient to exploit the irrigable land in the River Valley. The three concerned countries, Senegal, Mauritania and Mali have created the "Organisation pour la Mise en Valeur du Fleuve Sénégal" (OMVS) to plan and monitor river basin development. Development on the Senegalise side is the responsibility of SAED ("Société d'Aménagement et d'Exploitation du Delta et de la Vallée du Fleuve Sénégal"). The main objectives of the Manantali Dam and the OMVS are:

Construction of the dams in order to stabilize the discharge of the river to 300 m^3/second and to stop salt intrusion;

Establish permanent navigability of the River for 900 km, from St. Louis to Kayes in Mali;

Construction of a hydro-electric power generation station capable of producing 800 gigawatt hours;

Development of 375,000 hectares of irrigated cropland (240,000 hectares in Senegal); and

The development of crafts, industry, trade, housing and services.

In 1983 OMVS set itself the objective of providing (by 1990) each active member of the agricultural workforce a quarter-hectare plot. It was expected that this land would produce 4 tons of paddy per hectare and that two crops per year would be harvested [BA and CROUSSE, 1985]. Since the active agricultural population is about 50 percent of the total rural population, this amounts to one ton of paddy per rural resident - as demonstrated below.

Rural population 1988 = 578,651 * 0.5 = 289,325 active workers.
Active workers * 0.25 hectares/worker = 72,331 hectares.
Hectares * 4,000 kg/ha * two crops = 578,651 tons paddy.
Tons of paddy * 0.65 transformation = 376,000 tons rice

Total population in 1990 (7.323 million) * 65 kg rice/capita equals a total rice requirement of 476,000 tons.
Total requirement times 0.80 = 380,000 tons

This calculation is based on the area needed to produce 80 percent of Senegal's rice needs and has little relationship to the Nation's ability to support development of the required area or to farmers' ability (or incentive) to produce a double crop.

As shown in Table 5, Senegal has a large unexploited potential for irrigated land in the four Departments which comprise the Region: of the over 970,000 hectares of arable land about two-thirds is irrigable, but only 4.4 percent has been developed.

TABLE 5

SENEGAL RIVER VALLEY: POPULATION, ARABLE LAND AND LAND DEVELOPED

ITEM	DELTA	PODOR	MATAM	BAKEL	TOTAL
TOTAL POPULATION	285,348	144,945	220,913	114,284	765,490
URBAN	160,689	7,469	10,722	7,959	186,839
RURAL	124,659	137,476	210,191	106,325	578,651
% URBAN	56.3%	5.2%	4.9%	7.0%	24.4%
	(HECTARES)				
TOTAL ARABLE LAND	210,279	285,444	220,872	257,080	973,675
TOTAL IRRIGABLE LAND	137,912	242,082	139,250	122,680	641,924
LAND DEVELOPED 1988	12,927	8,045	5,435	1,842	28,249
% IRRIGABLE DEVELOPED	9.4%	3.3%	3.9%	1.5%	4.4%
ARABLE LAND/PERSON	0.737	1.969	1.000	2.249	1.272
IRRIGABLE LAND/PERSON	0.483	1.670	0.630	1.073	0.839
DEVELOPED LAND/PERSON	0.045	0.056	0.025	0.016	0.037
DEVELOPED LAND/ACTIVE*	0.207	0.117	0.052	0.035	0.098
AREA AREA PLANTED 1989					29,073
RICE					24,162
MAIZE/SORGHUM					2,991
TOMATOES					1,493
VEGETABLES					427

* ACTIVE AGRICULTURAL WORKER (50% OF RURAL POPULATION).
SOURCE: [ANNEX A-]

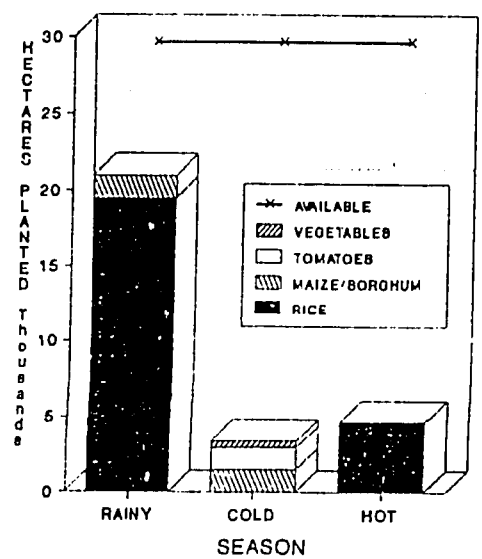
The goal of providing one-quarter hectare per active agricultural worker has nearly been achieved in the Delta (bottom line, Table a-), but is far from achievement in the other zones. However, from the point of view of the local community, and especially for the rural community, existing land is sufficient to meet total regional rice consumption needs ([100 kg/person]/4000]=.025 ha/person). In fact, area already developed is sufficient to meet local rice needs in all zones except Bakel with only one crop per year. The rural population has other food needs which also compete for the irrigated land and the other resources, but rice is the dominant crop (83% of irrigated area planted in 1989).

Information available on area planted to various crops during the three seasons suggest that cropping intensity is also much below the original goal. Figure a- shows area planted to major crops in 1989, by season. The Figure demonstrates two characteristics about present cropping patterns in the River

Valley: the area planted during the main cropping season (the rainy season) is about 5 thousand hectares below the total available (the total available is shown by the solid bar at the top of the Figure); and, areas planted in the two off-seasons, even if added directly to the main season area, just about equal the total area available. The figure also demonstrates that there is a considerable potential for improved use of existing land resources through intensification. This has important implications for the cost of development of irrigated land, the cost of producing various crops (water cost), as well as for processing costs. These factors are analyzed in more detail below.

FIGURE 2-5

SENEGAL RIVER VALLEY: AREA PLANTED TO MAJOR CROPS, BY SEASON
(THOUSAND HECTARES, 1989)



SOURCE: IBAED, 1990

There are a number of reasons why double cropping is not widely practiced in the Valley. The labor constraints which were discussed earlier

are one, but other disincentives, such as water delivery, input supplies, credit availability, technology availability, extension, the marketing system and State intervention are also important.

The role of the State: SAED, CPSP, CNCAS, ISRA

The principal agent for State intervention in the Valley is SAED which was created by law 65-01 on January 20, 1965 to replace the "Office Amenagement du Delta" which existed between 1960 and 1965. SAED activities concentrated on the Delta until 1974 when its mandate was expanded to cover the middle and upper valleys and the lower Faléme Valley. On July 10, 1981 it was change to a public company operating under contract with the State. To date there have been three contracts (Lettre de Mission). The current contract expires in July 1990 and a fourth is being prepared. At its inception SAED had a mandate to conduct regional rural development, agricultural production, marketing and processing, to provide technical assistance, to provide credit and agricultural inputs, and to support agricultural research.

While SAED's mandate has been very broad, its primary goal has been system development, with an original goal to develop 30,000 hectares in the Delta. The third contract (1987-1990) revised this goal to 35,896 hectares in the entire Valley by 1990. As was shown in Table æ- , this goal has not been achieved. The third contract established several other production goals, but most significantly, it also initiated a disengagement program. The SAED reorganization began in February, 1988. A major staff reduction was initiated in May of 1989.

The SAED staff was reduced by over 40 percent, from a total of 1,244 persons on May 31, 1989 to 732 persons on January 31, 1990. Most of the reduction was from temporary employees in URIC (rice mills), the land preparation units, and the central equipment repair shop (Autonomous Units).

See Figure æ- . Before the reduction the Autonomous Units accounted for nearly 30 percent of all staff; after the reduction they accounted for about 11 percent of the total. See Figure æ-

FIGURE æ-

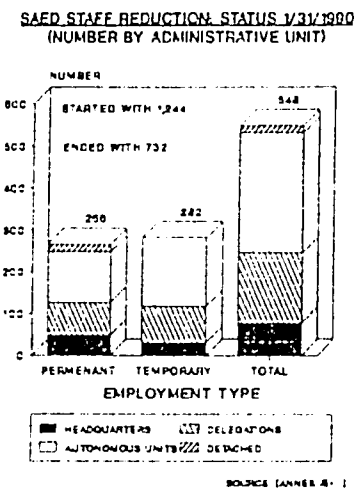
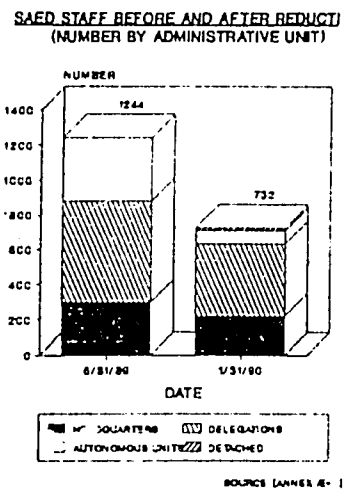


FIGURE æ-



The staff reduction accompanied SAED's disengagement from land preparation, credit and input supply functions and the beginning of the transfer of some irrigation support responsibilities to farmers and farm groups. The two rice mills (Ross-Béthia and Richard-Toll) were transferred to URIC (..) but SAED retained a monopoly on rice first-stage marketing and processing. Under this new form SAED retained responsibility for training and research, design and control, water management, perimeter development, extension and support to farmers groups.

SAED's activities are closely linked to CPSP, CNCAS and ISRA. The chain begins when a farmer applies for and receives credit from CNCAS. The farmer takes the credit approval to an input supplier, who provides the material then submits a bill to CNCAS. In the past, when SAED purchased the paddy from the

farmer it deducted for the loan and re-paid CNCAS. Now SAED pays in cash and the farmer deals directly with CNCAS. In the past, SAED, as owner of the paddy, arranged transport to the rice mills. Starting with the 1989/90 rice crop, farmers are responsible for arranging transport but SAED still pays for the transport. Once the rice is at the mill SAED pays a per kilo fee for processing. The processed rice is sold to CPSP which assumes transport and distribution responsibility. (More detailed information on rice marketing is given in Chapter --, page). Thus, despite the reorganization, a relatively complicated set of linkages still exist.

SAED's role in the agricultural research component of the research/extension link (promotion of the rural sector) is executed by convention with ISRA. Work is undertaken on a workgroup basis, i.e. mechanization, double cropping. ISRA works in two villages in the Delta and has benefited from USAID financing. [More information on research and extension is included in Chapter __, page .

SAED has an extension/training unit (Direction de la Formation et de la Recherche/Developpement-DFRD) which has 72 agents who work with SV and GIE who ask for their help. These agents are trained at the SAED training center, CNAPTI, (18 month period). The agents do training in tractor maintenance and management (SUMA), etc. (have benefited from FAO/PNUD Extension project (end 1989), PAGRI (Programme National de Vulgarization Agricole) test (BM). Most recently they have concentrated on training 20 agent-specialists in women's affairs, financed by the FAO/PNUD project. [DRSP, 1990, pg 26]

<u>ISRA:</u> Most of the agricultural research has been in the Delta, where nearly all of the research infrastructure is concentrated. As a result, most of the research has been oriented toward rice and rice based systems. Most of the rice related research has been conducted by ADRAO in direct collaboration with SAED, often with ineffective links to ISRA [ISRA, 1986]. Researchers have been provided by CIRAD and USAID. <u>The problem posed is one</u>

of research priorities, applicability, sustainability and coordination. These issues are discussed in depth in Chapter __, page __.

Administrative Services

Agricultural Inspectors: assist with rainfed and dryland crops, seeds, training in input use, marketing. The Inspectors are located at the CER's (Centre Expansion Rurale) at the arrondissement level. With few exceptions these units have very little operating capability (For example, an average of 1.16 liters of gas per day are available).

Livestock Service: helps with vaccine, marketing, and the formation of GIE to facilitate access to credit.

Cooperatives: Now gone. USAID supported a literacy project until 1988.

CER(Centre d'Expansion Rural): 11 CER units in the St. Louis Region with 50+ agents. Because the CER's have very little operational budget they are dependent on donor supported projects. There are three such projects in the Region, mostly aimed at women through the Women's Federation.

1. UNICEF has 4 components - production for women's perimeters, pumps

2. FENU, aimed at easing women's work, grain mills, etc supported by 10 monitirces in the CER's.

3. BIT-PNUD-DUTCH-FENU at Podor with 14 groups, mills, vegetables, small shops, cereals banks. [must get more info on these projects]

System development: SAED, USAID and Other Donor Activity.

SAED is also responsible for planning, executing and in some cases managing irrigated perimeters. As was mentioned earlier in this Chapter, these activities have been underway since the mid-1970's. A wide variety of donors and large investments have been mobilized. By 1989 a total of 30,000 hectares had been developed.

Development costs vary, according to the type of materials used, soil types, distance from the river and type of perimeter. Table x- shows data for

some recent developments, where per hectare costs range from 5.3 million CFCA ($19,000) to 271,000 FCFA ($1,000)[4],[5]. The most expensive developments use concrete lined canals, which should have a life of at least 20 years (yearly average cost of 265,000 FCFA) and the least expensive developments, being dirt only, will have to be rehabilitated each year. Considering the use of farmer labor one can imagine a yearly average cost of around 200,000 FCFA/hectare. This means that, just for development cost alone, a hectare will have to generate considerable revenue. For example, rice production with a yield of 4.5 tons/hectare would cost 44 FCFA/kg with a cropping intensity of one and 30 FCFA/kg for a cropping intensity of 1.5. Thus the delima: what crops, what cropping system, and who pays? This will be analyzed in detail in the following section of this Chapter.

The data in Table æ- and the figure on the following page also show that a large number of donor agencies have been active in irrigation development. The larger share of investment has come from _____ (%), followed by _____ (%) and _____ (%). USAID, which has been active in the Bakel area ranks __ in terms of funding and ___ in terms of area developed.

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[4]Converted using $1 = 280 FCFA

[5]According to [IDA/Guinard, June 1988] development costs are 4 to 5 times higher than in Southeast Asia

FIGURE æ-

PERIMETER DEVELOPMENT: SOURCE OF FUNDING, TOTAL COST, AREA, COST PER HECTARE (19-- TO 19--)

YEAR	PROJECT	FUNDING AGENCY	LOCATION	TOTAL COST (MILLION FCFA)	AREA	COST PER HECTARE	NOTE
	KASSACK NORD					3.040	
	REHAB. THIAGAR					1.156	
	NIANGA EXTENSION					2.948	LARGE PERIMETER
	DIOMANDOU					5.284	NETWORK IN CONCRETE (50% COST)
	PIV 6éme FED	FED				1.184	
	PIV MATAM		MATAM			.271	
1989	PIV	SAED	BAKEL	10.243	19.3	.531	CLASSIFIED AS "EASY"
	PIV	SAED	BAKEL	13.123	16.5	.680	CLASSIFIED AS "DIFFICULT"
	PIV	USAID (BSIP)	BAKEL	50.980	91.0	.560	WORK BY SAED (EXCL. FARMER, TECH. ASS'T. AND PUMP COST)

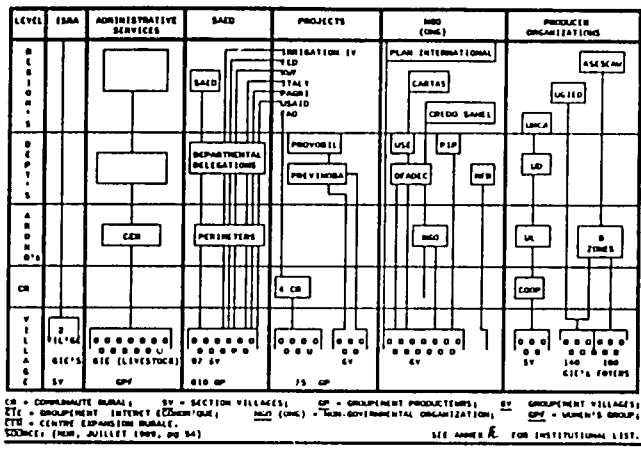
SOURCE [DRSP, 1990], [HARZA/REESER, MARCH 1990, pg 9c]

USAID costs do not include farmer investment, technical assistance or the cost of pumping systems; according to [HARZA/REESER, MARCH 1990, pg 9c] these costs account for 76% (including 33% farmer investment) of the total for the SAED "difficult" PIV in Bakel in 1989. One can only conclude that: either the excluded costs were somehow "folded" into the USAID costs, with little or not farmer investment, or the SAED perimeters were "marginal".

USAID experience:

FIGURE æ-

SAINT LOUIS REGION: FARMER SUPPORT AND ORGANIZATION



CR = COMMUNAUTE RURAL; SV = SECTION VILLAGES; GP = GROUPEMENT PRODUCTEURS; GV = GROUPEMENT VILLAGES;
GIE = GROUPEMENT INTERET ECONOMIQUE; NGO (ONG) = NON-GOVERNMENTAL ORGANIZATION; GPF = WOMEN'S GROUP;
CER = CENTRE EXPANSION RURALE.
SOURCE: (MDR, JUILLET 1989, pp 54)

SEE ANNEX K. FOR INSTITUTIONAL LIST.

Farmer Organization, Land Tenure and Agricultural Credit

Although the structure of the rural support system has changed considerably since the beginning of development in the Valley, the State is still the major organizing force. Farmer organization in the Valley is closely linked to land, expecially irrigated perimeters, political "management" of farmers, and agricultural credit. The basis for the State managed organization of the rural sector was, and remains, the 1964 land law, which reserves virtually all land to the State, and the July 2, 1976 law (76-66) which specified two forms of lease from the State (short and long term) and occupation and use rights. Only land under the two lease categories can be mortgaged. Application of the law (allocation of land) and recognition of transfer between generations is left to the Rural Communities. There is no legal, rural land market.

Figue æ- shows a simplified diagram of the various organizations which have evolved in the Valley; in particular, the Figure does not show the complete role of SAED and its links via the perimeters to the many organizations operating in the Valley.

Early Cooperative Development

In the early years (1960-65) in the Delta, farmers were organized into several cooperatives (about 30) each consisting of between 60 and 400 members. This was also a period when new settlers were moved into the Delta. This organization failed because of social conflicts. poor water management, poor credit repayment rates, low levels of technology and problems with fraud and mis-management. [NDIAYE, Juin 1989]. There was virtually no tenure security, because land was assigned to farmers in such a way that they could never know if they would receive land (let alone the same land) from year to year.

Producer Groups (GP)

The organizational concept was changed to center on Producer Groups (GP). These groups were relatively independent in that each was provided with a smaller area, a secondary irrigation system and motor pumps. These groups averaged about 12 farmers on 50 hectares and were managed by an elected leader. A contract arrangement was initiated, first between the individuals and the GP and then between the GP and SAED. Animal traction and related equipment, improved seeds and more intense extension were introduced. Following the droughts which began in the mid-1970's, and because of the same problems mentioned in the previous paragraph, farmers abandoned these technologies. SAED assumed land preparation responsibilities and the GP became more dependent on SAED.

Village Sections (SV)

Following the the cooperative reform of 1983 the GP were grouped into Village Sections (SV) [how many-from farm org Chptr] and the process of transfering responsibility for secondary system maintenance. pump management. and land preparation began. The SV's managed credit flows to and from the GP's and the GP's managed production. As shown in Figure x- , the SV's have been the primary targets of most development activities, especially for SAED and donor funded irrigation projects.

Credit repayment became a serious problem for SAED and the SV's and SAED refused credit and land to SV's in arrears. Thus, despite a progressive transfer of "responsibility" to producers, they were still heavily directed and controlled by the State and still dependent on SAED and still without secure land access.

Foyers de Jeunes (Foyers)

The Foyers have developed as relatively small, youth oriented, private efforts, generally without access to credit and with little formal connection to SAED. They are registered with the Ministry of the Interior. Most of the Foyers are located in the Delta zone and most are engaged in irrigated agriculture (some are also engaged in livestock). There are about 180 Foyer perimeters. SAED is involved with 34 (average size 42 hectares) [MDR, Juillet 1989 and Annex Æ-]. The main orgainzing force for the Foyers is ASESCAW, a Foyer specific federation (see Federations below).

Women's Groups (GPF)

The number of women's groups is not known with precision but according to a report from the MDR there are 100's in the Valley. [MDR, Juillet 1989]. Although these groups are registered with the Ministry of Social Development, they have no legal recognition and, thus, little access to credit. Primary activities for these groups are: production and marketing of vegetables, cereals milling, small livestock, cereals banks, and operating small shops.

Several projects and organizations have been active in supporting these groups: NGO's, UNICEF, FENU, and the FAO/SAED Rural Promotion Project. These interventions have been encouraging these groups to form GIE's so they will have access to credit (see Federations below)

Groupements D'Interet Economique (GIE)

A part of implementation of the NAP included a law (No. 84-37, May 1984) which permitted a new form of organization, the "Groupements D'Interet Economique" (GIE). This introduced a much more flexible and dynamic business

entity. A GIE can be formed by two or more people (moral or physical, i.e. two firms or two persons may form a GIE) and is not restricted to any specific activity. They are easy to form and operate and in many cases membership is parallel to the GP's and SV's because CNCAS insists that they form a GIE before it will provide credit (they may also be required to sign an agreement to repay old SAED debit before they are accepted).

The incentives for creating an agricultural GIE are access to credit, inputs and land. One important advantage is that they do not have to produce the 35 percent of the requested loan amount in personal cash and members may, in certain cases, avoid the credit restrictions imposed on SV's because of previous non-payment. As demonstrated by Figure æ- and Table æ- below, the number of GIEs registered in St. Louis began to accelerate when CNCAS began operations in mid-1987, totaling nearly 1400 by the end of 1989. In 1989, the GIEs received nearly 72 percent of all loans, and nearly 88 percent of the total amount loaned was for agricultural uses (production credit, livestock and agricultural equipment).

FIGURE æ-

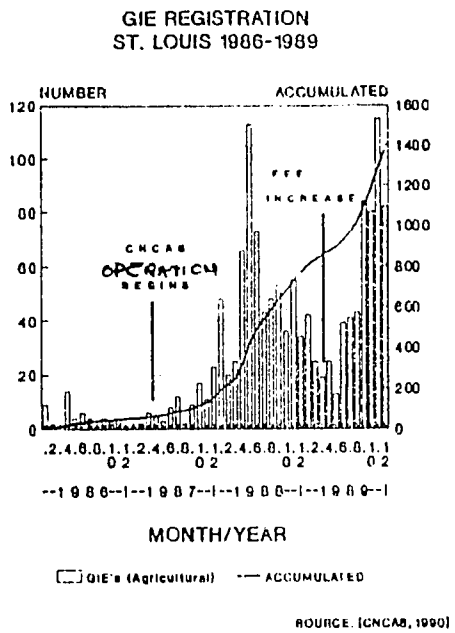


TABLE æ-

SAINT LOUIS: CNCAS LOANS 1988/89
(PURPOSE AND RECIPIENT)
(Excludes Matam)

PURPOSE	NUMBER OF LOANS				AMOUNT LOANED	
	SV	GIE	INDIV-IUAL	TOTAL	MILLION FCFA	% TOTAL
PRODUCTION	124	150	5	279	714	55.8
RICE (1)	89	116	3	208	533	41.7
TOMATO (2)	7	6	1	14	28	2.2
RICE (3)	28	28	1	57	153	12.0
AG. EQUIPMENT	10	60	3	73	357	27.9
FISHING	--	103	--	103	111	8.7
LIVESTOCK	--	47	--	47	56	4.4
COMMERCE	2	6	1	9	15	1.2
HOUSING	--	2	--	2	3	0.2
OTHER	--	1	2	3	23	1.8
TOTAL	136	369	11	516	1,279	100.0

SOURCE: (CNCAS, 1990, pg 31)
(1) RAINY SEASON, (2) COLD SEASON, (3) HOT SEASON.

The data in Table æ- show the great diversity and the importance of GIE activity in the Valley; they dominate CNCAS loan activity in nearly all categories, except off-season tomato and rice production, and nearly as many take loans for fishing as for main season rice production. Figure æ- also demonstrates a high degree of responsiveness to the business and policy environment. Registrations increased significantly after CNCAS began operations in the Delta in April, 1987, began to decline in early-1989, when registration fees were increased from 8,000 FCFA to 49,800 FCFA, and increased strongly toward the end of 1989 when SAED input distribution and land preparation units were privatized.

Federations

A Women's Federation has been formed. Each women's group (GPF) pays

22,000 FCFA to join. The money is used to provide credit.

A GIE (livestock specific) federation has been formed (by ministerial decree) but is not yet well organized.

UGIED (Union des GIE du Delta) was formed in 1987. It has 140 GIE member groups and 5,364 individuals. [MDR, Juillet 1989]. UGIED was formed through the efforts of a cooperatives agent in St. Louis and has ambitious plans to provide management, credit, livestock feed, and to construct cold storage facilities. A 5 billion FCFA credit request was submitted to the MDR. [when, what happened]

Non-Governmental Organizations (NGO or ONG)

Senegal has a large and active NGO population and the River Valley is no exception.

Bakel:

CECI

GRDR

AFVP

Matam:

CARITAS,

Plan International

Ital-Techno

Podor:

OFADEC

Luthern Mission

USE-PIP - primary activity in the walo and jerri lands. They have a staff of 10 and 60+ field agents engaged in literacy training.

Marketing, Processing and Private Sector Development

Private sector development, outside the traditional farmer based cereals and livestock trading, began with the disengagement mandated by the NAP. SAED is responsible for managing the disengagement, and indirectly private sector development, because it is exclusively involved. The first disengagement was an exit from credit activities, which were transferred to CNCAS in 1987[6]. Extensive disengagement began in 1989:

repair shops in April - to be completed in June, 1990;
land preparation - to be completed in June 1990;
pump repair and repair parts - also to be completed by June 1990.
SAED also disengaged from fertilizer distribution in 1989.

While the disengagement left SAED with a monopoly on first-stage rice marketing and processing, it permitted the development of numerous private and farm organization based agro-businesses. Initial concerns over the ability of the private sector to absorb "SAED" functions have not materialized, as show by the data in Table æ- and by the number of GIE's which have been formed. A total of 63 agro-business have developed in the St. Louis/Podor areas and are engaged in a borad range of activities.

[6]CNCAS was, itself, the result of the disengagement and decentralization. See Chapter __, page for further discussion.

TABLE x-

SAINT LOUIS/PODOR: NUMBER OF AGRO-BUSINESS FIRMS
(1989)

	BUSINESS ENTERPRISES	FARMER ENTERPRISES	TOTAL
FUEL	--	1 (MOBIL/RONKH)	1
TRANSPORT	--	3 (3 TRUCKS)	3
INPUT WHOLESALERS	3	--	3
INPUT DISTRIBUTORS	26	--	26
LAND PREPARATION	7	6 (11 TRACTORS)	13
HARVESTERS/THRESHERS	5	4 (4 MACHINES)	9
IRRIGATION SYSTEM DEVELOPMENT	3	--	3
MACHINERY REPAIR	2	--	2
FISHING EQUIPMENT	3	--	3
TOTAL	49	14	63

SOURCE: [CNCAS, 1990, pg 35]

While the stage is set for privatization of State functions in the Valley, a new initiative under the DPDA and SAED's Fourth Lettre De Mission will remove SAED from virtually all rice marketing and processing functions. The first steps are already underway, through a special commission in DRSP which will oversee the disposal of the SAED mills.

Input Distribution

ISRA RESEARCH SOON TO BE COMPLETED

Blank on purpose — Sor

Marketing and Processing

Rice

There are two SAED owned mills (Ross-Béthio and Richard-Toll in Dagana Department) and one privately owned mill which processes under contract to SAED (Delta 2000 in Podor Department). In addition to the industrial mills there are 140 small village mills in the Valley. The small mills are, in principal, permitted to process for home consumption only. Estimated processing capacity for the various mills is show in Table æ-

Table æ-

INDUSTRIAL AND VILLAGE RICE MILLS: CAPACITY AND UTILIZATION
(1989/90)

Mill	Annual Capacity (Tons)	Estimated Quantity Processed 1989/90 (Tons)	% Capacity
Ross-Bethio	16,500	15,000	90.9%
Richard-Toll	25,000	20,000	80.0%
Delta 2000	21,500	15,000	69.8%
Industrial mills	63,000	50,000	79.4%
Village Mills	62,000	62,000	100%
Total	125,000	112,400	88.9%
Production			

SOURCE: [ANNEX

The data in Table and in Figure æ- illustrate some of the main issues surrounding rice production, marketing and processing, privatization of the State owned mills and rice pricing policy.

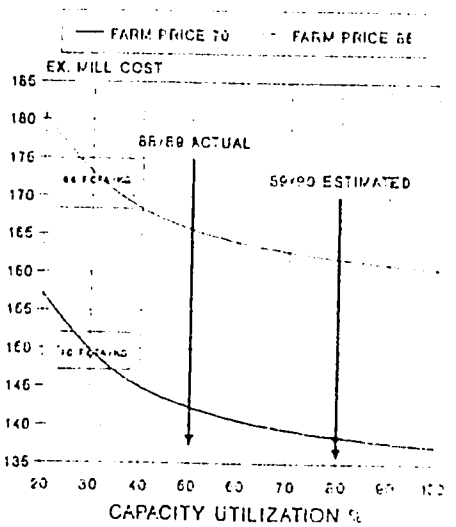
Table æ-

RICE PROCESSING COST: INDUSTRIAL AND VILLAGE MILLS
(1989/90 FCFA/KG)

ITEM	INDUSTRIAL PADDY	INDUSTRIAL RICE	VILLAGE MILL PADDY	VILLAGE MILL RICE
CAPACITY (KG PADDY/HR)	4,000		300	
TRANSFORMATION (%)	65%		55%	
PROCESSING COST	14.0	21.5	5.3	9.0
LESS BY-PRODUCT VALUE	3.4	5.2	9.0	16.4
NET PROCESSING COST	10.6	16.3	-3.7	-6.7
PADDY PURCHASE	85.0	133.4	30.0	54.6
TOTAL WITH PADDY	97.4	149.8	26.3	47.9
COLLECTION COST	11.0	17.0	11.0	20.0
TOTAL EX MILL	108.4	166.7	37.3	67.9
CPSP PAYMENT	115.7	178.0		
MILL SURPLUS (DEFICIT)	7.3	11.3		
TRANSPORT: ST. LOUIS	3.3	5.0	3.3	5.0
COST AT ST. LOUIS	119.0	183.0	40.3	73.9
WHOLESALE VALUE	78.7	121.0	71.5	130
SURPLUS (DEFICIT)	(40)	(62)	31.2	56.1

SOURCE: [ANNEX TABLE A-]

EX. MILL RICE COST AND CAPACITY USE
(INDUSTRIAL MILLS, RIVER VALLEY)



SOURCE: BASED ON ANNEX

101

Table

RICE MILLS IN THE SENEGAL RIVER VALLEY

ITEM	INDUSTRIAL: ROSS-BETTIO	INDUSTRIAL: RICHARD-TOLL	INDUSTRIAL: DELTA 2000	INDUSTRIAL: TOTAL	VILLAGE MILLS CAPACITY 450 T/YR	HOME PROCESSED AND OTHER	TOTAL PADDY PRODUCED (000 T)
LOCATION	DAGANA	DAGANA	PODOR	VALLEY	VALLEY	VALLEY	VALLEY
DATE CONSTRUCTED (1)	1972	1983	1988		1989	1989	1989/90
MILLING CAPACITY					140 MILLS		
RATED (T/HR)	6.0	6.0	4.0		0.300		
EFFECTIVE (T/HR)	3.2	4.2	3.4		0.300		
DAYS/YEAR (MAXIMUM)	330	330	330		330		
HOURS/DAY	24	24	24		6		
OPERATING TIME (%)	65%	75%	80%		75%		
ANNUAL (000 T)	16.474	24.948	21.542	62.964	62.370		125.334
PADDY PROCESSED (000 T)							
1986/87	6.600	9.500	1.900	18.000	55.688	11.335	85.022
1987/88	8.300	12.800	3.900	25.000	57.915	2.456	85.371
1988/89	8.700	13.900	8.200	30.800	60.143	0.261	91.204
1989/90	15.000	20.000	15.000	50.000	62.370	4.355	116.725
TRANSFORMATION RATE (%)	70.5	75.7	80.0	75.1			
RICE	61.0	67.2	67.4	65.3	55.0		
FLOUR	7.9	5.9	--	5.1			
BRAN	1.6	2.6	12.6	4.6	45.0		
PROCESSING COST (CFCA/KG)	PADDY	RICE		PADDY	RICE		
VARIABLE	9.8	15.1		2.0	3.6		
FIXED	4.2	6.5		3.3	6.0		
TOTAL	14.0	21.6		5.3	9.6		
BY PRODUCT VALUE	3.4	5.2		9.0	16.4		
NET PROCESSING COST	10.6	16.4		-3.7	-6.7		

NOTES

(1) DATE OF LAST CONSTRUCTION (2) 1988/89 MAIN SEASON RESULTS

SOURCE: [RABES, SEPT., 1989, pg 31, 35] [SONED, JUIN 1989, pg 59]

Farming Systems and Cropping Patterns

Farmer objectives and attitudes (food security at all costs)

Credit
Inputs
Tenure

Costs and Returns

Potentials for Development

The role of research.

Comparative Advantage and Strategic Issues