THE FOOD CHALLENGE IN THE SENEGALESE RURAL ECONOMY
AN ANALYSIS OF THE DOMESTIC CEREALS PROMOTION POLICY

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CHAPTER I

INTRODUCTION

Since the colonial era, the expansion of the Senegalese economy was greatly sustained by the agricultural sector in which more than three-fourths of the total population were involved. A 2.3 percent average annual growth of total production during the sixties matched the speed at which the agricultural population was growing and the rural economy was engaged in a kind of equilibrium path. During the late Sixties and early seventies, the situation began to change with an agricultural production growth rate dropping to the neighborhood of 1.3 percent against 2.8 percent for total population. Such a situation which is prevailing at the present time is seriously striking if we know that the agricultural sector should produce not only enough food for a rapidly growing population, but also raw materials for the development of local industries, mostly based on peanut and cotton. Per capita food production has been very unstable with large annual fluctuations but the trend has been clearly declining. World Bank experts noted that this situation is observed in the more general setting of sub-Saharan Africa and especially the Sahel region of which Senegal is part. They observed that this phenomenon occurred over a period when local authorities and foreign

aid focussed more than ever before on food production projects. In the specific setting of Senegal, food problems have been a major policy issue since the early years of the drought (1968) but some analysts support that a trend of shortage was already clear by 1960, the year of independence. The present food crisis is the result of various causes that have been in play for a long time.

A. Factors Contributing to the Food Crisis

To explain the present situation of inadequate food supply in quantitative terms, a number of factors can be identified involving government policies as well as supply and demand related problems.

A.1 Government Policies

The colonial legacy of a cash crop oriented policy has been maintained and even reinforced after independence for the sake of foreign exchange earnings. Very little interest has been given to the issue of food production in the allocation of national resources within the agricultural sector. Research institutes, extension services and rural development agencies have placed a heavy emphasis on commercial crops at the expense of food staples produced mostly by subsistence farmers for self consumption needs. Improved technological packages and support systems were generally designed to meet the needs in the export-oriented farming sector. Finally, the existing incentive structure is such that farmers have little interest in producing marketable surpluses, even if they could.

A.2 The Supply Side

With the relative deprivation felt by people in the rural areas, the agricultural labor force is being progressively undermined by migration to the cities. In fact, with the emergence of a new generation, the drudgery of the traditional farming system is less and less accepted and tends to be considered as a spare activity for survival when no other alternative is available.

Despite a rapidly growing total population, a USDA study carried out in 1981 ("Food Problems and Prospects in Sub-Saharan Africa: the Decade of 1980's" USDA Economic Research Service, Washington DC. August-1981) concluded that labor was the most binding constraint in the agricultural sector of sub-Saharan Africa, due to severe bottlenecks at peak periods. In the Senegalese case, three main causes of seasonal labor shortages can be identified:

a. A sexual division of labor in the traditional farming sector by which some specific tasks are performed by males and others by females.

b. The schooling of children who are generally not available during the periods of land preparation, early planting and late harvesting.

c. Temporary off-farm employment such as construction of buildings, roads, etc. which can keep part of the adult male labor force off the farm.

The argument of harsh environment generally stresses the low fertility of soils and inadequate conditions for nitrogen

fixation, which limits the efficiency of fertilizer when it is applied.

The list of supply hindering factors would not be complete without mentioning post-harvest losses which can be very serious and which are caused essentially by unexpected late rains, insects, birds, as well as inadequate harvesting, storage and processing methods.

All these problems combined have resulted in a worrisome situation of short supply in the Senegalese food sector, accentuated by about one decade of drought and a rapidly growing demand.

A.3 The Demand Side

The relatively high rate of population growth (2.8 percent annually against 1.6 percent for cereal production according to the V Plan) is recognized as the most important factor in the upward pressure on the demand for food. The demographic argument has received particular emphasis on the part of international experts but the relative contribution of population growth to the current situation is open to debate. During the World Population Conference held in 1974, it was considered by national representatives that a dynamic population control policy was not a top priority in Senegal at that time. However, if the present trend of population growth and urbanization is to continue, it is estimated that each active worker in the rural Sahel will have to feed at least 3.5 people by the year 2000, according to CILSS - Club du Sahel. Increasing demand for food is

also accentuated by higher income in some segments of the population.

In summary, it can be recognized that the present food situation in Senegal is the result of a long and complex process with various dimensions related to history, politics, nature, general economic framework and different social factors. The facts are overwhelmingly challenging and besides international debates and official reports, concrete steps must be taken to provide the population with more adequate food supplies and protect future generations against the calamity of hunger; the question is how?

The nature of the situation calls for both a short term and a long term strategy but in the present context, the ingredients of the former do not seem to help the implementation of the latter. In fact, the short term aspect of the problem has so far been dealt with by means of direct food aid which can be a necessity in some circumstances but it can be evil at the same time.

B. Direct Food Aid and Related Problems

During the critical periods of bad weather conditions, people in the Sahelian countries particularly, used to depend greatly on the international community in their struggle against starvation. The eradication of hunger was presented by W. Brandt as the responsibility of mankind as a whole and as a necessary condition for promoting cooperation and solidarity among nations. In his report entitled "North-South, a Program for Survival," the author states

that from the moral point of view, it makes no difference whether a human being is killed in war or is condemned to die of starvation because of the indifference of the others. The international community has, in fact, made significant steps toward coping with hunger threatening less developed countries in general and the Sahel region in particular.

During the period 1976-78, the average annual PL. 480 transfers of cereals to Senegal was estimated at 28,000 metric tons (estimates of the USDA in "Food Problems and Prospects in Sub-Saharan Africa, the Decade of 1980's"). The evolution and composition of total cereal aid to the country is reproduced in the following (Table 1-1) with units expressed in metric tons:

Table 1-1. Evolution and composition of Food Aid to Senegal

Year / Commodity	1970	1971	1972	1973	1974	1975
Rice	8,000	--	--	3,500	2,200	--
Wheat	4,000	--	--	43,400	5,400	6,200
Millet-sorghum	--	700	--	15,000	21,000	--
Maize	9,600	2,100	1,000	46,000	28,000	5,500
Total	22,400	2,800	1,000	108,500	57,000	11,700

Source: CILSS - Club du Sahel, "Marketing, Price Policy and Storage of Grains in the Sahel," CRED, University of Michigan August 1979, p. 333.

What appears clearly in the table is that wheat and rice are important components of the shipments directed toward senegal where they are not traditional staples. This means that dietary habits of recipient populations were somewhat "disturbed" with the development of a new taste for those commodities, mostly demanded in urban areas. Some people argue that the high urban demand for wheat and rice is explained by the fact that those commodities are more convenient in terms of preparation compared to traditional cereals (millet and sorghum). Nevertheless, one should not overlook the taste problem well established in the Senegalese case where consumers were reluctant to accept in their bread only 15 percent of locally produced millet flour. This would, however, generate 10,000,000 FCFA of average annual savings on wheat imports if the experiment could be generalized. The extent to which the so-called shift in consumption preferences can be attributed to food aid is, however, not clear but the alteration is now a fact which in not easily reversible.

A number of people have argued that a massive food aid strategy is just as dangerous as one which advocates no food aid at all. The point generally made is that substantial food aid has a tendency to delay the implementation of domestic production programs by being viewed as a substitute for national efforts instead of a supplement necessary only to cope with emergency needs. The argument that food aid reinforces the dependency syndrome was stressed by Rene Dumont at the World Food Conference in 1976 when he said

that, "In a few years with the growing world scarcities, whoever wields the strategic arm of exportable wheat (food) will wield an arm comparable to that of oil and will be able to impose economic and even political conditions on everyone else." (Quoted from C. Zuveka Jr., Economic Development, an Introduction, St. Martin's Press, New York, 1979, p. 398.) Professor Carl Eicher has also mentioned among other things the fact that food aid for development depresses farm prices in recipient countries and therefore tends to discourage domestic food production ("Facing Up to Africa's Food Crisis," Foreign Affairs Quarterly, Fall 1982, p. 167). However, the most crucial feature of food aid is that it is essentially unreliable due to political considerations and other new economic factors. The major food producing countries, namely North America, Western Europe and Australia, are facing increasing commercial import demand from middle income developing countries, Eastern Europe and U.S.S.R. Furthermore, economic difficulties facing major donors have seriously limited their capacity to provide aid.

On the other hand, it is interesting to note that the expressed demand reveals a certain bias toward non-traditional staples as can be seen in the following table which gives the income and price elasticities of basic food commodities in the Sahel region as a whole (Table 1-2).

Table 1-2. Income and Price Elasticities of Selected Food Commodities in the Sahel

	Income Elasticities	Price Elasticities of Demand
Wheat	0.92	-0.30
Rice	0.93	-0.35
Maize	0.46	Not significant
Millet-sorghum	0.15	-0.06
Roots and Tubers	-0.04	Not available
Pulses	-0.14	Not available

Source: USDA, "Food Problems and Prospects in Sub-Saharan Africa: the Decade of 1980's", USDA Economic Research Service, Washington DC, August 1981, pp 36-37.

C. The Alternative of Commercial Imports

Besides the compelling character of import needs, it is generally argued that self-sufficiency does not make economic sense for countries in which it is more efficient to develop exports and pay for imports. The logic of this argument implies that Senegal should put emphasis on the peanut industry and other activities for which it has a "comparative advantage" and which would generate foreign exchange earnings to pay for food imports (wheat and rice). Our purpose is not to discuss the conceptual framework of the comparative advantage as established by A. Smith, D. Ricardo or Hecksher and Ohlin, but we'll point out some

difficulties associated with such a strategy in the specific case of Senegal. In fact, the strategy of developing exports to pay for imports is constrained by the fact that Senegal, like most developing countries, has a relatively narrow export basis with very few commodities (groundnuts, phosphate, etc.) extremely sensitive to uncontrollable factors such as whimsical rainfall patterns and market fluctuation. As it is well known, the major export crops, namely groundnut and cotton, have been repeatedly and seriously affected by unfavorable weather conditions, causing very difficult balance of payment situations. Beside the effects of natural factors, the country has no bargaining power in the world market where it is generally a price-taker for its exports and imports. on the other hand, the existing productive capacities do not allow taking full advantage of the economies of scale that would result from a specialization according to comparative advantage which should, however, not be viewed as a static concept.

Another source of concern is that the traditional export commodities of the country, especially peanut and cotton products, are now facing serious competition from numerous substitutes in the world market. These problems are, however, longer term policy issues and the present reality is that increasing food needs of a growing population are to be met in one way or another.

As we have stated earlier, direct food aid is not a reliable source to feed a country and the gap between cereal production and estimated needs reveals a real catastrophe as

can be seen in the following evolution of the self-sufficiency ratio.

Table 1-3. Evolution of the Food Self-Sufficiency Ratio in Senegal.

Period	1961-65	1969-71	Projections for 1985
Ratios	70	66	59

Source: CILSS - Club du Sahel: commercialization, Politque des prix et stockage des cereales au Sahel. Tome I CRED, University of Michigan, August 1979, p. 239.

For rice, the production figure was 25,000 metric tons in 1975 against 5,000 for wheat while the projected needs for the year 2000 are respectively 600,000 and 300,000 metric tons. (Bulletin de l Afrique Noire: L' economie de pays du Sahel no special, 1976). These figures do not need long comments and the food import gap is already a major problem for the national budget. In 1973, food commodities accounted for 30 percent of total imports (FAO, "The State of food and Agriculture, United Nations, Rome 1980"). According to the national service of statistics, during the period 1971-76, 37 percent of the total cereal consumption was imported and the share of rice in total cereal imports was 55 percent against 28 percent of wheat. During the same period, cereal imports alone absorbed about 50 percent of total receipts from groundnut exports and explained 30 percent of the country's international trade deficit. Therefore, the dependency on food imports is very heavy and the cost in foreign exchange is getting higher and higher. Some

experts have argued that imported food is artificially cheap and represents a significant discouraging factor for domestic food production. However, a more relevant argument is that a strategy of national food security cannot be built upon import policy for a number of reasons discussed earlier and domestic production must be developed if the food crisis is to be tackled affectively. But such a strategy would necessarily place emphasis on the traditional cereals, namely millet and sorghum, better suited to the ecological conditions. In the new food investment strategy adopted by the government for the period 1977-1985, the objective is to reduce grain imports form the annual average of 325,000 metric tons (1971-74) to 75,000 metric tons in 1985 by encouraging the production and consumption of local cereals.

D. Objectives of the Study

The objectives of this study are three-fold.

--Identify some major issues to be dealt with in the implementation of a domestic food production strategy.

--Provide a systematic quantitative analysis of the production and consumption relationships which would be determinant in the final outcome of the domestic cereals promotion policy.

--Provide a framework for taking actions toward improving the present situation.

As early as this stage, it should be made clear that the quality of the results will necessarily be bound by

by that data used which were compiled from different sources.

E. Outline of the Study

--The introductory chapter was devoted to a general overview of the food situation in Senegal and a presentation of the economic rationale for promoting domestic cereals.

--Chapter II will identify and discuss some major issues related to the domestic food production strategy.

--Chapter III will deal with the supply aspect of millet and sorghum which are the basic food crops in the subsistence farming sector.

--Chapter IV will analyze the local consumption of those two commodities which raise a fundamental controversy as to whether they are superior or inferior goods for the Senegalese consumer.

--Chapter V, the concluding one, will summarize the major findings and put forth some suggestions that might help in implementing policies designed to cope with the present food crisis.

CHAPTER II

KEY ISSUES IN PROMOTING DOMESTIC FOOD PRODUCTION

Despite the present difficulties in the food situation, some people believe strongly that the Sahel region can become the granary of Africa, provided that the necessary efforts are undertaken. This point of view was expressed by A.M. Mbow, Director of UNESCO, during the fourth Conference of the "Club du Sahel" held in Kuwait in November 1980.[1]

A similar optimism was also expressed by the authors of MOIRA (Model of International Relations in Agriculture)[2] who support the statement that tropical Africa is physically able to produce no less than 128 times the food it did in 1965. However, for the Sahel countries to produce more food than they need or even to be self-sufficient, huge efforts must be undertaken to overcome some major constraints.

A. The Conventional Policy Approach

The food production strategy in the Sahel region has been based on the idea of agricultural modernization. This was understood as the adoption of improved technological packages, higher yielding varieties of crops (green revolution), large scale irrigation and so forth. In national development plans, food production has always held a top position but the actual achievements have so far failed to reflect the declared will. Since 1973,

multilateral assistance has been progressively oriented toward supporting the efforts to strengthen domestic agriculture. The national food strategies of Sahelian countries were in fact endorsed by the World Food Council at its fifth ministerial session held in Ottawa in September 1979. The purpose was to help those countries in preparing their food strategies by providing information and additional resources for investment programs. The underlying assumption was that a significant increase in food production can be achieved at relatively low cost by adopting new improved inputs and carrying out some policy reforms concerning land tenure, marketing systems, etc. However, food program designers used to believe that boosting agricultural production as a whole would automatically take care of the food problems facing the Sahel. If we take a look at the structure of the agricultural sector in the Sahel, it will appear that what is needed is not only strengthening agriculture but also a certain reorientation. For Senegal that structure is reflected through the following figures estimated by F.A.O. for 1979:

--Agricultural population as percentage of total population: 75 percent.

--Agricultural exports as percentage of total exports: 43 percent.

--Agricultural imports as a percentage of total imports: 30 percent.

With such a high percentage of its population involved in agricultural production, if food shortage is still a problem in Senegal, there is a serious matter for concern. Since independence, the bulk of the efforts to develop the agricultural sector have been export oriented. Therefore, the idea generally advocated nowadays is the adoption of a dynamic policy of reallocating resources between subsistence and commercial crops. However, the implementation of such a policy may generate unwanted side effects through a decrease in the production of export crops which represent a vital part of the country's economic engine.

B. The Potential Trade-Off Between Subsistence and Export Crops

With the existing productive capacity, the output level of food crops cannot be significantly increased without a simultaneous decrease in the production of foreign exchange earning crops. Mali and Niger have experienced this situation during the seventies. World Bank experts have noted that in Sub-Saharan Africa good performances of food production programs were generally offset by declines in other parts of the rural economy. As mentioned earlier, seasonal labor bottlenecks represent a serious constraint in the Senegalese farming system where the effective agricultural population for 1979. On another hand, arable land seems to be more limited than most people tend to think and was estimated at 12 percent of total land.

Therefore, one can conclude that unless the labor and land problems among others are overcome, more food

production is very likely to be achieved at the expense of other crops. However, production data over the last two decades show a positive sample correlation coefficient of 0.495 between the output levels of millet-sorghum and groundnut in Senegal. Nevertheless, one should not be fooled by such a positive relationship which may be spurious and explained by weather conditions which determine over 40 percent of the variability in the Senegalese agricultural output according to World Bank estimates. (West African food grain study." The World Bank, Washington D.C. 1978). On the other hand, both food and cash crops have the same increasing time trend in which the growth rate of rural population (2.1 percent) plays certainly a major role.

During the discussion symposium centered on the 1981 World Bank report and held at Michigan State University in April 1983, Rolf Gusten supported the idea that agricultural exports represent a necessary source of foreign exchange earnings without which agricultural development itself may be jeopardized. About 55 percent of the Senegalese foreign exchange earnings come from groundnut which represents with cotton the main basis of domestic industries. Therefore, a decrease or even a stagnation in the production of those crops may be damaging to the national economy. Consequently, adequate measures should be taken to prevent any trade-off that might take place at the expense of cash crops if a specific new emphasis is placed on domestic food production. Those necessary measures include, among other

things, the improvement of productivity in the agricultural sector as a whole.

C. Necessity for Improved Productivity

For the period 1975-90, F.A.O. estimated that 46 percent of total increase in the Senegalese agricultural production will be explained by cultivating more land against 37 percent by better yields and 17 percent by changes in cropping pattern. (F.A.O., "The State of Food and Agriculture," United Nation, Rome 1978). Given the relative limitation of cultivable land coupled with the fact that bringing more land under cultivation tends to accentuate the very serious problem of forest clearing, improved productivity becomes a crucial necessity for the new food production strategy to be a success.

Without better productivity, the producer price level which would generate a substantial increase in domestic food production would be very high. This would discourage the consumption of local cereals if they are not heavily subsidized at the retail level or if consumer prices of imported wheat and rice are not kept artificially high.

It should also be recognized that a significantly higher production level of food crops, whether achieved through bringing more land under cultivation or better productivity or both, will require additional productive capacities in the agricultural sector.

D. Necessity for Additional Productive Capacities

If we accept the argument of "poor but efficient" allocation of existing resources in the traditional farming sector, then one should not expect a significantly higher output without additional inputs. F.A.O. experts have concluded that a 30 percent increase in the official producer price of grains in the Sahel following the drought did not generate any output response due to lack of capital, which is, therefore, a seriously limiting factor. On the other hand, the use of commercial fertilizer is now becoming a necessity even to maintain soil fertility at its relatively poor current level. In fact, fallowing periods are getting shorter and shorter, due to population pressure which causes marginal lands ot be brought into cultivation. A. Niang[3] mentioned in a linear programming study that 22 percent of the farmers in the Senegalese peanut basin do not use any fertilizer and for those who do, the rate of application varies between 26 percent and 45 percent of the recommendations which are ignored by 60 percent of the farmers. It is our observation that, besides the cost of fertilizer compared to its potential return, farmers have come to realize that its use generates additional requirements for weed control especially if rainfall is good and it decreases the drought resistance of the plants, which increases risk in the Sahelian environment. In fact, with a temporary lack of rain, plants which received a higher dosage of fertilizer will be the first to dry off while in rainy years it is very frequent to observe entire fields

forsaken because of weed problems, always more crucial in fertilized areas.

The labor bottleneck problem reinforced by the use of fertilizer requires also new ways of performing certain tasks such as harvesting millet for which the problem is very crucial because it is entirely carried out by hand. According to the assessment of ISRA, the Senegalese Institute of Agricultural Research, 83 percent of the farmers are underequipped. Mechanization of farm work can only be partial and, therefore, ought to be carefully selective. Indeed, attention should be called to the fact that in some circumstances, it may even aggravate the bottleneck problem. This is already the case in Senegal where farmers have a general tendency to plant more than they can weed or harvest on time, due to relatively more efficient planting equipment. The animal traction which goes with this equipment necessitates specific human labor since animals are to be taken care of permanently and more forage must be produced.

According to estimates, about 360,000 production units fall in the category of small farms with a size ranging from three to ten acres and provide over 95 percent of total agricultural production. With such small farm sizes, equipment like tractors and combine harvesters are completely out of scope individual farmers. The ecological cost of agricultural mechanization is generally neglected on the basis that any developmental action has its associated negative side. In Southern Senegal, it was observed that

with introduction of agricultural machinery, soil erosion increased from 8.6 to 14.1 tons per hectare. (Afrique Agriculture, No. 27, November 1977). This can be understood if we know that the use of the machines requires more clearing of the land, the bushwood cover being uprooted while in the traditional farming system it is only cut short.

From a social point of view, the introduction of modern technological packages as a strategy for increasing food production is unlikely to benefit the poor subsistence farmers and would be the exclusive domain of richer people who can afford the required investments and for whom agriculture is generally a secondary source of earnings. In traditional farming sector, the adoption of new techniques and practices is also likely to decrease the relative efficiency of the farmers even with effective extension services. In fact, the efficiency of the farmers within the traditional system was acquired after a long process of trial and error in a relatively stable environment. It can be logically believed that any drastic change in that environment, which is not endogeneous to the very system will require a new round of trial and error before a good understanding and adaptation can be developed. During the transitional phase, which can only be reduced but never eliminated by extension work, farmers cannot be as efficient as they are in a traditional setting. Efficiency will not be achieved without an adequate understanding of the modern system and for farmers with little or no scientific

background, the truth is generally not what the extension agent says, but rather what empirical experience has revealed. As an example, some farmers in the peanut basin used to apply millet fertilizer on their groundnut fields only because yield response of millet to millet fertilizer is higher than yield response of groundnut to groundnut fertilizer. Similar kinds of "wrong beliefs" one acquired with the help of specific circumstances are not easy to destroy and their psychological effects can be very strong, whether sustained by "illusive" success or "accidental" failure.

On another hand, mechanization of agriculture can greatly reduce employment opportunities for landless farmers who represent an important portion of the rural population. Those migrant farmers who derive their livelihood from agriculture would be forced out of the rural areas if they cannot sell their labor to the so-called "progressive" (but non-professional) farmers.

All this discussion raises the problem of appropriate technology[4] but so far, in concrete terms, we know more about technologies that are not appropriate. it is also clear that the availability of improved technological packages would be meaningless to the average Senegalese farmer if adequate credit facilities do not exist as well as a better functional level of education. However, as proven by recent history, agricultural credit is very risky in an environment where the most determinant factor, rainfall in this case, is completely out of control. Therefore, more

stable productive conditions have to be created justifying the need for developing irrigated agriculture.

E. The Need for Developing Irrigation

In the West African food grain study carried out by the World Bank in 1979, it was found that 50 to 70 percent of the variability in the production of millet and sorghum in the sahel region was attributable to the rainfall factor.

During the last decade, Senegal, like other Sahelian countries, has experienced unfavorable weather conditions, causing tremendous losses of crops and livestock, as well as a serious disintegration of the rural community. In fact, with the permanent threat of the drought which is still a present problem, the agricultural business has become very risky for 70 percent of the Senegalese population deriving a livelihood from it. However, even if rainfall has become so whimsical and unreliable, water in general is not so scarce a resource in the region. In fact, the tremendous volumes of water carried every year by the Senegal River (15.9 billion cubic meters per year), the Gambia River (9.46 billion m^3) and the Casamance River (0.192 billion m^3) are mostly thrown into the sea while human beings and cattle are starving, partly because necessary efforts are not undertaken to avoid the loss of such a needed treasure. (CILSS - Cub du Sahel: The development of irrigated agriculture in the Sahel: Review and perspectives, Club du Sahel. Paris, April 1980). Therefore, in launching any sound agricultural scheme with the purpose of coping with

the food crisis, one cannot ignore the necessity for creating drought-proof conditions to the extent feasible by exploiting the potentialities of irrigation. According to the same source, modern irrigation farming provided in 1979 less than 5 percent of the irrigated land was completely protected from climatic hazards. For Senegal, the irrigation potential that could be developed within the next 20 to 25 years is estimated at 460,000 hectares while only 91,000 hectares of irrigated area (total = partial water control) were farmed in 1978-79.

The concern about the lagging irrigation sector was expressed in the "Ottawa Strategy" which set the target of bringing under full water control 500,000 hectares by the year 2000 and development of 100,000 hectares of rice with controlled flooding in the Sahel region. The necessity of irrigation in Senegal is reinforced by the fact that highly demanded commodities, namely rice and wheat, as well as sugar, cannot be produced locally under rainfall conditions. The projected domestic needs for those commodities in the year 2000 are respectively 600,000, 300,000 and 200,000 metric tons with 230,000 hectares of irrigated land required to meet the production targets of self-sufficiency at the current level of yields. However, to bring the water resources under full control, very ambitious investment programs have to be carried out, with the need for financial assistance on the part of the international community. In fact, river basin development schemes require tremendous amounts of capital while the existing resources are

particularly limited and the short-term needs crucial. The Senegal Valley Scheme undertaken by Senegal, Mali and Mauritania involve in a first stage the construction of two dams (Diama in Senegal and Manantali in Mali) for a cost estimated at $890 million in 1981 prices without taking into account the irrigation infrastructure and the operating expenses. The Diama dam is expected to enable the irrigation of 42,000 hectares of which 28,000 would be in Senegal. For the Manantali dam, projections of total irrigated area are 255,000 hectares of which 14,000 would be in Senegal. The beginning of the operations have been delayed many times due to lack of funds and the enthusiasm shown during the early years of the drought by local governments and donor countries seems to be decreasing. In fact, people have come to realize that the particularly high cost of developing irrigation necessitates a careful reconsideration of expected performance with respect to objectives, externalities and other foregone alternatives. The maintenance of modern irrigation infrastructure involves technical, managerial and financial problems that deserve attention on the part of program designers. In fact, in 1979, a survey carried out by the C.I.L.S.S. concluded that about 25,000 ha of irrigated land previously developed in the Sahel were no longer farmed because of maintenance problems. Indeed, most of the farmers involved were not used ot irrigated agriculture and didn't have the required skills. Specialized agencies were created to deal with

maintenance problems but the results are still not encouraging at all.

Such failures can have major psychological effects on farmers and greatly reduce their interest in irrigated agriculture, which is a domain where the problem of appropriate technology is particularly challenging. According to World Bank estimates,[5] irrigation projects in Niger and Mauritania have cost more than $10,000/hectare in 1980 prices. Under such conditions, producing one ton of rice at the present level of yield would require $600 of expenses and the varieties of rice imported by Senegal and Gambia is at least 40 percent less expensive. Compared to the traditional farming pattern, modern irrigation is a very costly undertaking and, therefore, its economic viability will be conditional upon a significantly higher yield, which implies that the "green revolution" is a necessary condition for the "bulldozer revolution" to be a success.

F. The Green Revolution Controversy

The cost factor of agricultural modernization at the present stage of the arts dictates the necessity of adopting higher yielding varieties of crops. In fact, with the present level of yields for the traditional varieties of cereals, investing in modern irrigation and new machinery would be financially unprofitable. However, agronomic research has been oriented in such a way that the cereals mostly affected by the green revolution are mainly rice, wheat and corn to a lesser extent, while in Senegal millet

and sorghum are the basic food crops in the subsistence farming sector. Even if the seeds can be made available, one should keep in mind that a major characteristic of existing green revolution crops is their high requirements for water and modern commercial inputs such as intensive use of fertilizer, pesticide, and so on. This would contribute to the reinforcement of the dependency of domestic agriculture on the technology of industrial countries. The water requirements of green revolution crops would confine their suitability to very limited areas and the bulk of the agricultural population is not in a position to be among the direct beneficiaries. Therefore, a green revolution oriented strategy would necessarily create a greater dichotomy between a modern irrigated agricultural highly capital intensive and a lagging traditional subsistence sector with no chance of getting a fair share in the allocation of national resources within the agricultural economy. Nowadays, irrigated farming covers some 230,000 hectares of land against 13 million hectares for rainfed farming which is expected to provide about 90 percent of total cereal production at least up to 1985 according to the estimates of the current national development plan (VI^{e}plan). On the other hand, if modern inputs have to be imported to support a green revolution, the situation would be a real paradox because, as we know, one purpose for developing domestic food production is to cope with a burdensome trade deficit.

Besides all these considerations, the ecological environment does not seem to be well suited to the existing

green revolution crops and Professor Carl Eicher noted that hybrid sorghum varieties from India were not successful in Upper Volta, Mali and Niger because of unforeseen problems such as diseases, variability in rainfall, poverty of soils, etc. Another factor is that up to now, very little is known about the capability of the soils to bear highly intensive agriculture.

This chain of difficulties and dilemmas has certainly contributed to the shift of food production strategies toward other alternatives. In fact, it is more and more believed that even at the present level of productive capacities, food output can be significantly increased, provided that an adequate incentive system is set up, especially through the official pricing policy.

G. The Price Incentive

Willis L. Peterson[7] argued that estimates of long-run aggregate agricultural supply elasticity from cross-section data revealed a relatively high response of price incentives in the range of 1.25 to 1.66. He supported that, with more favorable farm prices, agricultural output in a group of 27 developing countries could have been 40 percent to 60 percent higher than it was and the national income of the group would increase by 30 percent annually. On the basis of this argument, he concludes that if farmers in developing countries had enjoyed the level of prices prevailing in developed countries, or in the world market, there would be no such thing as food shortage. For Senegal, Niger and

Upper Volta, he estimated that the social cost[8] of low farm prices were respectively $43,468,000, $100,626,000 and $40,217,000 in 1962 prices. All these conclusions are drawn on the basis of a high price elasticity in farm supply functions at the aggregate. However, it should be made clear that a mere supply response analysis is not a sufficient basis for policy recommendation if the demand side is left out of the picture. This picture would also be different if it included a necessary distinction between the commercial export oriented crops and the foodstuffs produced in the subsistence sector.

Among the explanatory factors of the food crisis in the Sahel region, the price policy set up by governments has recently been given much attention on the part of numerous development analysts. It is argued that since farmers have been responsive to price incentives in the cash crop sector, the same mechanism would work as well in the food producing subsistence sector. Some authors are still skeptical as to the viability of such a strategy, arguing that subsistence farmers may not attach a high value to monetary gains and have a complicated set of motivations that need further investigation. In the Senegalese context however, there's not a clear separation between subsistence farming on one hand and the cash crop sector on the other hand. Instead, both activities exist generally on each farming unit and relative prices may well be a decision criterion in the process of allocating resources at the farm-family level.

Professor Carl Eicher noted that in Mali, raising official producer prices of food may be more effective than 20 new food production projects. (Facing up to Africa's food crisis, Foreign Affaires, Fall 1982, p. 172). In the 1981 World Bank report entitled, "Accelerated Development in Sub-Saharan Africa, An Agenda for Action," it is stated that, out of nine projects implemented under favorable prices, seven actually achieved or surpassed their production targets while 13 out of 18 under unfavorable prices failed to do so. However, it would be interesting to know the circumstances under which prices were favorable or unfavorable, that is, the nature of the commodities that were involved as well as the characteristics of corresponding demands.

In the Senegalese food sector, it is claimed that official price policy tries to achieve three main goals:

--Provide the farmers with higher income.

--Create incentives for more production.

--Protect the interest of the consumer.

In such a situation, a real magic formula must be found if these three sensitive issues are to be given equal concern.

H. Problems in Pricing

Using prices as a means for increasing farm income and creating production incentives does not involve many alternative ways of implementation. In fact, the only possibility is to increase the prices farmers receive for their products. The question is, however, what prices

should be increased, how much would be enough to fulfill the objectives without producing major undesirable effects, especially on the demand structure for agricultural products. The quantitative relationships within the rural economy will be analyzed in the next two chapters and for the moment, we want to examine and discuss some possibilities for price increase on a purely qualitative basis.

Rural production in Senegal is heterogeneous and three main crop groups can be distinguished:

--The export oriented crops (peanut, cotton).

--The import substitution crops (rice).

--The traditional subsistence crops (millet-sorghum).

H.1 Increasing Prices of the Export Crops

This alternative can well contribute to the objective of increasing rural income but may also accentuate the domestic food production problems and boost the demand for imported rice and wheat. In fact, the current difficulties in the Senegalese food system are largely attributed to the hypothesis that official producer prices have always been distorted in favor of the export sector and particularly groundnut. On the other hand, the extent to which domestic producer prices of export crops can be increased may be limited by external forces coming from the world market in which the country is a price-taker or by the capability and willingness of the government to subsidize farm prices. For 1982-83, it was estimated that the government incurred a loss of 20,000 francs CFA for each metric ton of groundnut exported, due to high domestic producer prices compared to

those prevailing in the international market. (S. Taleb: "Senegal, un temps d'austerite:" Jeune Afrique No. 1183: September 1983, p. 36). Such a situation is very critical because groundnuts have always been a source of gains for the government and the main support for subsidies in other sectors, particularly within the food system.

H.2 Increasing Prices of the Import-Substitution Crops

The main import-substitution crop is rice which is also a subsistence crop in some areas, particularly in Southern Senegal. This crop is essentially confined to irrigated lands which represent a relatively small portion of the agricultural system. On another hand, the production impedements for rice are much more related to ecological factors than anything else. A study conducted in the region showed that only Mali was well suited to grow rice profitably. Therefore, even a substantial price increase at the producer level would generate very little supply response if any, due to natural constraints. In fact, iron, salt, sand, acidity and low nitrogen are major natural constraints in the rice growing areas of southern Senegal where the necessary drainage of the mangrove swamps is immediately followed by a drop of soil P.H. to the neighborhood of two, which is too acid.

Furthermore, the rural population involved in growing rice is very small and, therefore, at both social and economic levels, even positive price effects would have a limited scope with respect to underlying objectives.

H.3 Increasing Prices of the Subsistence Crops

The main food crops produced in the subsistence sector are millet and sorghum which are mostly auto-consumed. They represent the most widely grown cereals and are relatively well suited to the ecological environment.

If official producer prices are increased in that sector, farmers will probably have greater incentives to produce more millet and sorghum but if such a situation occurs, the demand problem will necessarily have to be solved for non-home consumed output. In fact, the urban consumption of those commodities is relatively limited for controversial reasons among which we have inconvenience in preparation, non-availability in urban markets, cheap imported rice, preferences, economic inferiority, etc. however, what can be observed is that the urban consumption pattern is expanding to rural areas where imported rice and wheat are gradually more and more demanded.

The C.I.L.S.S. has agreed that it is hazardous to base pricing policy on the assumption that the eventually induced increase in production can be easily exported if it is not consumed locally. In setting up producer prices of millet and sorghum, some other critical considerations should be taken into account. In fact, rural people are themselves the major consumers of those commodities. In Senegal, it is frequent to observe farmers sell part of their grains during harvest to meet specific expenses and the temptation is reinforced by the fact that millet matures before groundnut at a time when peasants are completely broke. Those farmers

generally buy back later in the year at higher prices. Therefore, higher farm prices for millet and sorghum can be expected to boost their production by wealthier farmers who already have a more urban-type consumption pattern. However, this would simultaneously tend to discourage poorer farmers to consume millet-sorghum since the supplement to insufficient family production would be obtained at higher prices. Such a situation would then reinforce the consumption trend toward rice and wheat, that is, in other words, the remedy would help develop the disease. One could argue that the retail prices of imported grains should be increased to thwart the substitution mechanism. However, such a strategy of generalized price increase may leave the consumption pattern unchanged but the situation would not be socially neutral. In fact, the large masses of poor people in rural and urban areas would bear the burden of a simultaneous increase in the retail prices of domestic and imported grain. Those low income groups spend a much greater portion of their earnings on food and they would be relatively more penalized.

I. Concluding Comments

While the need for promoting domestic cereals in Senegal is fundamentally crucial, finding effective approaches is not an easy task.

As J. Robinson said, "The purpose of studying economics is not to acquire a set of ready answers to economic questioning, but to learn how to avoid being deceived by

economists.... With most problems nowadays, economic answers are only political questions." (J. Robinson, 1960). But if we accept Arnold Toynbee's idea that the process of socio-economic change is one of challenge and response, it will be clear that a spontaneous groping is unlikely to generate the most adequate response possible to a given challenge for a desired change. Some basic understanding of the relationships within the system is required, explaining the need for quantitative analysis. Therefore, if domestic production of traditional cereals is to be promoted in Senegal, a supply response analysis is a necessary step to cast some light on how different parameters relate to each other within the millet-sorghum industry.

CHAPTER III

DOMESTIC SUPPLY FACTORS IN THE MILLET-SORGHUM INDUSTRY

A. Background

As mentioned earlier, millet and sorghum represent the main staples in the Senegalese rural area where they are grown as substance crops on about 40 percent of cultivated land. On the production side, the major competing crops are groundnut and cotton, while rice represents the basic "substitute" in consumption. Producer prices of millet-sorghum, groundnut and cotton, as well as the retail price of mostly imported rice, are set by the government.

During the past years, the self-sufficiency ratio for millet-sorphum has been fluctuating but deficit seems to be the general rule. In 1977, total needs were estimated at 70,000 metric tons and domestic production was only 554,000 metric tons. Nevertheless, it is believed that the country can be self-suficient in those staples provided that weather conditions are favorable and the price structure adequate. In fact, the government has the objective of promoting a progressive substitution of millet and sorghum for imported rice, especially in urban area such as Dakar where the per capita rice consumption averaging at 103 kg. in 1979 is intended to be reduced to 60 kg. by 1985.[10] Besides that anticipated additional need, the partial substitution

program of millet for wheat flour in the bakery sector would require by itself 12,000 metric tons of millet per year over the period 1981-85. The analysis that will follow is based on time series data collected from various sources and covering the period 1960-61 to 1981-82.

B. Quantity Dependent Supply Model

Millet and sorghum will be treated together as one commodity since they are considered as such at all levels of the agricultural policy. Even though they may be grown on different fields, they are generally mixed after harvest by the producers themselves before being processed for family consumption or transformed into cash through the market channels.

B.1 Model Specification

The regressand in this case is the total production of millet and sorghum designated by TPMS The variables that can be expected to be relevant in the determination of total production are the following:

-- The producer price of millet-sorghum which is officially determined by the government each year. Since those prices used to be announced long after planting, we have considered that farmers' calculations and anticipations are based on the producer prices that prevailed during the previous year. Therefore, for each period t, we have used the corresponding price

lagged one year and designated by $PPMS_{t-1}$ standing for producer price of millet-sorghum lagged 1 period.

-- The expected producer price of groundnut (P P G) can also be determinant in the production of millet-sorghum since groundnut is the main competing cash crop which is grown on the same types of land generally in a rotational process. A lag 1 expectation model will also be used for the producer price of groundnut, that is P P G_{t-1} for the same reason as in the case of millet-sorghum.

-- The current retail price of rice (RPR_t) is also expected to have an influence on farmers' decisions in the production of millet and sorghum which are the main staples in the Senegalese rural areas. Nonetheless, as mentioned earlier, the urban consumption pattern is now expanding to those areas where rice and wheat are more and more demanded. Therefore, the interest farmers have in producing their own food or putting emphasis on other cash crops in order to pay for rice is partly determined by the expected retail price of rice which is assumed to be the current official consumer price.

-- Without any doubt, rainfall plays a very important role in the output level of millet

and sorghum almost entirely grown under rainfall conditions. In fact, only a very small portion of sorghum comes from uncontrolled flooding cultivation mainly along the Senegal river but even under those conditions, rainfall is still very determinant.

-- It should also be mentioned that in some parts of the country, particularly in Southern Senegal, cotton and maize compete with millet-sorghum in the production process but price data for those crops were not available for the earlier years of our sample period (1960-61, 1981-82) because their development in Senegal is relatively recent.

-- Given the high rate of rural population growth (2.1 percent on the average) which allows the cultivation of more land and the improvement of cultivation techniques, it is expected that total production of millet-sorghum will have an increasing time trend.

-- The econometric model was formulated as follows, with all monetary values deflated by the consumer price index (CPI) for the African type consumption[11] based on 1970 = 100. (Non deflated prices are expressed in Franc CFA/Kg and per capita income in 1000 F. CFA).

$$TPMS_T = b_0 + b_1 \times PPMS_{t-1} + B_2 \times PPG_{t-1} + B_3 \times RPR_t + B_4 \times R\ I_t + B_5 \times PCRI_t + B_6 \times Time + E_t$$

with

--$TPMS_t$ = total production of millet-sorghum in year t expressed in 1000 metric tons.

-- B_o = constant term.

-- B_i (i = 1...6) = regression coefficients.

--$PPMS_{t-1}$ = producer price of millet-sorghum lagged 1 year.

--PPG_{t-1} = producer price of groundnut lagged 1 year.

--RPR_t = rainfall index with the annual average over the period 1931-1960 taken as base 100.

--$PCRI_t$ = per capita rural income in the current period(real).

--Time = the rank of sample observations were used (1...22).

-- E_t = error term supposed to be random with zero mean and constant variance.

B.2 Results of the Estimation

The ordinary least squares procedure was used in the estimation which yielded the following results (Table 3-1):

B.3 Statistical Features of the Model

The R^2 reveals that 91.1 percent of the variability in total production of millet-sorghum during the period 1960-61, 1981-82 is explained by the model. The statistical significance of the relationship is shown to be quite strong by the overall F test with a calculated value of 25.810 at (6,15)

Table 3-1: Results of the Quantity-Dependent Supply Model

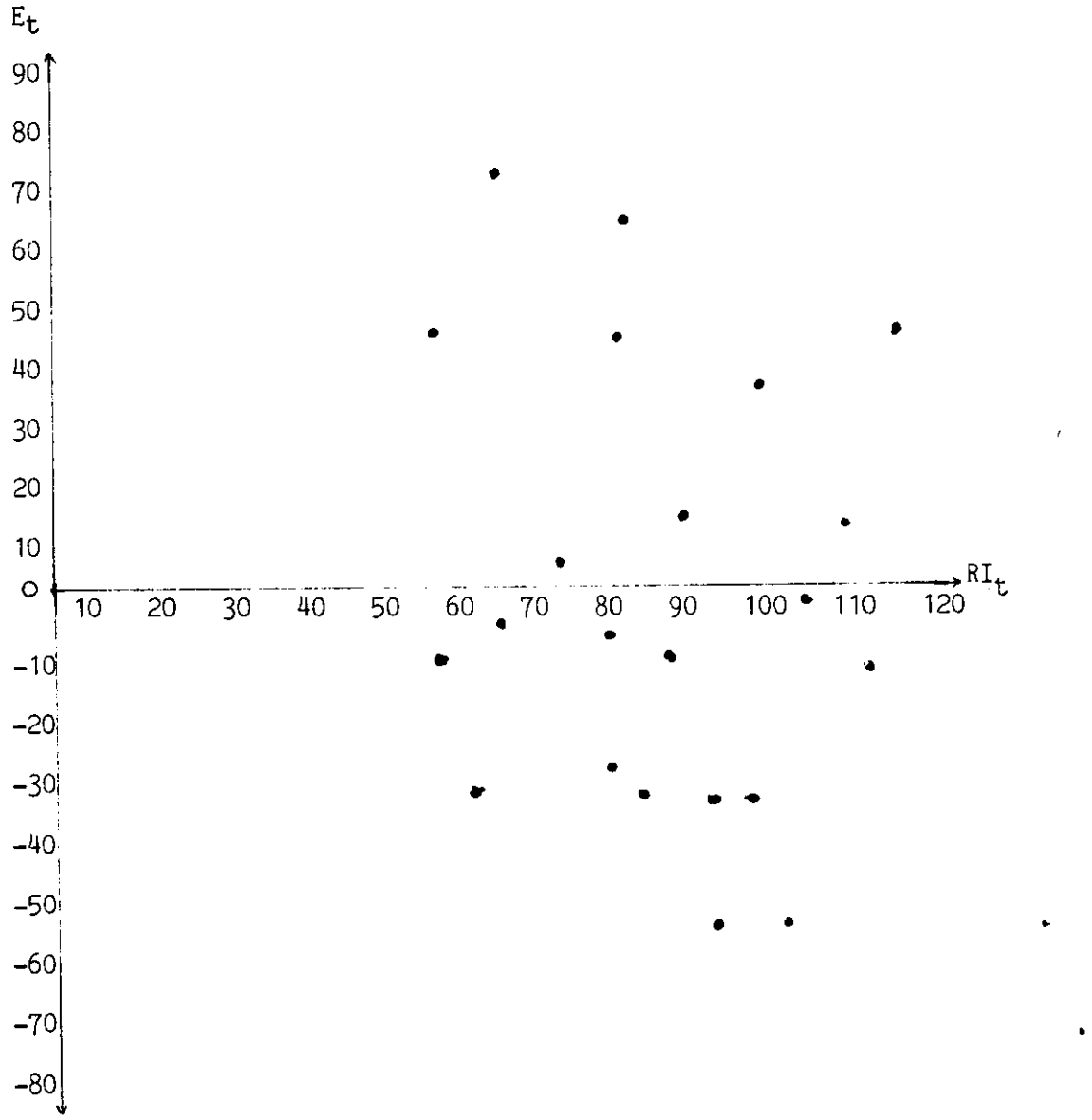
Dependent variable = $TPMS_t$		Number of Observations: 22, period 1960-82	
Mean of Dependent Variable = 547.591 (1000 metric tons)			
Right hand side variables	Estimated Coefficients	Standard Errors	T-Statistics
B_o	- 1078.720	305.113	-3.535
$PPMS_{t-1}$	1957.510	1500.850	1.304
PPG_{t-1}	2806.580	914.114	3.070
RPR_t	664.781	157.743	4.212
RI_t	5.363	0.645	8.304
$PCRI_t$(deflated)	- 1944.820	547.820	-3.550
Time (1.....22)	29.863	5.070	5.889
R squared = 0.911.			
F statistic (6; 15) = 25.810			
Durbin-Watson Statistic = 2.016			
Standard error of regression = 55.305			

degrees of freedom against a tabulated value of 7.09 at the .01 level.

Except for $PPMS_{t-1}$ (producer price of millet-sorghum lagged), each of the estimated coefficient is statistically significant at least at 0.1 level (two-tailed test). The highest T statistic is associated with the rainfall index variable while the lowest one corresponds to the producer price of millet-sorghum. The Durbin-Watson test does not reveal any first order serial correlation. A plot of residual E_t against rainfall index which is a stochastic variable does not

give any pattern suggesting a contemporaneous correlation between the two variables. Therefore, the OLS estimator is still appropriate. (P. Kennedy: A Guide to Econometrics, Simon Fraser University, The MIT Press, Cambridge, MA, 1979, p. 93).

Figure 3-1: Plot of Residuals Against Rainfall Index



B.4 Economic Interpretation of the Results

B.4.1 Producer Price of Millet-Sorghum ($PPMS_{t-1}$)

It appears from the results that the lagged official producer price of millet-sorghum is not statistically significant at 90 percent level of confidence. This is not surprising if we know that millet and sorghum are basically considered as subsistence crops mostly grown for family consumption at the farm level. Over the sample period, the portion of commercialized output was very small, especially during the early years of independence. In fact, the market economy was not fully expanded to rural areas where food security was synonymous to self-sufficiency.

On the other hand, the non agricultural population was much less important, which limited the potential market to some remote growing urban centers more oriented toward imported commodities. To understand the revealed poor responsiveness of millet-sorghum output to producer prices, one should go beyond the market fundamentals based on the conventional economic rationality. In fact, a great deal of the variability in the production of millet and sorghum is explained by natural factors.

On another hand, the problem of productive capacities and asset fixity discussed in Chapter II may explain part of the story. The price

changes have been very smooth over the sample period and in general only slight changes occurred after a few years of constant price. Those changes averaging at 1.36 francs CFA per year over the period of the study were, in our opinion, very unlikely to be greater than the response threshold perceived by the farmers, the range of variation being 0 to 7 francs CFA in nominal terms.

One should also mention that for reasons of pure social ethics, sales of basic food commodities used to be viewed as unwise practice in the traditional community. All this means that a high producer price of millet-sorghum may not induce by itself a great production response because traditional subsistence farmers are generally reluctant to sell those commodities even when output exceeds the annual consumption needs of the family.

B.4.2 Producer Price of Groundnut (PPG_{t-1})

The producer price of groundnut is fairly significant with a positive coefficient, which seems to be a paradox. In fact, groundnut is the major competing crop grown by those same farmers who produce millet and sorghum. Therefore, it could be expected that more attractive producer price of groundnut would have a negative effect on the production level of millet and sorghum in a ceteris paribus condition. This result can be

compared with other previous findings of the World Bank which revealed that in Sub-Saharan Africa, performances in the subsistence and cash crop sections were positively related.[12] In the case of Senegal where commercial and subsistence crops coexist in each farming unit, the positive relationship of their performance can be explained by the fact that the same farm implements are used in planting and weeding of groundnut and millet-sorghum.

B.4.3 Retail Price of Rice (RPR_t)

The current retail price of rice is also very significant with a T value of 4.214 and its effect on the production level of millet-sorghum is strongly positive. In fact, rice (mostly imported) is the main substitute for millet-sorghum in consumption and the more expensive it is, the more farmers are motivated to cover their food needs with their own production. This argument is always found in food policy recommendations generally stressing the point that poor performance in the Senegalese food production sector is mostly due to "low" retail price of imported rice.

B.4.4. Rainfall Index (RI_t)

The rainfall index is by far the most significant explanatory variable with the highest T statistic (8.304). In fact, as mentioned

earlier, millet and sorghum are cultivated under rainfed conditions and the huge output fluctuations observed over the sample period were directly connected to rainfall levels. However, this is not to say that a high annual rainfall index will necessarily induce a good production because the distributional pattern of rains over time and space may even be more determinant than annual averages on which this study is based.

The strong effect of the rainfall index variable is comparable to the finding of the West African food grain study carried out by the World Bank in 1976 and which revealed that for the Sahel region, 50 percent to 70 percent of the variability in the production levels of millet-sorghum were attributable to rainfall patterns. (West African food grain study, the World Bank Washington D.C., 1976).

B.4.5 Per Capita Rural Income ($PCRI_t$)

The current per-capita rural income has a significantly negative effect on the production level of milet-sorghum, with a T-value of -3.55. This result corresponds well to our expectations. Indeed, during the sixties, millet and sorghum represented the quasi exclusive components of the rural diet. Consequently, as income increases, any diversification of consumption, which is a general tendency, will necessarily occur at the

expense of those commodities. Therefore, it can be understood that, as rural people get better off in terms of disposable income, they tend to include more rice in their consumption, which reduces their need for millet-sorghum. This tendency toward substitution may be due to a mere desire to diversify consumption or to a preference of rice and wheat over millet and sorghum but most likely, to both factors simultaneously.

Another possible explanation of the negative effect of income is that millet and sorghum may be viewed by farmers themselves as inferior goods. In such a situation which will be discussed in the next chapter, increased per capita rural income would have a negative effect on local production which can be treated as a demand for auto-consumption given the low level of commercialized output.

B.4.6 Time Trend

A clearly increasing time trend appears in the results and can be attributed to the factors identified earlier, namely the cultivation of more land by a growing rural population, improved farm implements and better cropping patterns.

B.4.7 Elasticities

The own lagged producer price elasticity turned out to be 0.60 at the mean values of price and quantity and 0.28 for the last sample

observations (1981-82). This low short-run elasticity corresponds to our expectations based on the previously discussed factors affecting millet-sorghum production in Senegal. Some further observations can be added to the points already made concerning the relatively low price responsiveness of millet-sorghum production. In fact, the harvest of those crops begins just a few weeks before groundnut matures and even some varieties of groundnut more adapted to short rainy seasons mature during the harvest period of millet-sorghum. Farmers frequently stop harvesting millet when groundnut cannot wait any longer without major damage. Generally, before they come back after completion of groundnut harvest, insects and birds will already have eaten most of the rest.

This is, therefore, related to the problem of technology in the harvest of millet-sorghum entirely done by hand. The labor bottleneck problem, particularly crucial during that period, is reinforced by the fact that children are generally not available to help because school starts at this time. Furthermore, an important part of the farm labor force is composed of seasonal workers who grow only groundnut and go back home generally after selling their harvest while millet, almost entirely grown by heads of

households, still needs post-harvest work. Therefore, even if producer prices become more attractive, farmers will take these facts into account and regardless of financial incentives, they have no interest in planting more than they will be able to handle afterwards.

Another point that deserves attention is the fact that farmers are compelled to grow a minimum acreage of groundnut because, among other reasons, it's the main source of fodder necessary for the maintenance of animals, especially horses and oxen used for traction. Even though Senegal is a major groundnut producer, the resulting fodder is hardly sufficient to feed farm animals during the dry season. If such is the case, relatively more attractive producer price of millet-sorghum compared to groundnut cannot be expected to have a significant effect since any reallocation of resources that would be at the expense of groundnut is not workable.

Lastly, the post-harvest requirements of millet-sorghum for woman labor is very high, which explains partly the fact that they are especially grown by heads of households and in particular, those with large families and several wives. Therefore, even if millet can be marketed just like groundnut, the labor and time required to get it ready for sale represents a discouraging factor

which is certainly among the multiple causes of low producer price elasticity revealed in the analysis.

With respect to the retail price of rice (RPR_t), the cross-elasticity of millet-sorghum production is 0.41 at the mean values and 0.20 for the last sample period. This means that presently, a 10 percent increase in the retail price of important rice can be expected to induce about 2 percent increase in total production of millet-sorghum under a "ceteris paribus" condition. This suggests that the willingness of rural people to consume more rice for whatever reason is quite strong and not easily reversible by increasing the consumer price of imported rice.

With respect to groundnut producer prices, a cross-elasticity of 0.40 is obtained for the last sample period observations and this positive association was discussed in Section B.4.2 of this chapter.

B.5 Comparing the Model with Previous Studies

A. M. Niane is the only one of my knowledge who previously estimated an econometric model of the domestic supply relationships for millet-sorghum in Senegal at the national level, based on time series data (Plan B paper, Michigan State University, 1979). In his model with total quantity of millet-sorghum as

dependent variable, the author considered the following regressors:

--Producer price of millet-sorghum lagged 1 year.

--Producer price of groundnut lagged 1 year.

--Producer price of rice lagged 1 year.

--Current price of fertilizer paid by farmers.

--Amount of rainfall in millimeters.

--A dummy variable with value 1 for the years 1973-76 and 0 elsewhere, which is supposed to represent a change in pricing policy: (Higher prices for 1973-76).

With respect to specification, the fundamental difference with our model is that we have preferred to use the retail instead of producer price of rice as Niane did. In fact, millet and sorghum are mostly grown in areas where cultivating rice is not an alternative for the farmers while imported rice is available throughout the country. The conditions suitable for rice are confined to very limited areas where millet cannot grow even though some varieties of sorghum may be an alternative to rice under river flooding conditions. The price of fertilizer is not included in this study. In Niane's estimation, the corresponding coefficient was insignificant, which does not contradict the point we discussed in Chapter II.D about the use of fertilizer.

We have included rural per capita income as explanatory variable, which was not the case in Niane's analysis.

With the same O.L.S. estimation procedure. Niane found a highly significant coefficient for the lagged producer price of millet-sorghum with a positive sign and a T-value of 4.0 for 16 observations. This yielded an own lagged price elasticity of 2.5 at the mean value (p. 34) against only 0.69 for groundnut (p. 68). These findings mean that millet and sorghum, basically known as subsistence crops, are even more price responsive than groundnut, the main Senegalese cash crop, which is not very easily understandable.

Our model yielded a lagged own producer price elasticity equal to 0.60 at the mean values of total production and producer price (deflated) and 0.28 for the last observations. This relatively low elasticity reflects the usual characteristics of basic subsistence crops as millet and sorghum are in the Senegalese context. In Niane's analysis, the lagged producer price of rice, with a coefficient of -39.49 and a T-value of 4.91, turned out to be even more determinent than rainfall with a coefficient of 0.42 and a T-value of 4.90 (p. 26-24).

On the other hand, the rainfall variable is by far the most statistically significant in our model, which is compatible with the 1979 World Bank findings.

Serial correlation was a problem for NIane who found a Durbin-Watson statistic equal to 3.07 and the CORC method was used to correct for it. After that, the T-statistic for lagged producer price of rice

jumped up to 6.21 (in absolute value) and became the highest of all, whereas the T-value for rainfall fell to 3.97 (p. 27).

Concerning the effect of producer price of groundnut on the millet-sorghum output level, the relationship was negative in Niane's study and positive in our model. The reality is, however, less clear in this case but in the 1981 World Bank report, it is stated that a rather positive correlation between the performances in food and cash crop sectors were revealed by studies based on F.A.O. data for about 40 african countries.

Numerous other studies carried out by John H. Cleave (African Farmers: Labor Use in the Development of Smallholder Agriculture, 1974) revealed also that performances in the commercial farming sector were generally not achieved at the expense of food production. A direct comparison of these conclusions with our results should, however, not be made but if we accept the fact that performances in the commercial sector are directly related to producer prices of cash crops, then a positive relationship between producer price of groundnut and millet-sorghum output as we have found, can be understood with the light of the above conclusions. Nevertheless, it should be mentioned that, a quantity dependent supply model for millet-sorghum in Senègal, no matter how accurate it may seem, has certainly a limited value when used as a tool for

describing the ways farmers behave in response to policy parameters. In fact, the millet-sorghum production level is far from being under farmers' control and many other factors such as pests, distributional pattern of rainfall and so forth are crucial in the determination of total output. For those reasons, it is our belief that an area dependent formulation would give a better description of how farmers behave toward policy variables in the process of making their production decisions.

C. Area-Dependent Model

The intention of the farmers is better reflected by planted area on which they have a rather good control compared to total production. Unlike groundnut for which the government can have a direct influence on planted area by controlling the amount of seed distributed, millet and sorghum are not under such a direct influence. In fact, the availability of millet-sorghum seeds have never been a constraint for the farmers who get them from their own reserves and very small quantities of grains are sufficient to plant immense fields. Therefore, an important part of the variability in planted area can be expected to be induced by farmers' response to policy variables.

C.1 Identification of Explanatory Variables

-- The expected producer price of millet-sorghum will certainly play a role in the

determination of how much area will be planted.

-- If we consider millet and sorghum as essentially subsistence crops, then the total quantities produced in year t-1 may influence the amount of area planted in year t for some reason that will be discussed later.

-- Since millet is almost always grown in a rotational system where it alternates with groundnut from one year to the next, the total area harvested of groundnut in year t-1 can be determinant. In fact, millet is never grown in Senegal immediately after a fallow or another millet crop and it generally follows groundnut on the land. One can understand that millet is never grown immediately after a fallow by the fact that it is sown during the dry season, when farmers are expecting the first rains. at that time, the soil is very hard in fallowed areas and for that reason, farmers always use their last year's groundnut fields where the job is much easier, due to the effects of the previous tillage.

-- For the farmers, purchasing rice is an alternative to growing their own food. Since their ability to purchase is mainly determined by their income from cash crops, the purchasing power of groundnut with respect to

rice can be expected to play a major role in farmers' decisions concerning their food production plans.

-- Finally, the nature of the marketing channels are unlikely to be neutral with respect to farmers' motivations to produce beyond their own consumption needs.

Based on these variables, the model was specified as follows:

$$APMS_t = C + B_1 \times PPMS_{t-1} + B_2 \times TPMS_{t-1} + B_3 \times AHG_{t-1} + B_4 \times FBPGR + B_5 DVM + E_t$$

where:

$APMS_t$ = Area planted of millet-sorghum in year t in 1000 hectares.

C = Constant term

B_i $(i = 1...5)$ = Regression coefficients.

$PPMS_{t-1}$ = Producer price of millet-sorghum lagged 1 year in FCFA/Kg (current prices).

$TPMS_{t-1}$ = Total production of millet-sorghum in the previous year in 1000 metric tons.

AHG_{t-1} = Area harvest of groundnut in the previous year in 1000 hectares.

EBPGR = Expected buying power of groundnut with respect to rice.

= Producer price of groundnut lagged 1 year in FCFA/kg divided by the current retail price of rice in FCFA/kg (PPG_{t-1} /RPR_t)

DVM = Dummy variable for marketing, with value 1 during the years in which ONCAD, the national marketing board, had a legal monopsony for purchasing grains from the producers and 0 elsewhere.

C.2 Estimation and Results

The ordinary least squares procedure was used to estimate the model and the results are presented in the following tableau. (Table 3-2)

Table 3-2: Results of the Area-Dependent Supply Model

Dependent variable = $APMS_t$ in 1000 hectare

Mean of dependent variable = 1001.91

Number of observations = 21:period 1960-61 - 1980-81

Righthand side variables	Estimated Coefficient	Standard Error	T-statistic
C	1522.460	207.274	7.345
$PPMS_{t-1}$ (Franscs CFA/kg	3.758	2.022	1.858
$TPMS_{t-1}$ (1000 metric tons)	- 0.253	0.124	-2.034
AHG_{t-1} (1000 hectares)	- 0.138	0.192	-0.721
EBPER	-492.497	114.246	-4.310
DVM	- 96.073	36.218	-2.652

R-squared = 0.667

F-Statistic (5 : 14) = 5.632

Standard error of regression = 57.809

Durbin-Watson Statistic = 1.764

C.3 Statistical Properties of the Model

-- With this formulation of farmers' response in the production of millet-sorghum, 66.7 percent of the variability in planted area can be attributed to the set of explanatory variables we have considered. Such a relationship does not seem to be just a sample phenomenon existing by chance since the overall F-statistic, with a calculated value of 5.632 for (5:14) degrees of freedom, is significant at the .01 level.

-- Except for AHG_{t-1} (area harvested of groundnut in the previous year), all the regression coefficients are statistically significant at least at the .1 level, based on the individual T-statistics.

-- The Durbin-Watson test for first order serial correlation was not conclusive at 99 percent level of confidence, with a D-value of 1.764.

C.4 Economic Interpretation of the Results

In this area-dependent formulation of supply response, most of the included explanatory variables can be manipulated by the government. In fact, except for the constant term C and the lagged total quantity produced ($TPMS_{t-1}$), all the other explanatory variables are parameters under the direct control of policy makers.

With a relatively low coefficient of multiple determination (0.66), it seems that a great deal of farmers motivation is related to factors outside the scope of official policy. Such a possibility seems to be supported by the fact that the constant term is by far the most significant element on the basis of standardized coefficients and it has the highest individual T-statistic with a value of 7.345.

The lagged producer price ($PPMS_{t-1}$) has a positive effect as expected with a value of 3.37. However, the corresponding standard error is relatively high (2.02) and, consequently, the associated T-statistic has a value of only 2.858, which is the second lowest. This is similar to the result found in the quantity dependent model and the same explanation given in Section A.4.1 of this chapter holds in this case.

The elasticity of planted area with respect to expected producer price is only 0.088 at the mean values. This is certainly related to the labor problems discussed earlier as well as the difficulties involved in getting the grains ready for sale. All this is reinforced by the fact that, regardless of the incentive structure, a minimum acreage of groundnut must be grown if farm animals are to be fed during the dry season. At the present time, no alternative forage is available at large scale. The limited availability of adequate land can also be among the factors explaining such a low elasticity. Compared to total

quantities, the planted area is much less responsive to expected producer prices. This suggests that if the incentive structure is changed in favor of millet-sorghum, the induced adjustment is likey to be more under the form of better care for millet-sorghum fields than an expansion of cultivated areas. (More weeding, better use of fertilizer, etc.)

The area planted of millet-sorghum in year t is negatively related to the total quantity produced in year t-1. The estimated coefficient is -0.253 with a T-value of -2.034. This suggests that if production for a given year exceeds the annual family consumption needs, farmers would rather have a propensity to put their surplus in reserve for the next year instead of selling it. In such a situation, the negative relationship can be explained by storage contraints which are often a problem at the farm level. On the other hand, area planted of millet-sorghum tends to increase following a bad harvest which always reinforces farmers strategy concerning food security issues. All this confirms the fundamental characteristics of millet-sorghum viewed as basic subsistence crops by the Senegalese farmer.

The lagged harvested area of groundnut didn't turn out to be statistically significant above 75 percent level. However, the calculated coefficient has a negative sign (-0.138) which means that the area planted of millet-sorghum would potentially change in opposite

direction compared to the harvested area of groundnut in the previous year. If the latter increases, it can be expected that the former would decrease and a possible explanation of such a relationship may be the fact that farmers need each year to leave part of their land in fallow, particularly those areas previously planted with groundnut which exhausts the land more quickly. Given the limited total land available to the farmer, it can be understood that the more he has to set aside for fallowing consecutive to expanded groundnut acreage in year t-1, the less he'll have available for planting millet in year t. The weekness of the relationship may be due to the fact that only millet, and not sorghum, is involved in a somewhat strict alternating process with groundnut in the rotational system.

The expected buying power of groundnut with respect to rice (EBPGR) defined as the ratio of expected producer price of groundnut by the current retail price of imported rice, is by far the most determinant of the policy parameters included in the model. This corresponds well to our expectations and the ratio formulation of this variable is based on the fact that increasing the numerator can be expected to have a similar effect as decreasing the denominator and vice-versa. The calculated coefficient for the variable is -492.497 with a T-value of 4.310. In fact, with the recent evolution in the rural economy, rural markets provide a much better availability of imported

rice compared to what the situation was in the earlier years of independence. Consequently, the notion of food security as preceived by the farmers tends to shift from self-sufficiency to disposable income at the family level. Since groundnut represents the main source of income for most Senegalese farmers, its buying power with respect to rice will weigh heavily in the determination of food strategies by peasants.

In his linear programming model, A. Niang[13] concluded that the worst situation in terms of income was the one in which the farmer was constrained to produce all his family food requirements. He noted that if the head of household were allowed to purchase food, only wives would grow millet. These conclusions support the fact that food self-sufficiency becomes less and less important as a goal for a farmer who can grow cash crops and pay for generally preferred imported rice.

The dummy variable for marketing came out with a negative coefficient of -96.073 and a T-value of -2.652. This means that the monopsonization of grain purchase from the farmers by O.N.C.A.D., a former national marketing board, had a negative effect on planted acreage of millet-sorghum. Therefore, it seems that O.N.C.A.D. gave less convenience to the producers in the commercialization of their grains compared to local traders. This may not be a matter of substantial price differential as one would think. In

fact, the situation can be understood if we know that O.N.C.A.D.'s collecting points were situated only in specific villages where surrounding farmers had to go to sell their products. Even though some farmers had to travel very long distances with their products, the system work well for groundnut but for millet-sorghum, it was much less satisfactory. In fact, threshing millet by hand is a very tough job, extremely time-consuming and exclusively carried out by women who have many other household tasks. Therefore, only small quantities are threshed at a time and with family consumption needs, not much is available for sale in a relatively short time. Moreover, small quantities are not worth traveling long distances and O.N.C.A.D. generally purchased at large scale. Furthermore, the period for commercialization was limited and did not cover the whole year. One could wonder why those small quantities cannot be aggregated over a certain period and then transported to the marketing point for sale. The answer is that if such quantities were available, the wives would rather enjoy a few-days break without threshing. On the other hand, the local traders, usually involved in farming also, are found in every village and purchase any quantity, no matter how small it is, even 1 kilogram. with them, neither distance, nor scale was a marketing constraint for the farmers and often times, the exchange took place in barter terms. Therefore, if some day a wife wished to change

the usual millet sorghum based meal, she could trade the daily ration of millet-sorghum against rice, provided that she could afford the extra expenses involved, generally by selling grains of her own. This may explain why the wives themselves had a greater interest in growing millet and sorghum under the previous situation. Even in the situation of monopsony, some local traders were still engaged in the purchase of small quantities, especially after the closing O.N.C.A.D.'s operations and they probably paid lower prices because of the legal risks that were involved. In summary, the open market situation seems to have provided better incentives for farmers to produce millet and sorghum compared to the monopsony which imposed additional marketing constraints to farmers.

D. Policy Implications of the Results

The econometric analysis carried out in this chapter highlights the extent to which conventional policy tools can be manipulated to boost domestic production of millet-sorghum. As mentioned earlier, the poor performance in millet-sorghum production was attributed to a number of factors among which official price policies have recently received particular attention. The argument of low farm price policies have recently received particular attention. The argument of low farm price of food compared to cash crops was presented by many development experts as the main cause of short supply. If this is so, setting higher

producer prices for millet-sorghum would be a strong policy tool to consider in trying to boost domestic supply. It came out from the analysis that even though expected producer prices were positively related to the production levels, their effect on domestic production was not highly significant.[14] In such a situation, increasing producer price should not be expected to work miracles. Obtaining a significant output increase would require price increase much higher than those implemented in the past. However, demand considerations set a limit to such a policy. This limitation of policy scope reflects the irony expressed by Heilleiner in 1975 when he said that research on the price responsiveness of small farmers have reached a point of diminishing returns. This idea seems to be bought by Denis Goulet[15] who advocates that more research in developing countries should be devoted to moral incentives because price motivations are generally not looked at by the average people in those areas. However, it is our belief that dealing with the relatively low short run price responsiveness of millet-sorghum production in the specific case of Senegal should first of all consider the imput factors and technological problems discussed in previous chapters. Nevertheless, it should also be recognized that the forces determining food production in the subsistence sector go beyond conventional input-output relationships. In fact, complicated problems of social ethics are involved and most of them are not subject to easy manipulation. Furthermore, the forces of nature, namely rainfall in this

case, turned out to be very determinant.

The official retail price of rice turned out to be a critical factor which can be viewed as a major policy tool. The most recent official steps taken by the Senegalese authorities reflect a more explicit recognition of this argument considered fundamental by the International Monetary Fund. Some sensitive policy issues related to this point will be discussed in the next chapter.

Contrary to a widespread but undocumented opinion, relatively more attractive producer prices of groundnut didn't have a direct negative effect on the production of millet-sorghum. Therefore, even if farm prices of millet-sorghum were to be significantly increased, it would not be at the expense of groundnut producer prices. Such a strategy would sacrifice the objective of increasing rural income which is lagging far behind the level of revenues in the other sectors of the economy in per capita terms.

E. Projections of Total Supply for 1984-85

The VI^e Plan[16] which covers the period 1981-1985 projects an average annual increase of 8% for domestic agricultural prices and 10% for the cost of imported goods. We have assumed that those rates will apply respectively to domestic produce prices and to retail price of imported rice. The projected value of rural production for 1984-85 is 246 billion FCFA with a rural population growing at 2.1% annually. Based on these figures and assuming a 33.475 percentage points increase per year. (average for the last

5 sample observations). For the consumer price index (1970 = 100), the following estimates were obtained with monetary values in nominal terms.

--Producer price of millet-sorghum for 1983-84: 58.32 FCFA/kg.

--Producer price of groundnut for 1983-84: 81.668 FCFA/kg.

--Retail price of rice for 1984-85: 139.755 FCFA/kg.

--Per Capita rural income for 1984-85: 57.849 thousand FCFA.

--Consumer price index for 1984-85: 446.025 (1970 = 100).

With these values, the quantity, dependent supply model gives the following projections for 1984-85 under various rainfall levels:

Table 3.3: Supply projections for 1984-85

Rainfall index: (Annual average 1931-1960=100)		Total quantity of millet-sorghum (1000 metric tons)
Average sample observation:	82.18	834.83
20% below average:	65.74	746.66
20% above average:	98.616	922.97
Highest sample observation:	114.	1005.48
Lowest sample observation:	50.	662.24

F. Concluding Remarks

What came out clearly from the supply response analysis is that for neither formulation, were expected producer prices a major determinant factor in the production of millet-sorghum. For the total quantity produced, the most important explanatory variable, namely rainfall, is not subject to policy manipulations. The variables that can be officially controlled directly or indirectly were given a

specific emphasis in the area-dependent model but a great deal of the variability in farmers response was still unexplained by those policy parameters.

A direct comparison of the two models on the basis of their R^2 is not meaningful since the dependent variables are not the same but both formulations revealed that expected producer price of groundnut and current retail price of rice were critical factors. While the quantity dependent model was compared to A. Niane's analysis, there's no previous work of our knowledge similar to the second formulation such that no comparison was possible. Nevertheless, the results yielded by both models met our expectations based on empirical knowledge of the millet-sorghum industry in Senegal.

However, policy recommendations should not be based only on a supply analysis and the consumption side should not be left out of account.

CHAPTER IV

THE ECONOMICS OF MILLET-SORGHUM CONSUMPTION IN SENEGAL

The policy of promoting traditional cereals in Senegal should not be confined to the supply aspect of the problem. In fact, the demand side represents a very important aspect and contrary to what the French economist Jean B. Say said, output does not necessarily generate its outlet and consumption preferences or potential outlets can highly influence production.

A. The Importance of Consumption Preferences

The nature of potential outlets can even be more determinant than official producer price policies in influencing production. This is particularly the case whenever a parallel market exists, which is very often in the Sahelian countries. Such a situation is well established in Mali where the official producer prices of coarse grains are the lowest in the region. Despite that fact, food production in Mali is very dynamic especially for millet-sorghum compared to performances obtained in neighboring countries. This is certainly related to the fact that local demand for those commodities is very high. Consequently, prices in the parallel market are high and attract grain smugglers from surrounding countries, mainly Upper Volta where the official producer price of millet-

sorghum is, however, much higher. Therefore, one can imagine that the forces of parallel market have played a role in the relatively good performance of food production in Mali.

The case of Mauritania is also similar with a relatively high demand for millet-sorghum compared to rice. Even though the production of millet-sorghum in Mauritania is constrained by natural factors, the non-official market provides good incentives due to the demand structure. In a study carried out by the "CILSS Club du Sahel," it was found that in January 1977, the consumers in the capital city of Nouakchot got 1 kg. of rice for 14 ouguiyas against an official retail price of 17.4 ouguiyas. On another hand, 1 kg. of millet-sorghum cost between 30 and 35 ouguiyas while the official consumer price was only 15 ouguiyas. From these observations it can be concluded that the market forces of the underground economy may overwhelm official pricing policies within the food system where the ultimate driving force is the effective demand. Even though the demand structure need not be taken as a fixed parameter, its nature should not be ignored in the process of setting up price policies.

Compared to the case of Mali and Mauritania, the situation of millet and sorghum in Senegal is less clear and doubts still exist as to whether or not they are inferior goods for the Senegalese consumers.

B. Are Millet and Sorghum Inferior Goods in Senegal?

Economists refer to inferior goods as those which tend to be less demanded as the income level of the consumers (more exactly their buying power) increases and vice-versa. The controversy about whether or not millet and sorghum in Senegal fall in such a category is still an open question. A U.S.D.A. cross-section study of food problems in Sub-Saharan Africa revealed an income elasticity of 0.15 for millet-sorghum consumption in the Sahel region for 1979. This means that at the aggregate, millet and sorghum are superior goods for the average Sahelian consumer. However, such a conclusion may not be very meaningful if we know that in the Sahel, consumption patterns are very different from one country to another and even from one group to another within a given country.

In the specific case of Senegal the University of Michigan carried out in June 1979 a cross-section study on grain demand and consumer preferences based on 75 households in Dakar. The conclusion was that income did not seem to influence millet-sorghum purchasing but per-capita consumption was negatively correlated with income. However, such a situation was qualified as a paradox which might be explained by a spurious correlation phenomenon between per capita consumption and income because of the observed weak but positive relationship between income and household size.

Another study based on three villages, Thienthie, Layabe and Sessene in the Diourbel region, which is a millet growing area in Senegal, yielded the following equation:

Millet consumption per capita = 63.25 + 0.0064 Income per capita with R^2 = o.6428, F = 66.58, T = 8.16 for per-capita income.

(Consumption Effects of Agricultural Policies, Senegal and the Cameroons; CRED: University of Michigan, p. 217).

These results reveal that millet is a superior good in that part of Senegal and, therefore, per capita consumption tends to change in the same direction as per capita income.

In a nation-wide demand model estimated by A. Niane and based on time series data, the income elasticity of millet-sorghum at the mean values turned out to be -2.01 with the ordinary least squares method and 0.1 after correcting for serial correlation by the Cochrane-Orcutt technique. Therefore, the question of superiority vs. inferiority remains unanswered so far. However, basic philosophical wisdom teaches that most human errors come from the use of "or" instead of "and." In fact, a common feature to all the studies reviewed is that none of them made room for the possibility of a "yes and no" answer, which seems to be characteristic of the millet-sorghum case in Senegal as we'll try to show. To understand the point, one need to know how millet and sorghum are consumed in Senegal.

First of all, a very clear difference exists between rural and urban consumption patterns as can be seen in the following table (4-1) where the figures correspond to the year 1974.

Table 4-1. Rural-Urban Distribution of Millet-Sorghum and Rice Consumption, 1974

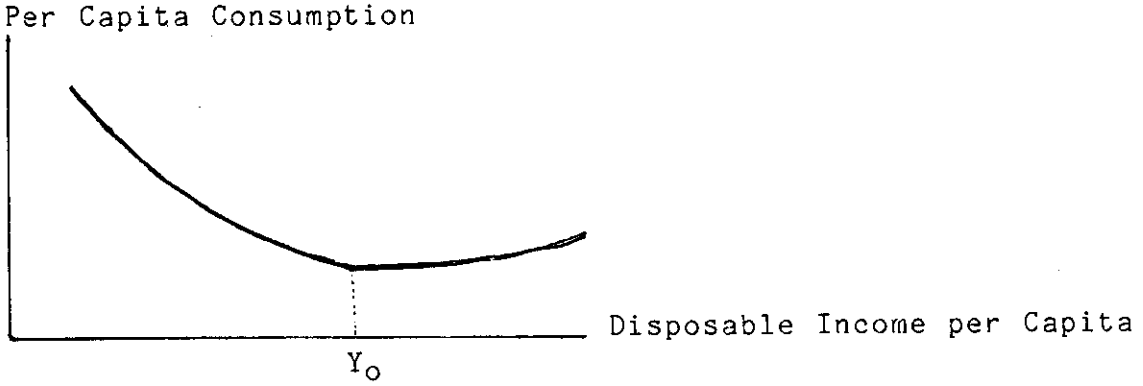
	Average	Rural	Urban
Millet-sorghum consumption/cap.	72.7 kg.	96.7 kg.	20.7 kg.
Rice consumption/cap.	54.2 kg.	37.2 kg.	91 kg.

Source: Ministere du Plan et de la cooperation. V^e Plan de Developpement Economique et Social. Dakar, 1977.

This rural-urban dichotomy was even much greater in the earlier years with a lower rural consumption of rice and a quasi-exclusively millet-sorghum based diet. It was also mentioned that the urban consumption pattern was expanding to rural areas with the shift of food security concept from self-sufficiency to disposable income. Therefore, purchasing power becomes a decisive factor in millet-sorghum consumption and it is likely to have opposite effects from rural to urban areas or more exactly from low income to high income groups. In fact, millet and sorghum are consumed under various forms and a very important point to keep in mind is that they go with numerous complements that are substitutes among themselves. Those complements range from leaves and fruits of wild local plants, costless in rural areas, to fish and meat, that is, from undoubtedly inferior to highly superior commodities in Senegal.

For the consumers, the economic nature of millet-sorghum with respect to superiority versus inferiority is determined by the type of complements they can afford. Therefore, it can be expected that millet and sorghum are

inferior goods for low income groups and superior for wealthier consumers. Graphically, the phenomenon can be represented as follows:



This is consistent with the fact that poverty has been characteristic of rural areas where per-capita consumption of millet-sorghum was very high, and tend to decrease with income-induced diversification. The income level Y_o represents a turning point corresponding to a low per-capita consumption and above which consumers are gradually able to afford superior goods complementary to millet-sorghum. The portion at the left of Y_o corresponds more to the reality in rural areas while the right-hand portion represents what can be expected from wealthier urban consumers with a very high level of rice consumption. However, it would be a mistake to believe that such a diagram matches exactly a rural-urban duality because rural and city dwellers are not perfectly homogeneous groups.

Based on this discussion about superiority versus inferiority, any demand model for millet-sorghum in Senegal should take those considerations into account. More

clearly, the possibility of a changing sign for income elasticity should be built in.

C. Specification of the Consumption Model

For each year of the period 1960-61 to 1981-82, we have assumed that total consumption is equal to the sum of domestic production, commercial imports and the millet-sorghum component of food aid. The dependent variable used in this analysis is the average annual per capita consumption expressed in kg.

C.1 The Independent Variables

--The retail price of rice officially set and controlled by government is included as an explanatory variable because rice is the main substitute for millet-sorghum in consumption.

--The consumer price of millet-sorghum, unlike the producer price, is not strictly controlled and complete series of retail prices are not available for our sample period. For that reason, we have derived estimates of retail prices in Dakar, the capital city. The derivation was made as follows:

For three years (1972, 1973, 1974) we have the average annual retail prices in the free market of Dakar estimated by the "CILSS Club du Sahel." We have the following annual averages with the corresponding standard deviations:

$\bar{P}_{1972}$ = 39.83 FCFA/kg. with σ_{1972} = 7.29

$\bar{P}_{1973}$ = 72.41 FCFA/kg. with σ_{1973} = 30.15

$\overline{P}_{1974}$ = 37.00 FCFA/kg. with σ_{1974} = 2.34 (The unusually high average for 1973 can be explained by the fact that it was a year of severe drought.) We have attributed a weight W_t to each average price P_t. The coefficients W_t are proportional to the corresponding ratios $1/\sigma_t$ and are such that $\sum_{t=1}^{3} W_t = 1$. Therefore, estimates of retail prices with higher standard deviations are given lower weights and vice versa. The computation of the weights yielded:

$$W_{1972} = 0.23$$

$$W_{1973} = 0.015$$

$$W_{1974} = \frac{0.755}{1.000}$$

The weighted annual average of retail prices over three year period is, therefore, 0.23 X 39.83 + 0.015 X 72.41 + 0.755 X 37.00 = 39.6 Francs CFA/kg. For the same period, the corresponding average farm price is 19.6 FCFA/kg. Therefore, the associated average annual marketing margin in nominal terms is 39.6 - 19.6 = 20 FCFA/kg. For the same period, 1972-74, the average consumer price index based on 1970 = 1 is 1.25. Thus, the average deflated marketing margin is $DMM_{1972-74}$ = 20/1.25 = 16 FCFA kg. From this point, we have assumed that the deflated marketing margin has a constant value of 16 FCFA/kg. over the whole sample period.

For each year t, we have estimated the nominal marketing margin by: $NMM_t = 16 \times CPI_t$ with NMM_t = nominal marketing margin, CPI = consumer price index in year t based on 1970 = 1. The retail prices of millet-sorghum are derived for each year t by:

$RPMS_t = PPMS_t + NMM_t$ with

RPMS = Retail price of millet-sorghum.

PPMS = Producer price of millet sorghum.

NMM = Nominal marketing margin.

--The gross domestic per capita income is used as a proxy for net disposable income.

--The percentage of urban population is also included as a regressor, given the rural-urban difference in consumption patterns.

--We consider that it is necessary to include a variable which can describe any variation that might be induced by changing preferences.

--It would also be interesting to have an idea of how ONCAD, a former government agency in charge of collecting grains, importing and wholesaling as a regulated monopolist affected the level of millet-sorghum consumption.

Based on these considerations and the discussion in the previous section about whether or not millet and sorghum are inferior goods for the Senegalese consumers, the model was specified with the following functional form.

C.2 Functional Form

$$Ln(PCC_t) = C + B_1 Ln(RPR_t) + B_2 Ln(RPMS_t) + B_3 X 1/GPCI_t + B_4 Ln(GPCI_t) + B_5 X UP_t + B_6 DVCP + B_7 DVM + E_t$$

with:

Ln = Natural logarithmic function.

PCC_t = Per capita consumption of millet-sorghum in kg.

C = Constant term.

B_i (i=1....7) = Regression coefficient.

RPR_t = Retail price of rice in FCFA/kg. (Nominal)

$RPMS_t$ = Retail price of millet-sorghum in FCFA/kg. (estimated nominal values for the free market of Dakar)

$GPCI_t$ = Gross per capita income in 1000 FCFA deflated with CPI based on 1970 = 100

UP_t = Urban population as a percent of total population.

DVCP = Dummy variable for consumption preference with value 0 from 1960-61 to 1970-71 representing the first half of the sample period and 1 for the second half (1970-71; 1981-82).

DVM = Dummy variable for marketing with value 1 during the years of ONCAD's monopoly (1975-1980) and 0 elsewhere.

D. Estimation and Results

When the ordinary least squares method was used, a high serial correlation was revealed with a Durbin-Watson statistic equal to 3.23. After correction with the Cochrane-Orcuttprocedure, the following results were obtained.

Table 4-2. Results of the Per-Capita Millet-Sorghum Consumption Model.

Dependent variable = Ln(PCC); Number of observations = 21

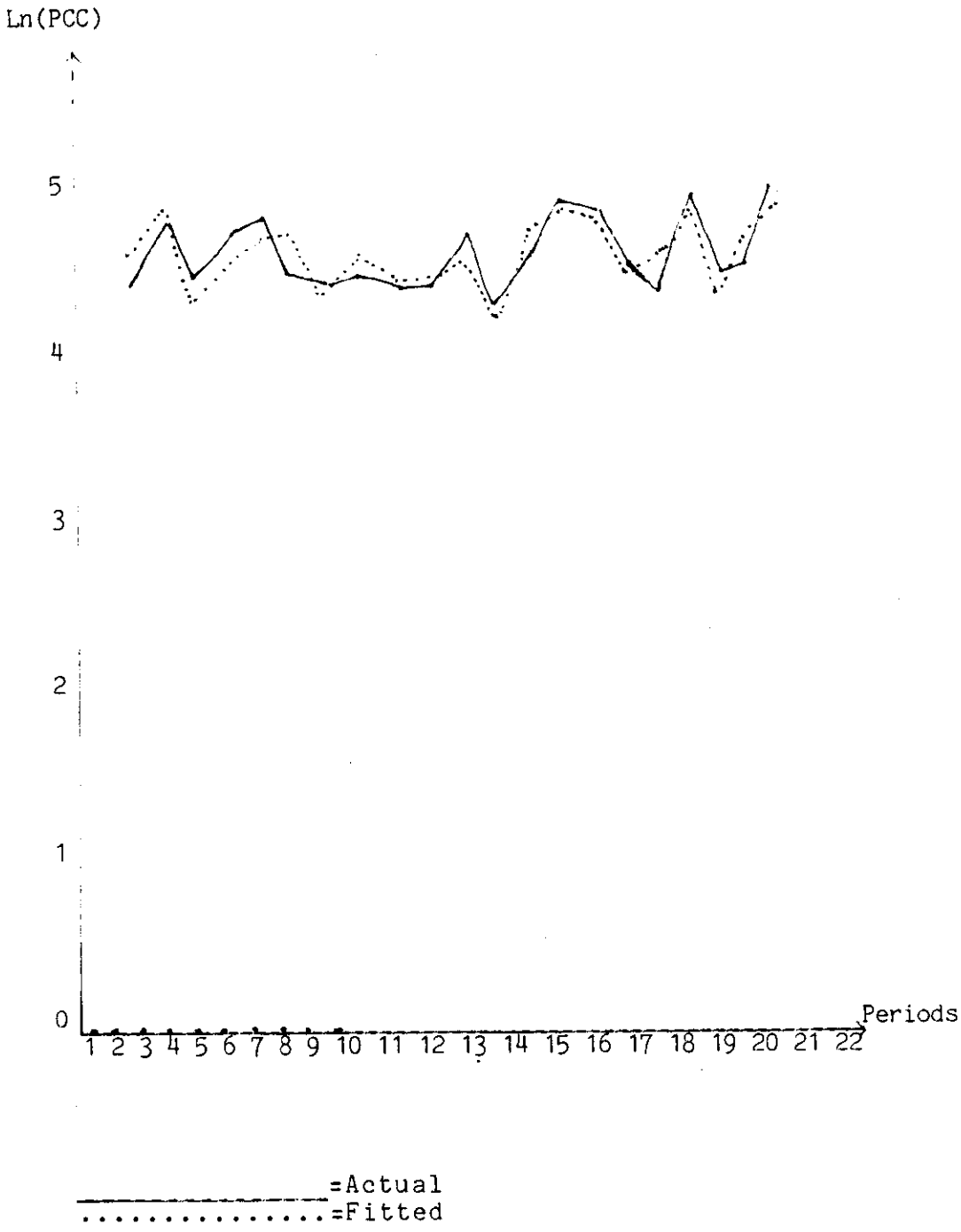
Regressions	Coefficients	Standard Errors	T-Statistics
C	3.817	1.008	3.783
$Ln(RPR_t)$	0.978	0.335	2.913
$Ln(RPMS_t)$	-0.706	0.403	-1.751
$1/GPCI_t$	1.945	1.253	1.552
$Ln(GPCI_t)$	4.263	3.089	1.379
UP_t	-0.0455	0.0292	-1.558
DVCP	-0.163	0.0871	-1.876
DVM	0.318	0.168	1.894
R squared = 0.751			
F-Statistic (7: 13)		3.018	
Durbin-Watson Statistic		2.554	

E. Statistical Performance of the Model

The first order serial correlation coefficient calculated with the Cochrane-Orcutt technique is -0.763, which is a quite high value (in absolute terms) obtained after two iterations.

--The overall F test shows that the fitted relationship is statistically significant at the .05 level, with a R^2 of 0.751. Each of the regression coefficients is statistically significant at least at the .15 level.

--The relationship between observed and fitted values is represented in the following graph (figure 4-1):



Concerning the Theil's coefficients, the model yielded

$$U_1 = \frac{\sqrt{\frac{1}{n}\sum_{t=1}^{21}(E_t - O_t)^2}}{\sqrt{\frac{1}{n}\sum_{t=1}^{21}E_t^2} + \sqrt{\frac{1}{n}\sum_{t=1}^{21}O_t^2}} = 0.011$$

with

n = sample size = 21.

E_t = estimate value of the dependent variable in period t.

O_t = observed value of the dependent variable in period t.

The second coefficient is

$$U_2 = \frac{\sqrt{\frac{1}{n}\sum_{t=1}^{21}(E_t - O_t)^2}}{\sqrt{\frac{1}{n-1}\sum_{t=2}^{21}(O_t - O_{t-1})^2}} = 0.328$$

Both U_1 and U_2 are far below 1, meaning that the forecasting ability of the model seems to be quite strong.

F. Economic Interpretation of the Results

The logarithmetic-reciprocal formulation of this model with respect to income was intended to build in the possibility of changing sign income elasticity as discussed

in section B of this chapter. The derived income elasticity formula is:

$$E_y = \frac{-1.945}{GPCI} + 4.263$$

Where GPCI = gross per capita income deflated by the consumer index with 1970 = 100.

Therefore, it can be seen that negative income elasticities correspond to lower values of per-capita income as expected and positive values to higher income. The point of zero income elasticity is obtained at 45,625 Francs CFA of per-capita income in 1970 prices with the CPI converted to 1970 = 1. Consequently, below this level of per-capita income, millet-sorghum is an inferior good. For the values of the last sample period (1981-82), the calculated income elasticity is -1.93.

Higher income groups are mostly urban dwellers with a rice dominated diet, suggesting that there's scope for increased per capita millet-sorghum consumption in the cities.

The cross-price elasticity with respect to rice is 0.978 corresponding to a relationship of substitutability. This coefficient is the most statistically significant and reveals the importance of rice prices in the consumption of millet-sorghum. In A. Niane's linear demand model estimated with the Cochrane-Orcutt method, the cross-price elasticity of millet-sorghum with respect to imported rice was -1.08 at mean values (p. 37, Table VII-a), corresponding to a relationship of complementarity which is very hard to understand.

The own price elasticity turned out to be -0.706. This relatively low responsiveness of millet-sorghum consumption to market prices reflects well the fact that most of the millet-sorghum consumers grow their own grains and, therefore, their consumption is not expected to be highly sensitive to retail prices. The own price elasticity found by Niane was -1.1 at mean values, which the author believed was too high in absolute value.

The rate of urban population is negatively related to the per capita consumption of millet-sorghum. This result derives from a number of factors which contribute to the existence of a rural-urban gap in consumption patterns. In fact, urban people generally have to buy their food and the availability of millet-sorghum in urban markets has so far been very limited. On another hand, the lifestyle in the cities tends to shift the demand toward more convenient food and the labor requirement of millet-sorghum is getting less and less compatible with the changing status of urban women. Another possible cause of the negative relationship between per capita consumption of millet-sorghum and the rate of urban population is that the growth of the cities is accelerated by rural-urban migration which undermines the rural labor force and therefore tends to decrease per capita production.

A decreasing pattern of per capita consumption is shown by the negative coefficient of DVCP (dummy variable for consumption preferences). This is likely to be the result

of changing preferences combined with a better availability of rice and wheat in both rural and urban markets.

The coefficient on DVM (dummy variable for marketing) shows that government involvement in the millet-sorghum sector through O.N.C.A.D. had a positive effect on domestic consumption of these commodities.

G. Demand Projections for 1984-85.

The gross domestic production projected for 1984-85 in the VI plan is 945 billion FCFA in current prices. This value was used to estimate gross per capita income for 1984-85, based on a 2.8% annual growth rate of total population.

With the information used in section E of chapter III concerning prices, the projected retail price of imported rice is the same and the retail price of millet-sorghum is derived from the projected producer price and the assumption of constant deflated marketing margin. (Section C-1 of this chapter) For 1984-85, the following projections were obtained with monetary values in nominal forms.

--Retail price of rice: 139.755 FCFA Kg.

--Retail price of millet-sorghum (free market in Dakar) 134.34 FCFA.

--Gross per capita income: 147.636 thousand FCFA.

--Percentage of urban population: 34.15 (based on the average annual increase over the last5 sample observations).

For DVCP = 1 and DVM = 0 (see section D of this chapter), the consumption equation yields a per capita

demanded quantity of 102.97 kg for 1984-85. With a projected total population of 6,400,877 estimated on the basis of a 2.8% demographic annual growth rate, the projected total demand is 659.098 thousand metric tons of millet-sorghum for 1984-85.

With DVM = 1, the per capita figure is 141.51 Kg corresponding to a total quantity of 905.788 thousand metric tons. If we compare these figures to supply projections in section E of chapter III, demand would be a problem for promoting millet-sorghum in Senegal under the circumstances of the first scenario. (DVM = 0).

H. Policy Implications

Implementing a policy designed to induce higher per-capita consumption of millet-sorghum, particularly in urban areas, requires the understanding of why urban people consume little of those commodities.

H.1 Reasons for Low Urban Consumption of Millet-Sorghum.

As mentioned in the supply analysis, millet and sorghum are essentially considered by growers as subsistence crops mostly devoted to family consumption. Only very small quantities are commercialized and, consequently, the availability of those grains in urban and even rural markets is limited, contributing to the low level of their consumption by urban dwellers. However, limited availability was not listed as a constraint in a consumption survey carried out in the capital city of Dakar by Ross. C in June 1979.[19] In

a sample of 75 households, the reasons for not consuming more millet and sorghum are distributed as follows:

--Difficulty of preparation: 23 households.

--Income: 5 households.

--Digestibility: 4 households.

--Preference for rice: 22 households.

--Diversified diet: 21 households.

Therefore, it appears clearly that none of these factors can be easily manipulated by policy makers who focus, therefore, on prices to promote a substitution of millet-sorghum for rice but this strategy has some social implications.

H.2 Price Policies and the Social Dilemma

The official retail price of rice turned out to be the most statistically significant among the explanatory variables in the consumption function. The argument of "cheap" imported rice has been presented by many development experts as the main factor explaining the low demanded quantities of millet and sorghum. Therefore, the most important point made in all policy recommendations is to set higher retail prices for imported rice.

The proponents of this argument agree that rice is preferred by urban people who are wealthier and would be willing to pay more than the price levels that prevailed in the past. If this is the case, substantial increases in the retail price of rice would

be necessary to generate any significant substitution effect in favor of millet-sorghum consumption. This point is not contradicted by the magnitude of the cross-elasticity of millet-sorghum consumption with respect to retail price of rice, which is 0.97 (less than 1). Contrary to what many people believe, the rural-urban duality in consumption patterns does not reflect a difference in taste and preferences but a real dichotomy in living standards and distribution of wealth. On the other hand, a high level of rice consumption is not necessarily a characteristic of only high income groups. In fact, poor people in both rural and urban areas may be compelled to buy rice, due to limited availability of millet-sorghum in market places. In a study based on three villages (Thienthie, Layabe and Sessene), the CRED[20] found that the highest per capita consumption of rice was recorded in the poorest of the three villages (Thienthie) where most of the farmers were not able to produce enough millet-sorghum for their consumption needs. They couldn't buy it either because it was not available in the market and, therefore, rice was their only alternative. Therefore, setting higher retail price of rice without solving the production and marketing problems in the subsistence farming sector would greatly reduce the food security level of poorer social groups. The policy recommendations for higher retail price of rice is partly intended to reduce the rural urban welfare

gap but as J. Hirshleiffer said, when people become committed to policies, they don't want to hear of possible disadvantages. In the area of nutrition, the concept of well being is often viewed in terms of satisfied preferences. Therefore, if rural people who are generally among the low income groups have a strong desire to diversify their consumption by including more rice in their diet, preventing them through price impediments would be a major social dilemma. However, this conclusion is based on specified preferences biased toward rice but preferences themselves can be indirectly subject to policy manipulations.

H.3 The Problem of Preferences

If we accept that policy deals with shaping behavior in order to achieve specific goals, then assuming that behavioral patterns are given would be a serious inconsistency. Consumption preferences are endogeneous to the food system and result from the opportunity set facing people. The paradigm of Stimulus-Behavior-Reinforcement (S.B.R.) developed by D. Skinner showed that reinforcement contingencies are what shape behavioral patterns in all learning animals, including mankind (Contingencies of reinforcement: A theoretical analysis. Appleton, New York, 1969). Concerning the consumption of millet-sorghum in Senegal, positive reinforcement could take the form of

industrial processing which would make those grains more attractive to urban consumers.

H.4 The Strategy of Industrial Processing

Many people still believe that the declining trend of millet-sorghum consumption is essentially due to a higher demand for more convenient food rather than for rice and wheat as such. It follows from this opinion, that if millet and sorghum were industrially processed, their urban demand would be more important that it has been so far. However, if such a strategy was to be implemented the processing would need to go beyond the stage of flour because the main Senegalese dish based on millet-sorghum, namely "couscous," still requires much preparation work from the stage of flour. This would not be an easy task if we know that consumers have very specific tastes and preferences which are difficult to meet even with advanced technological achievement. On the other hand, processing means increased cost which would negatively affect the competitiveness of millet-sorghum in the food market. Furthermore, the study on grain demand and consumer preferences carried out in Dakar by Ross. C in 1979 and referred to in section G.1 of this chapter revealed that only occasional consumers of millet-sorghum bought flour or "couscous." Out of the 75 households surveyed, 61 never bought couscous and 53 always bought grains. This suggests that consumption of millet-sorghum in urban areas is very sensitive to cost

factors and poor families would choose to purchase grains rather than to pay higher prices for flour or "couscous." If such is the case, industrial processing may not increase the use of millet-sorghum as a substitute for rice. Nonetheless, the possibility of substituting millet-sorghum flour for wheat in the bakery sector is promising despite some resistance on the part of some bakers and consumers. The recent government action sets higher retail prices and lower profit margins for bread entirely made of wheat compared to that with a certain percentage of millet-sorghum flour.

I. Concluding Comments

The analysis of millet-sorghum consumption revealed that the objective of promoting local consumption of those cereals especially in urban areas is a challenging one. The econometric results obtained in this chapter do not contradict our expectations.

Concerning the question of whether or not millet and sorghum are inferior goods for the Senegalese consumers, the correct answer seems to be "yes and no" as shown in the study. However, the sort run aspect of this analysis should be kept in mind when using the results for policy purposes. Given all the socio-economic factors that shape consumer preferences in the evolving Senegalese society, assuming stability of the consumption function does not seem to be realistic.

A number of forces are working against the promotion of millet-sorghum consumption. Among those forces we have a strong preference for rice coupled with the fact that most of the millet-sorghum based dishes are not compatible with fish, which represents an important part of the Senegalese diet. All this raises a question of social ethics concerning the promotion of domestically produced millet-sorghum at the expense of preferred imported rice. With respect to this situation, the balance to maintain between the short-term satisfaction and the long-run interest, the social and the economical, would only be a political decision.

CHAPTER V

CONCLUSION

A. General Summary

The domestic cereals promotion policy in Senegal seems to be based on a well taken rationale, given the food crisis facing the country. However, a number of problems and constraints within the rural economy must be tackled if the new food strategy is to be a success. The most serious of those problems seem to be related to the concept of appropriate technological packages but also to natural factors which limit the possibility for growing the country's preferred but mostly imported cereals, namely rice and wheat. The emphasis is therefore place on millet and sorghum better suited to the ecological environment and widely grown as subsistence crops in the traditional farming sector. On the production side, a great deal of challenges seem to jeopardize the chances of success.

The most determinant factor in domestic supply turned out to be rainfall, which is very unstable. Consequently, a millet-sorghum based food strategy in the present conditions would do very little concerning security issues which were among the initial motivating factors for promoting domestic food production.

Another great challenge has to do with the low responsiveness of millet-sorghum production to price incentives which represent the major policy tool at the disposal of the government in the short run. Such a situation may be due to constraints facing farmers in the production process where labor bottlenecks are major problems as well as the low level of productivity. However, food production in the subsistence sector is also influenced by cultural factors such that farmers' behavior cannot be easily manipulated with conventional policy tools essentially based on price incentives.

On the consumption side, whether or not millet and sorghum are inferior goods for the Senegalese consumer necessitates recognition that we should not be restricted to a "yes or no" answer. Another alternative, namely "yes and no" was expected and found in the consumption model of Chapter IV which yielded a changing sign for income elasticity of millet-sorghum consumption. In fact, millet and sorghum were inferior goods at low income levels and superior goods at high income levels. Low income groups are mostly small producers with a highly specialized diet basically composed of millet-sorghum. For these groups, higher income can be expected to generate a consumption diversification which is likely to be achieved at the expense of millet-sorghum. The official retail price of imported rice was a critical factor in both production and consumption. However, increasing it to promote less

preferred domestic cereals raises ethical and social questions since imported rice may be the main food security device for poor people in rural and urban areas. Moreover, the structural evolution of the Senegalese society coupled with a changing status of women, reinforces the decreasing trend in the consumption of millet and sorghum which are less convenient than rice and wheat in terms of preparation.

Even though the partial substitution program of millet-sorghum flour for wheat in the bakery sector offers some hope, the objective of reducing per capita rice consumption in the capital city of Dakar from its 1979 level of 103 kg. to 60 kg. in 1985 by promoting traditional cereals seems to be very ambitious.

B. A Framework for Actions

B.1 Background

Donald A. Schon (Technology and Change, 1967) argued that we have not lacked theories about what might be done, nor have we always been unwilling to make sufficient commitment of resources to the problems, but we have not had an adequate theory of the process to carry any program of change into effect.

In fact, moving from a problematic situation to a solution involves a process by which some means are combined in order to achieve specific results. The choice of means should be based on an adequate understanding of the problem and a careful examination

of alternative solutions. In our judgment, a useful sequence of steps might be the following:

--Problem diagnosis.

--Identification of causes.

--Assessment of possible alternative solutions.

--Choice and implementation of a solution scheme which must lead to stated goals.

A sketch of this sequence can be recognized in the introductory chapter of this study based on the officially chosen solution scheme of promoting domestic cereals to tackle the problem of high dependency on food imports and at the same time, provide farmers with better living conditions. A relevant question to ask at this stage is why is the dependency on food imports viewed as a problem despite the satisfaction provided to the consumers? A number of answers can be given including the foreign exchange cost, national security considerations and the hypothesis that these imports benefit mostly the urban consumers, discourage domestic food production and hinder the efforts to improve living standards in rural areas. The problem is therefore multidimensional and consequently, any simple solution scheme taken alone is unlikely to provide a full satisfaction.

Concerning the burden of foreign exchange in food imports, regional cooperation should be promoted to develop potential complementarities and take advantage of national differences. For instance, it was noted

earlier in this study that Mali, a neighboring country in the same currency zone (Franc), is a potential rice exporter and the Malian demand seems to be biased toward millet and sorghum. Therefore, developing an effective food cooperation between those two countries ought to be sought. At the national level, research should be undertaken to determine the extent to which recently introduced maize can substitute for rice in consumption. However, the main aspect of the overall solution scheme is still the promotion of millet and sorghum for which the implementation framework must be well defined.

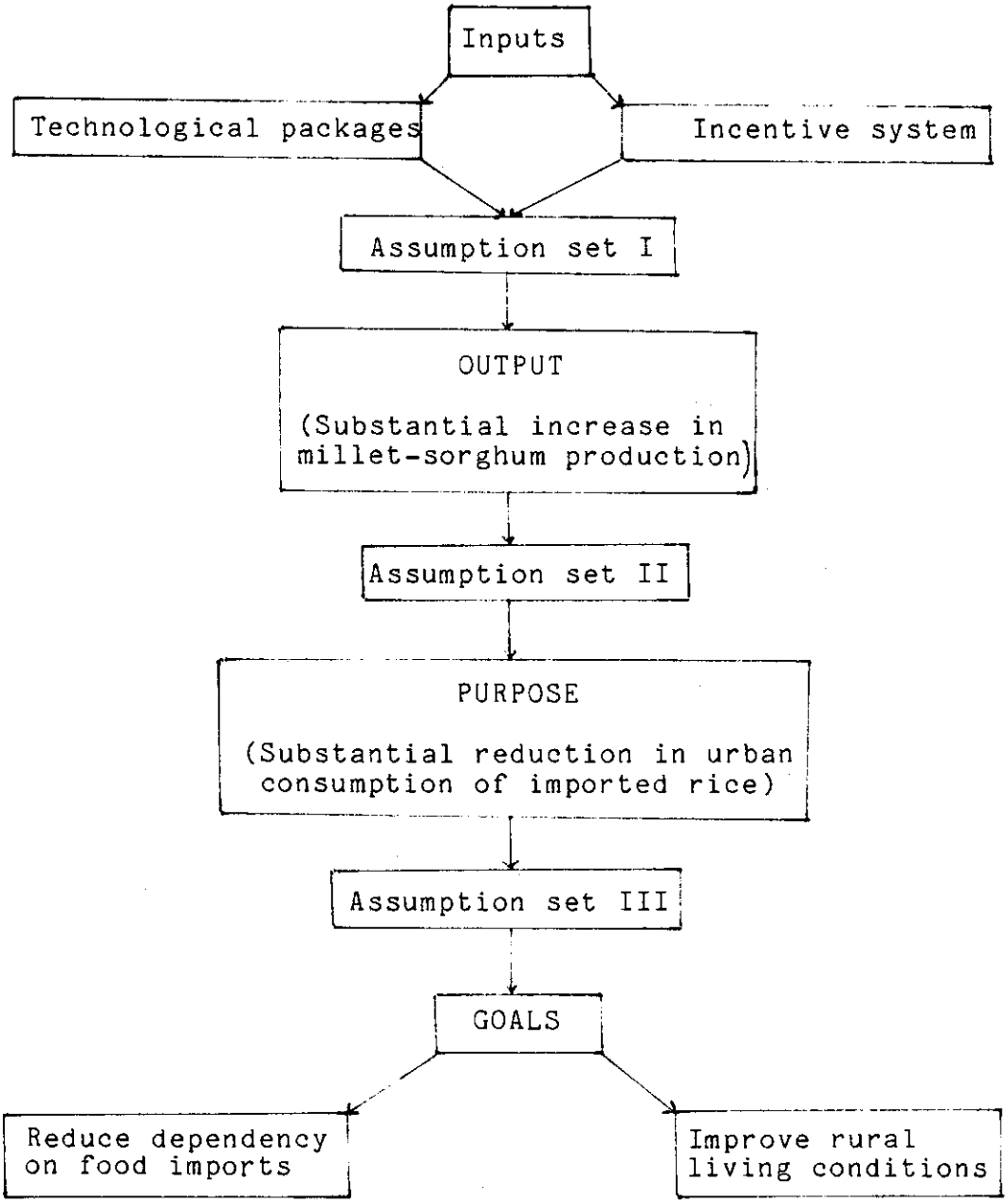
B.2 Framework for Implementing the Millet-Sorghum Promotion Policy.

The most important challenge in policy implementation is to direct actions toward state goals. Implementation itself can be viewed as a process by which different activities are related to one another with the aim of achieving a goal or set of goals. At various levels of the process, there are some underlying assumptions that might be crucial to success and of which one should be aware. Using a vertical logic chart, the process can be represented as follows (figure V-1).

B.2.1 Inputs

Viewed in a general sense, the concept of input in this case stands for various initial means which are grouped in two categories for simplification.

Figure 5-1. Means-ends relationship chart for promoting millet-sorghum production



B.2.1.1 Improved Technological Packages

The choice of adequate technological packages is among the most critical aspect of agricultural policy in Senegal. The technologies to be developed should not depend on imports since reducing the balance of payment deficit is among the ultimate goals. Therefore, they ought to be based on an effort to improve the efficiency of traditional farm implements and practices. Research on the improvement of local millet-sorghum varieties should be encouraged instead of focusing efforts on how imported green revolution crops can be adapted to the domestic environment which is unsuitable.

One should also take into account the fact that technology may not be appealing to farmers if it is specialized in one crop. In fact, the traditional farming system is generally characterized by the existence of numerous crops in each farming unit and in some cases, mixed cropping is performed.

B.2.1.2 Incentive System

Even when technological inputs are made available to farmers, the incentive system must be adequate to orient their decisions toward producing more food. The limited effectiveness of price incentives alone as a

supply booster was discussed in Chapter III. Nevertheless, it's our belief that farmers would be more interested in growing food crops, especially millet-sorghum, if some reinforcing conditions were created. In fact, it was mentioned that low price responsiveness of millet-sorghum production was at least partly explained by the post-harvest difficulties involved in preparing the grains for sale. On the other hand, with the expansion of the market economy, greater premium is placed by rural people on monetary values. Therefore, the ease and timeliness with which farm production can be transformed into money after harvest can be very important. Groundnut has always been more convenient in that respect. Therefore, farmers would be more interested in growing millet if they could sell it in the form of stalks to government agencies or other traders and those buyers would take care of the threshing. This might greatly increase farmers' interest in producing millet and sorghum which have over groundnut the advantage of being harvested first (except for some specific non-widespread varieties), at a period when farmers' available cash resources are the most scarce. In the present

situation, early millet-sorghum harvest does not generate any substantial cash inflow at the farm level before groundnut is sold, due to the post-harvest constraints in marketability discussed earlier.

With the strategy of selling millet-sorghum in stalks, those constraints particularly discouraging for seasonal migrant workers because of time and woman labor requirements in threshing, would be removed.

B.2.2 Assumption Set I

A "bridge" of assumptions exists between the combination of inputs and the desired output of substantial increase in millet-sorghum production. The most critical of those underlying assumptions is related to natural factors and especially to rainfall. In fact, millet and sorghum are basically grown under rainfed conditions and with the drought experienced during the past years, many people are now pessimistic. Therefore, medium and long-term planning of domestic food production should not be based on too optimistic assumptions about the future of rainfed agriculture in the Sahel region.

B.2.3 Assumption Set II

The expected substantial increase in domestic production of millet-sorghum should

significantly reduce urban consumption of imported rice. However, this is conditional upon the following assumptions.

First of all, the urban demand for millet-sorghum will increase by means of the incentive tools discussed in the previous chapter. Secondly, the substantial increase in millet-sorghum production will be sustained in the future so that a higher urban demand can be met. Finally, the marketing problems will be solved and rural surpluses will be easily channeled to urban markets. Therefore, a general concern of food production planners should be how realistic these assumptions are concerning what could reasonable be done in the future in light of the present situation and the past experience.

B.2.4 Assumption Set III

The purpose of reducing urban consumption of imported rice is not a meaningful end by itself and must help achieve broader objectives of reducing dependency on food imports and improving rural living conditions.

With respect to reducing dependency on food imports through decreased urban consumption, it is implicitly assumed that rural demand for imported rice will not substantially increase in the future if

greater millet-sorghum production is achieved. Given the negative income elasticity of millet-sorghum consumption for low income levels characterizing rural dwellers, this assumption does not seem to be very realistic and needs a careful reconsideration.

B.2.5 Concluding Comments

The logic of the vertical chart can be a useful planning tool and a framework for action, provided that critical assumptions are not unrealistic. It has at least the merit of making people aware of those implicit assumptions that might even be unperceived by food production planners. For the sake of logical consistency, one may consider moving along the chart from the bottom to the top, that is, from the ultimate goals to the inputs. However, the stated purpose and goals are somewhat arbitrary and even goals themselves can be viewed as intermediary means for achieving broader objectives.

APPENDIX

Table A-1. Selected Demand Variables

Year	Consumption of millet-sorghum		Gross per capita income in current prices	Retail price of rice	Consumer price index:
	Total (1000 metric tons)	Per capita (Kg)	(1000 FCFA)	(FCFA/Kg)	(1970=100)
1960-61	426	122.0	45.57	30	77.9
1961-62	413	115.8	46.76	30	80.7
1962-63	439	120.4	48.43	30	78.8
1963-64	502	134.7	47.96	35	84.4
1964-65	541	142.0	50.75	35	87.6
1965-66	556	144.7	50.91	40	91.5
1966-67	427	107.1	51.77	40	94.2
1967-68	659	161.4	48.79	45	93.7
1968-69	453	108.3	51.90	45	94.1
1969-70	674	157.4	51.38	45	97.8
1970-71	405	92.4	54.10	40	100.0
1971-72	610	122.0	54.70	40	103.8
1972-73	362	78.5	64.30	40	110.0
1973-74	545	115.1	48.30	60	122.4
1974-75	754	155.2	58.70	100	144.1
1975-76	671	134.5	66.00	90	180.0
1976-77	562	109.8	96.50	80	193.0
1977-78	410	89.7	104.70	80	211.7
1978-79	862	159.6	105.60	80	237.2
1979-80	540	97.0	106.20	80	268.0
1980-81	597	104.2	107.40	80	304.5
1981-82	1006	170.8	108.50	105	345.6

Sources: -BCEAO: Notes d'informations et Statistiques (various issues).
-Societe Africaine d'Edition: Le Senegal en Chiffes, 1982.
-Ministère du Plan et de la Cooperation V^e Plan de développement Economique et Social, Dakar, 1977.

Table A-2. Selected Supply Variables

Years	Production of millet-sorghum		Producer price of millet-sorghum	Producer price of groundnut	Rainfall index (Annual average 1931-1960 = 100)
	Total (1000 metric tons)	Per capita (Kg)	(1000 FCFA)	(FCFA/Kg)	
1960-61	392	112.3	15	22.0	95
1961-62	410	115.0	15	22.0	78
1963-64	425	116.5	16	22.0	87
1964-65	521	136.8	16	21.5	86
1965-66	554	144.0	16	21.5	106
1966-67	424	106.3	17	21.5	114
1967-68	656	160.7	17	21.5	100
1968-69	450	107.6	17	18.0	55
1969-70	635	148.3	18	18.5	110
1970-71	405	83.0	18	18.5	73
1971-72	580	116.0	18	19.5	90
1972-73	351	76.0	18	23.0	55
1973-74	496	104.7	23	23.0	57
1974-75	754	155.2	30	29.8	80
1975-76	668	134.0	35	41.5	80
1976-77	554	108.3	35	41.5	65
1977-78	420	80.0	40	41.5	50
1978-79	802	148.5	40	41.5	90
1979-80	520	93.4	40	45.5	75
1980-81	545	95.0	50	50.0	55
1981-82	1006	170.8	50	70.0	>100*

* 105 was used in this study

Sources: -BCEAO: Notes d informations Statistiques (various issues).
-Société Africaine d'Edition: Le Senegal en Chiffres, 1982.
-Ministere du plan et la Cooperation V^E Plan de Developpement Economique et Social, Dakar, 1977.

Table A-3. Planted Areas of Millet-sorghum and Groundnut

Years	Millet-sorghum	Groundnut
1960-61	762	977
1961-62	831	1026
1963-64	865	1015
1964-65	959	1084
1965-66	1011	1055
1966-67	1069	1114
1967-68	997	1114
1968-69	1155	1164
1969-70	1054	1191
1970-71	1037	953
1971-72	952	1049
1972-73	975	1060
1973-74	936	1071
1974-75	1094	1026
1975-76	1155	1052
1976-77	963	1203
1977-78	948	1346
1978-79	943	1113
1979-80	1055	1179
1980-81	955	1097
1981-82	1084	1050

Sources: -BCEAO: Notes d'Information et Statistiques. (Various issues).
-Le mois en Afrique, vol. 17, Janvier-Fevrier, 1982, p. 52.

Table A-4. Evolution of Rural Income in Senegal

Years	Total rural household gross income (billion FCFA in current prices	Rural per capita income (1000 FCFA in current prices)	Rural income as a percentage of total domestic income
1960-61	49.10	18.065	36.9
1961-62	50.79	18.377	36.7
1962-63	53.89	19.170	36.6
1963-64	48.32	16.907	34.1
1964-65	56.29	19.373	36.6
1965-66	59.72	20.480	38.1
1966-67	63.96	21.253	39.9
1967-68	58.83	19.293	37.9
1968-69	66.20	21.201	39.5
1969-70	55.26	17.370	32.1
1970-71	63.39	19.567	33.7
1971-72	36.76	11.110	21.7
1972-73	57.13	16.938	27.8
1973-74	51.67	15.013	22.7
1974-75	67.86	19.345	23.8
1975-76	99.38	27.798	30.2
1976-77	149.06	41.047	30.2
1977-78	157.31	42.664	27.4
1978-79	120.57	32.026	21.1
1979-80	141.84	36.884	23.9
1980-81	120.15	30.619	19.5
1981-82	113.75	28.470	17.8

Sources: -Societe Africain d'Edition: Le Senegal en Chiffres, 1978, 1979-1980, 1981, 1982.
-BCEAO: Notes d'informations et Statistiques (Various issues).

Table A-5. Importance of Agricultural Sector in the Economy of Selected Sahelian Countries

Country	Agricultural GDP as a percentage of total GDP (1978)	Agricultural population as a percentage of total population (1979)	Agricultural exports as a percentage of total exports (1979)	Agricultural imports as a percentage of total imports (1979)	Percentage of total merchandise imports financed by agr. exports (1979)
Chad	52	84	89	16	76
Gambia	58	78	69	20	28
Mali	38	87	76	16	52
Mauritania	25	83	36	31	20
Niger	43	88	28	21	14
Senegal	29	75	43	30	35
Upper Volta	40	82	39	26	30

Source: F.A.O.: The State of Food and Agriculture, United Nations, Rome, 1980, p. 168.

Table A-6. Indices of Agricultural Production in the Sahel (Annual average 1969-1971 = 100)

Country	1975		1976		1977		1978		1979	
	Total	Per capita	Total	Per capita	Total	Per capita	Total	Per capita	Total	Per capita
Gambia	111	95	113	94	104	84	90	71	108	83
Mali	105	93	110	95	105	90	118	96	112	89
Mauritania	78	68	83	71	86	71	89	72	94	74
Niger	79	69	104	88	106	87	112	90	114	88
Senegal	140	120	126	105	90	73	134	107	102	78
Upper-Volta	105	102	108	94	111	94	120	99	124	100

Source: F.A.O.: The State of Food and Agriculture, United Nations, Rome, 1980, p. 141.

Table A-7. Indices of Food Production in the Sahel (Average 1969-71 = 100)

Country	1975		1976		1977		1978		1979	
	Total	Per capita	Total	Per capita	Total	Per capita	Total	Per capita	Total	Per capita
Gambia	111	95	113	94	104	84	90	71	108	83
Mali	102	90	105	91	103	87	113	93	107	85
Mauritania	78	68	83	71	86	71	89	72	94	74
Niger	78	68	104	88	107	88	113	90	114	89
Senegal	139	119	125	104	89	72	134	106	100	78
Upper-Volta	115	102	107	93	109	92	120	99	122	98

Source: F.A.O.: The State of Food and Agriculture, United Nations, Rome, 1980, p. 139.

Table A-8. Percentage of Cereal Consumption Satisfied by Domestic Production, Commercial Imports, and Food Aid in Senegal

Period	Domestic production	Commercial imports	Food aid	Total consumption in 1000 metric tons of cereal equivalent
1969-70	76	22	2	1,017
1970-71	60	39	1	836
1971-72	72	28	1	968
1972-73	49	37	14	757
1973-74	65	29	6	900
1974-75	79	20	1	1,131
1975-76	74	24	2	1,159

Source: CILSS Club du Sahel: Commercialisation, politique des prix et stockage des cereales au Sahel: Etude diagnostique. Tome I, CRED, University of Michigan, August 1979, p. 265.

Table A-9. Rural-Urban Consumption Patterns in the Sahel Region (dominant staples)

Country	Rural	Urban
Cap- Verde	Maize	Maize
Chad	Millet-sorghum	Rice-wheat
Gambia	Rice	Rice
Mali	Millet-sorghum Rice	Rice-wheat
Mauritania	Millet-sorghum	Rice-wheat
Niger	Millet-sorghum	Rice-wheat
Senegal	Millet-rice	Rice-wheat
Upper Volta	Millet-sorghum	Rice-wheat

Source: U.S.D.A. "Food problems and prospects in sub-saharan Africa. The decade of 1980s." U.S.D.A. Economic Research Service, Washington, D.C., August 1981, p. 280.

Table A-10. Percentage of foreign exchange earnings from cash crops in the Sahel. (1979)

Country	Percentage	Main cash crops
Cap Verde	18.7	Bananas
Chad	57.9	Cotton
Gambia	95.2	Groundnut
Mali	51.3	Cotton-Groundnut
Maueitania	----	----
Niger	0.1	----
Senegal	55.5	Groundnut
Upper Volta	63.4	Cotton, Groundnut

Source: U.S.D.A. "Food problems and prospects in Sub-Sahara Africa, the decade of 1980's" USDA Economic Research Service, Washington, D.C., August 1981, Appendix 3.

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[4]According to Wharton (1969), appropriate technology should be:

- --within the means of the farmers to use, own or hire.
- --economically viable.
- --socially and culturally acceptable.
- --known to the farmers as to its existence and use.
- --available at the right time and in sufficient quantity.
- --adopted to farmers' environment and situation.

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[8]Unrealized potential gain assuming an equilibrium price of $5.88 per 100 kg of wheat equivalent.

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[11]Two series of CPI are available, one referring to the European type consumption.

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[14]Note the short run nature of the estimates. Long run estimates might be different.

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