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AN ECONOMIC ANALYSIS OF FACTORS AFFECTING MILLET PRODUCTION AND TRANSACTIONS IN THE PEANUT BASIN OF SENEGAL

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AN ECONOMIC ANALYSIS OF FACTORS AFFECTING MILLET PRODUCTION AND TRANSACTIONS IN THE PEANUT BASIN OF SENEGAL

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ABSTRACT

AN ECONOMIC ANALYSIS OF FACTORS AFFECTING MILLET PRODUCTION AND TRANSACTIONS IN THE PEANUT BASIN OF SENEGAL

By

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The main objective of this study was to evaluate the performance of the millet subsector in Senegal and to determine the prerequisites to achieving the government's objective of encouraging local cereals production for consumption. The study relied on primary data collected from samples of 160 farm households between October 1986 and September 1987, 18 markets between October 1984 and December 1989, and 66 wholesalers between October 1986 and September 1988.

The study found that only 16 percent of household heads in the Northern and the Central Peanut Basin were capable of producing enough millet to cover 6 months of consumption. In the Southern Peanut Basin 82 percent of household heads were capable of producing enough millet to feed their dependents for an entire year. Seventy-four percent of household heads in the entire sample were net buyers of millet. The percentage of millet production marketed was low, indicating that the markets are thin.

The extent to which household heads sell millet at harvest and buy back was investigated in the study. The results implied that when markets are uncertain, the behavior of prices may provide losses as well as occasional windfall gains for farmers who sell at harvest and buy back later.

The analysis of temporal market integration indicated that millet storage was very risky due to uncertainties about markets and the price volatility. As a result, it is not in private traders' interest to get involved in long-term storage.

The study also found evidence of efforts by farmers to reduce risk through the use of informal social contracts. The evidence of farmer solidarity seems to indicate that a traditional "safety net" is already in place in rural areas, which should be explored by the government for the design of the future cooperatives.

DEDICATED

To

My beloved parents,

Moussa Ndoye and Nafi Ciss,

My wife and my son,

Aïda and Moussa Jr.,

for all of their blessings and love

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LIST OF ABBREVIATIONS

ADO	Agricultural Development Office
AEW	Adult Equivalent Worker
BAME	Bureau d'Analyses Macro-Economiques
BCEAO	Banque Centrale des Etats de l'Afrique de l'Ouest
CFA	Communauté Financière Africaine
CILSS	Comité Permanent Inter-Etats de Lutte Contre La Sécheresse au Sahel
CRA/BAMBEY	Centre de Recherches Agricoles de Bambey
CSA	Commissariat à la Sécurité Alimentaire
DRSAEA	Direction de Recherches sur les Systèmes Agraires et L'Economie Agricole
EBP	Environment, Behavior, Performance
FSR	Farming System Research
GOS	Government of Senegal
ICRISAT	International Center for Research in Semi-Arid Tropics
IFPRI	International Food Policy Research Institute
IMF	International Monetary Fund
ISRA	Institut Sénégalais de Recherches Agricoles
IRAT	Institut de Recherches Agronomiques et Tropicales
IRRI	International Rice Research Institute
MDR	Ministère du Développement Rural
MPC	Ministère du Plan et de la Coopération
MSU	Michigan State University
NPA	Nouvelle Politique Agricole
ROCAFREMI	Réseau de l'Ouest et Centre Africain de Recherches sur le Mil
SAIS	School of Advanced International Studies (The Johns Hopkins University)
SAL	Structural Adjustment Loan
SEPFA	Société d'Exploitation et de Production pour la Fourniture de l'Arachide de Bouche
USAID	United States Agency for International Development

CHAPTER 1

INTRODUCTION

In 1984 and 1986 the government of Senegal (GOS) defined a New Agricultural Policy (NPA) and a Cereals Plan aimed at substituting local cereals (millet, sorghum, maize) for imported rice and attaining 80 percent cereal self-sufficiency by the year 2000. One key policy instrument was to liberalize local cereal markets. As underlined by Staatz et al. (1989), market liberalization should be understood as "a process of removing legal prohibitions to private trade in selected commodities and taking other actions aimed at facilitating the functioning of the private sector, with the objective of placing greater reliance on the market to allocate resources". The step toward liberalization of local cereals markets was a necessary condition since the previous rules of the game had negatively affected the performance of the agricultural sector.

By liberalizing local cereals markets, the GOS expected more aggregate supply response, especially for millet. The assumptions implied were that improvements in the relative prices of millet would shift resources away from peanuts to increase millet production beyond the subsistence level. Furthermore, the government expected that liberalizing the millet markets would result in higher net real incomes to farm households, and that the gain in revenue from millet after the policy reforms would be greater than the loss in revenue from peanuts. The underlying assumption for the GOS was that the majority of rural households were or would become net sellers of millet, so that an improvement in the relative prices of that commodity would significantly increase its marketed surpluses.

In order to help monitor and evaluate the effectiveness of the NPA, the Macroeconomic Analysis Bureau (BAME) of the Senegalese Agricultural Research Institute (ISRA) initiated a research program with a three major components (Newman et al., 1984):[1]

a) **Production economics**, which focussed on the distribution and use of inputs (seed, fertilizer, equipment) and the adoption of improved technology;

b) **Marketing**, which addressed the organization, operation and performance of different subsectors (cereals, cash crops, fish, livestock, vegetables);

c) **Food security** at the household, regional, and national levels, and the tradeoffs involved in achieving them.

Several studies conducted under the BAME research program contributed to the policy debate launched by the government of Senegal. Frederic Martin (1988) analyzed food security and comparative advantage in Senegal. He showed that the government objective of achieving 80 percent cereal self-sufficiency was very optimistic and challenging, due to the low supply response to price for local cereals. Furthermore, he showed that maize production was more responsive to price than millet, and given the current low demand for maize, there could be a surplus if sufficient production incentives were provided to farmers. According to Martin (1988), the substitution of local cereals for rice by raising rice prices alone would have negligible effects on production, and would impose substantial costs on consumers.

Valerie Kelly (1988) examined the causes of low demand for fertilizer and identified a number of options for making fertilizer policy more responsive to farmers'

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[1] This research program was initiated with support from the Senegal Agricultural Research Project, financed by USAID and implemented by the Department of Agricultural Economics of Michigan State University.

needs and government objectives. She found that fertilizer demand was constrained by, among other things, the lack of financial liquidity on the part of farmers, as a result of low agricultural productivity, which contributed to lowering farm incomes in the Peanut Basin of Senegal. She recommended that the government provide credit to stimulate both farm demand and the private sector involvement in fertilizer distribution.

Michael Morris (1986) studied rice marketing in the Senegal River Valley. He showed that private traders offered market outlets that favored both farmers and consumers. Furthermore, he stressed the complementarity between the public and the private sector in carrying out the necessary functions to improve the performance of the rice subsector. In other words, complete privatization of the subsector or complete elimination of the private sector involvement in rice marketing were both not desirable, but there should be an appropriate mix.

Finally, Stephan Goetz (1990) shed light on the technological and input-related complementarities between food crops and cash crops in Southeastern Senegal. He showed that many farmers in Southeastern Senegal were not capable of responding to the floor price set by the government to stimulate local cereals production. The main reason was that for the majority of farmers, the markets either selectively failed (40 percent of households surveyed), or if they participated in the markets, they tended to be net buyers. According to de Janvry et al. (1991), selective market failures imply a situation where in general the markets exist, but they selectively fail for particular households, making the commodity a non-tradable good for them. Market failure means that transaction costs are so high that trade is not profitable. Goetz also stressed the availability of processing technology for local cereals and more market information to increase market participation.

1.1 Problem Statement and the Need for the Study

This study aims to address two major questions: 1) What is the actual performance of selected components of the millet subsector in Senegal? and 2) How those components and coordination among them be improved so that the government's objective of encouraging local cereals production for consumption can be facilitated? Answering these questions requires dealing with issues related to millet productivity and profitability relative to peanuts, maize, and rice; millet transactions, storage and profitability; access of farmers and private traders to supporting institutions, competitiveness of the millet markets, integration of input and output markets; government policy and the legal foundation of the millet markets.

The above issues contribute to the policy debate launched by the GOS since the New Agricultural Policy and the Cereals Plan, concerning the feasibility, the challenges and the conditions that must be met to facilitate local cereals consumption in Senegal. Addressing these issues will help evaluate arguments made in previous studies about the need for the government to raise agricultural productivity by facilitating farmers' access to improved technologies and by providing supporting institutions in order to increase millet production. Furthermore, answers to the above issues will shed light on the ability of rural markets to allocate resources, the need to maintain and strengthen the market information system currently underway, and to improve the level of infrastructure. Moreover, the empirical evidence obtained from the above issues will enable policy makers to understand better the risk involved in storing millet, the importance of providing credit to encourage both private traders and farmers to store, and the need to stabilize the millet markets if prices are volatile. Answers to the above issues will also allow the behavior of farmers in the Peanut Basin to be compared with the behavior of

farmers from other parts of Senegal (for example, comparing the degree of market involvement between farmers in the Peanut Basin and farmers in Southeastern Senegal).

The promotion of local cereals for consumption in Senegal also requires that the millet subsector be linked with regional and international markets. Because domestic millet production fluctuates tremendously (the coefficient of variation of production for the period 1979-1988 is 28 percent), one could look to regional and international markets as an alternative source of millet to help stabilize the market. Unfortunately, there is no international market for millet, which makes it a non-traded good. Millet (milo) is produced in the United States, but it is used exclusively as livestock feed.

In West Africa where production is mostly concentrated, there are no futures markets, terminal markets, or electronic markets that would facilitate quotation and exchange at a distance. The regional market suffers from uncertain supply, poor infrastructure, lack of coordinated policies among West African countries and ambiguous and frequently changing rules of the game (which discourage private sector investment and movement of commodities among countries), nonexistence of a centralized market information system that informs participants about market conditions and outlook for all the countries.

Since an international market does not exist for millet, and because of the unreliability of the West African regional market, the primary focus for Senegal is to increase domestic millet production significantly, to improve the marketing system such that it delivers millet at a competitive price, and to promote millet processing.

The choice of millet for this dissertation is justified since it is the most important locally grown cereal in Senegal both in terms of area and production. In 1989, about 900,000 hectares of millet (40 percent of all arable land) was grown (van Veen, 1989).

Therefore improvement in millet production becomes necessary for the following reasons:

i) higher millet production and consumption would decrease the reliance of Senegal on imported rice, thus enabling the government to save a substantial amount of foreign exchange. The latter is very important since peanuts, which used to be the primary source of foreign exchange, are facing serious competition in the international market.

ii) higher millet production would increase marketed surpluses and farm income and thus the well-being of the majority of the farm population.

1.2 Economics of Millet Production in the Peanut Basin

Barry et al. (1992) show that millet production is profitable for home consumption in the Peanut Basin. According to the authors, the domestic resource costs (DRC) for producing millet in the Southeast and the Southwest Peanut Basin using semi-intensive and extensive production techniques are 0.69 and 0.77 respectively. This suggests that both the Southeast and the Southwest Peanut Basin have a comparative advantage in millet production. Furthermore, the simulation results from Barry et al. (1992) indicate that if millet yields increase by 20 percent, the Southern Peanut Basin becomes more competitive in supplying the wholesale markets in Dakar.

Martin (1988) investigated the profitability of millet production in the Peanut Basin under 5 modules. The first module corresponds to millet production using a high level of intensification, i.e., the level of inputs recommended by agronomists. The second and the third modules represent millet production using decreasing level of intensification, i.e., average and low levels of inputs, especially fertilizer. The fourth and the fifth modules represent millet production in the home gardens ("champs de case")

and late millet cultivation relative to the optimal calendar due to replanting.

According to Martin (1988), in a bad year, millet production is not financially profitable[2] in the Central Peanut Basin for any of the five modules. In an average and a good year, millet production is financially profitable to the farmer. In the Northern Peanut Basin, millet production is not financially attractive (except for module 4) in both a bad and an average year. In a good year, millet production is profitable for all modules. In the Southwest Peanut Basin, millet production is profitable for all modules and for all state of nature (bad, average and good year). In the Southeast Peanut Basin, millet production is not profitable in a bad year for modules 2 and 5, but it is profitable for all the other modules and states of nature.

1.3 Place of Millet in the Farming System in the Peanut Basin

Millet is traditionally grown for home consumption in the Peanut Basin in rotation with groundnuts and cowpeas. Even though past studies have shown that millet is less profitable than peanuts and maize in Senegal (Martin, 1988; Kelly, 1988; Sidibé, 1991), it will continue to be produced because of its importance in the current millet-groundnut or millet-cowpeas crop rotations. Farmers cannot cultivate groundnuts on a continuous basis in the same field. Furthermore, with population pressure, farmers can no longer afford to fallow their land to increase its fertility. Maize production is profitable in the home gardens ("champs de case") which benefit from manure, but constraints on further expansion include the crop's high nutrient demands, high cost of production, competition for peak labor and drought sensitivity (Agel and Yung, 1985). According to Posner and Crawford (1989), expanding the production of maize beyond the home gardens necessitates finding economical ways of increasing soil organic matter,

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[2] Based on net margin with labor costs.

raising soil PH, and managing fields in blocks to mitigate problems of damage from animals. Another problem with maize relates to its difficulty in processing using traditional methods compared to millet. For example, it takes women an average of two hours per kg to transform maize to flour using mortar and pestle, whereas on average women obtain two kg of millet flour in one hour using the same traditional techniques (Mbengue, 1987; Mbengue and Diouf, 1987).

All the above factors make millet production very appealing to farmers despite its lower profitability compared to groundnuts and maize.

1.4 Objectives of the dissertation

Using data from the Peanut Basin of Senegal, this dissertation investigates what constraints affect millet production and marketing, and what policies and actions may improve the performance of the subsector and therefore better respond to the government's objective of encouraging local cereals production for consumption. Specifically the study aims to: a) examine household millet transactions in the Peanut Basin and the impact of personal relationships on farmers' behavior; b) evaluate the competitiveness of the rural assembly markets for millet; and c) assess the policy implications of the above objectives. The more specific questions to be addressed in the study are as follows:

a) What is the percentage of millet production marketed by households in the Peanut Basin?

b) Are farmers in the Peanut Basin "forced" to sell millet at low prices at harvest and to buy back at higher prices? What can be done to help farmers following such behavior to improve their food security?

c) What are the implications of social closeness for household behavior in

the Peanut Basin? i.e., how do farmers who know each other develop social contracts to reduce risk and the volatility of market prices? What would that suggests for the legal foundations of the Senegalese economy?

d) How well are the rural assembly markets coordinating the transactions of market participants?

e) Is it profitable to store millet to take advantage of seasonal price variation?

1.5 Organization of the Dissertation

Chapter 2 discusses the conceptual framework used in this study. Included are an extension of the environment, behavior, performance (E-B-P) paradigm to the millet subsector in Senegal, some market-related concepts such as the importance of the legal environment of markets (the rules of the game, contracts and their enforcement, protection of property rights, specification of appropriate grades and standards), transaction costs and market coordination.

Chapter 3 reviews the data collection procedure of the study. The chapter describes the Peanut Basin and its importance in terms of population, agricultural production and area. The length of the marketing year is then specified along with a discussion of the importance of the different seasons within a given marketing year. Finally, the data collection procedure is presented.

Chapter 4 investigates the impact of household resource endowment on millet production. Included in this chapter are a description of the characteristics of households in the sample, an examination of the impact of equipment ownership on millet production, the constraints to millet production, what farmers think the government should do to help them, and the need for institutional innovation to increase

millet production.

Chapter 5 examines household millet transactions in the Peanut Basin and the impact of personal relationships on farmers' behavior. Included in this chapter are an estimation of the percentage of millet production marketed by various categories of households, the degree of market involvement and the determination of the percentage of households that are net buyers and net sellers of millet, a test of the hypothesis of "forced" sales, the determination of the magnitude of the loss of welfare implied by such behavior, and the role of personal relationships in farmers' market transactions.

Chapter 6 evaluates the competitiveness of the (rural assembly) millet markets. Included in this chapter are an investigation of the relationships between millet price volatility and the profitability of storage for both farmers and private traders, an investigation of spatial market integration, and an analysis of traders' marketing costs and margins.

Chapter 7 summarizes the performance of the millet subsector, policy implications of the study, and the need for further research.

CHAPTER 2

CONCEPTUAL FRAMEWORK AND DESCRIPTION OF MILLET SUBSECTOR PARTICIPANTS

2.1 An Extension of the Environment-Behavior-Performance Paradigm to Evaluate Millet Production and Transactions in Senegal

The objective of this section is to extend the environment, behavior, performance paradigm to evaluate millet production and transactions in the Peanut Basin. An underlying feature of this extension is its attempt to establish some performance norms to evaluate the millet subsector.

The millet subsector evolves in an environment which shapes the opportunity sets of participants (Shaffer, 1980). An opportunity set is defined as "the available lines of action open to an individual" (Schmid, 1987). The environment in which the millet subsector participants operate can be broken down into three components:

i) The physical environment, which includes weather, insects, crop diseases, soil quality and type, and physical infrastructure.

ii) The institutional environment, which includes research, extension, credit, factor and product markets, government ideology (i.e., government perceptions about how the millet subsector should operate), and the rules of the game, which constrain the behavior of the participants.

iii) The socio-economic environment, which includes household resource base (land, labor, capital), household size and composition, literacy, education of participants, human capital, and the community structure, norms and beliefs.

2.1.1. Relationship between the Environment and Participants

The sub-components of the environment affect the behavior of participants in the millet subsector. The result is performance or the total flow of consequences or outcomes (Shaffer, 1983), which in the case of the millet subsector include the quantity of millet produced and marketed by rural households, quantity of millet assembled by first handlers and distributed to consumers and the cost of the different marketing services (figure 1). Any improvement in the components of the environment as defined above results in an expansion of the opportunity sets of participants in the millet subsector. Factors that explain improvements in the physical environment include better distribution and more abundant rainfall, eradication of insects and crop diseases through research in plant pathology and entomology, dissemination of drought-resistant varieties, amelioration of soil fertility, prevention of soil erosion, and investment in physical infrastructure. Improvements in the institutional environment can be due to better design of agricultural research and extension, provision of agricultural credit, increased incentives for better working of factor and product markets, better definition and clarification of the rules of the game and changes in government ideology. Improvement in the socio-economic environment can come from participants' perceived changes in the millet subsector (i.e., their view on whether to consider millet as a cash crop, their willingness and ability to invest in the subsector, to adopt improved technology, and improve management practices), changes in land tenure, and human capital improvement to increase the quality of the labor force in agriculture.

In the case of Senegal one can argue that since independence not all the components of the environment have improved simultaneously for millet, leading to less than a full expansion of participants' opportunity sets. For example, if there is

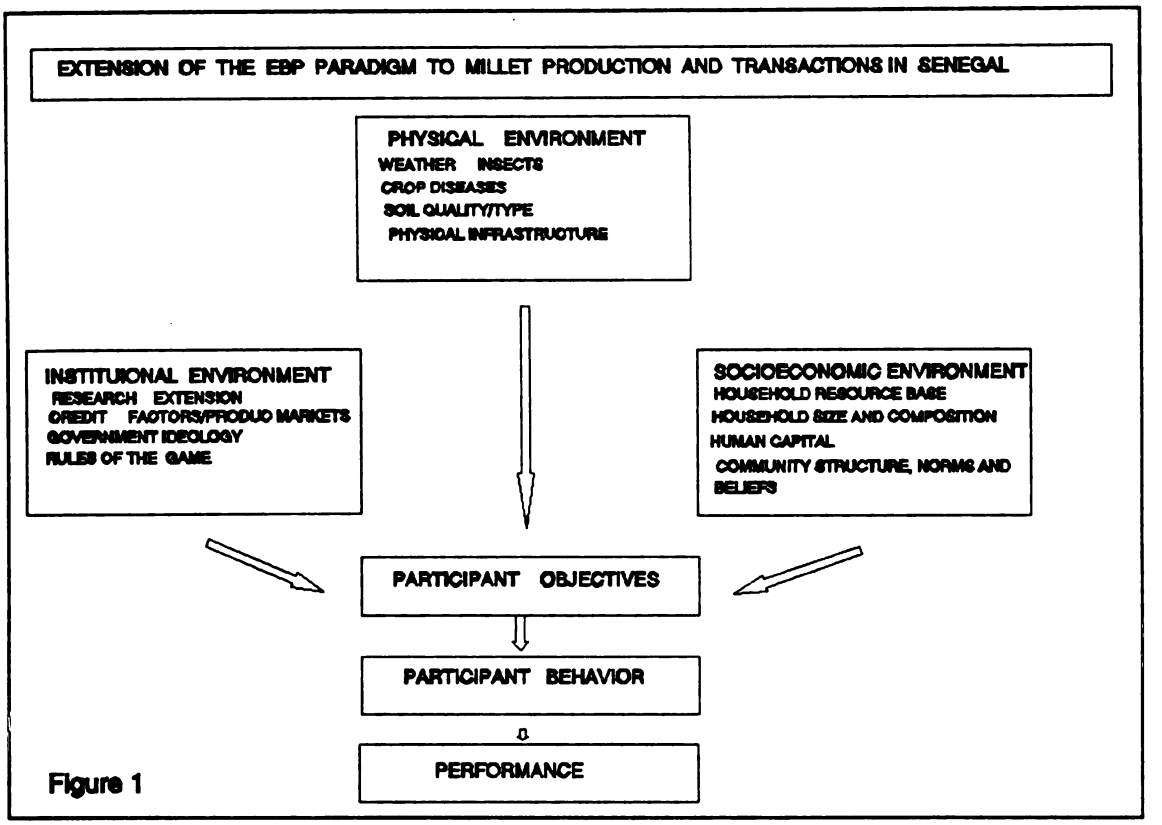


Figure 1

improvement in rainfall leading to a bumper crop, the physical environment improves but the institutional and the socio-economic environment may not if government regulations enforce pan-territorial and pan-seasonal pricing, complicated licensing procedures, and restriction of the transport of millet from one area to another. If the government liberalizes the millet markets (as it is currently the case), the institutional environment improves, but the physical and socio-economic environment may not if there is persistent drought and if market participants perceive changes in the institutional environment as short-run phenomena.

All this is to say that the government's objective of promoting millet consumption in Senegal requires achieving a significant increase in production per capita and thus potential marketable surpluses through technological innovation and better ways of

instituting factor and product markets. This implies that there must be a significant improvement in the components of the environment that would expand the opportunities for a large proportion of participants in the millet subsector.

2.1.2. Relationships between the Sub-components of the Environment

The physical environment affects the socio-economic environment in many ways. For example, better roads increase the availability of transport services, which reduce the time spent by farmers to market their crops compared to using carts or foot. Furthermore, more abundant rainfall puts more pressure on the household to carry out the cropping activities on time and may influence farmers to adopt improved technologies if they are available.

The physical environment affects the institutional environment by dictating the changes research has to consider. For example, when there is persistent drought, agricultural research must develop drought-resistant varieties to cope with the situation. When there are persistent insect attacks as it is currently true in the Sahel, agricultural research must respond.

The institutional environment affects the physical environment by changing farmers' ability to cope with that environment. For example, better working of the input markets increases the probability of using more inputs and to maintain soil fertility.

The institutional environment affects the socio-economic environment in many ways. For example, better working of input and output markets can influence farmers to use more inputs, to generate marketable surpluses, and increase their incomes, and thus to enhance their status within the community. Less restricted regulations can increase farmers' incentives to produce and sell their crops. Predictable rules of the game can bring private traders to increase their investment in the agricultural sector.

The socio-economic environment affects the physical environment in the sense that farmers' willingness to plant trees can prevent continuous deforestation. Furthermore, farmers practice intercropping, which is very useful in nitrogen fixation to the soil.

The socio-economic environment affects the institutional environment since farmers' unwillingness to adopt technology may make policy makers provide more credit and other supporting institutions.

2.1.3 The participants and their behavior

The participants in the millet subsector include households, assemblers, wholesalers, retailers, consumers, public agencies and the government.

2.1.3.1 Households

The household is a decision-making unit composed of the household head or "borom njeul"[3], his dependents (male and female) and his wives. Households in the Peanut Basin consume a significant amount of the cereals they produce. Furthermore, the households rely primarily on family labor for their production activities. For these reasons, their production and consumption decision cannot be separated. In the new household economics (Singh, Squire and Strauss, 1986), the household is assumed to maximize a utility function, which depends on the consumption of goods produced, goods purchased and leisure, subject to three constraints. The first is a cash income constraint, which states that the total expenditures of the household on market purchased goods is equal to total revenue from marketed surpluses minus total wage payment. The second is a time constraint, which states that the household cannot allocate more time to off-

[3] borom njeul is a Woloff term meaning the person who is responsible for providing food and shelter to people within the household who depend on him.

farm employment, leisure or on-farm production activities than the total time it has available. The third is a production constraint, where the household's output is a function of land and labor. The three constraints are collapsed into a single full income constraint where the total expenditures of the household (own production, own time and market-purchased commodities) are equal to the full income measured by the value of the stock of time owned by the household and farm profits.

In the Peanut Basin, the household head is responsible for providing food to all members in the household. An important goal he has is to meet household food consumption needs. The household head shapes the behavior of the other members in the household, who in turn shape the behavior of the household head. By being fed by the household head, all the other household members are obliged to devote certain working days each week on the fields of the household head. On the other hand, to prevent the other members from migrating, the head of the household is obliged to give them peanut seed (Benoit-Cattin and Faye, 1982). Thus, by reducing significantly peanut seed credit under the New Agricultural Policy (NPA), the government is jeopardizing an important source of labor at the household level. In order to cope with this situation, the household head has learned that he either must save seed from his past peanut production, sell millet to purchase peanut seed, or raise cash to buy it in order to prevent the dependents from migrating to the city. Therefore, in order to maintain and sustain his power, the head of household must be able to feed on a continuous basis the dependents and to give them peanut seed. This may prevent the head of the household from selling a significant percentage of his millet production.

Male dependents are free to cultivate whatever they want in their individual fields. In most situations they cultivate peanuts with the seed they obtain from the

household head and keep the revenues from peanut sales. Male dependents may also cultivate millet in addition to peanuts if they are married. Cultivating millet enables them to increase the quantity their wives receive from the household head when it is their turn to cook. Non-married dependents specialize in peanut production in the fields in their possession (Benoit-Cattin and Faye, 1982).

Women, especially the wives of the household head, play a crucial role in the household. They sell part of the millet provided by the household head at the market because the household head usually does not provide financial resources to enable women to buy condiments. A standard operating procedure (SOP) at the household is that the head of the household provides a little more than what is required for daily consumption to enable women to market the excess and buy condiments. For this reason women (especially those who have their turn to cook) may want to reduce the time spent at the market searching for a good bargain.

The behavior described above has an implication for who provides quantity information in consumption studies. If only the household head is asked how much is consumed in the household, the estimate he provides may overestimate actual quantities consumed. A second implication is that any policy that aims to stimulate rural households to increase millet sales must either evolve around a sound technological package that significantly boosts millet productivity or targets the dependents.

2.1.3.2 Assemblers

Assemblers provide an important source of market outlet for farmers, given the nature of cereal sales in the Peanut Basin. There exists two types of assemblers: the independent and the dependent assembler.

The independent assembler has few financial resources at his disposal, but they

are sufficient to buy 100 kg at a time.

The dependent assembler does not come into the market with his own financial resources but collects millet with money provided by a wholesaler. When the wholesaler arrives at the market he knows millet prices in the village, semi-urban or urban market of his residence and other periodic markets where he operated previously. Having this information, he distributes money to small assemblers (the amount assemblers receive varies from 35,000 to 100,000 CFA F) and specifies to them the price he will use to value the quantities of millet they will have to turn back to him before the end of the market day. Then the assemblers try to purchase based on the reference price set by the wholesaler. If the interaction of supply and demand is such that prices at which farmers sell is above the price set by the wholesaler, then either the assembler gives the money back or the wholesaler readjusts his reference price. If many wholesalers from different localities set different reference prices to assemblers to collect on their behalf, those who received money from a wholesaler with a low reference price may buy and sell to wholesalers with higher reference price and turn back the money taken from the wholesaler who financed them. But in many occasions the assembler cannot do this because the relationship he has with that particular wholesaler makes him not want to deceive the wholesalers.

The dependent assembler buys from farmers either in cans or with a small roman scale and assembles the quantities in bags provided by the wholesaler. After the assembler finishes purchasing millet, the bags are brought to the platform scale or "bascule" where they are weighed to make sure there is conformity between the amount of money the assembler received and the quantities delivered. When the verification is over the assembler gets a commission from the wholesaler.

2.1.3.3 Wholesalers

Unlike assemblers, wholesalers make transactions in bags and not in small quantities. Wholesalers purchase millet in villages, in periodic markets and in urban markets. Their activities were heavily regulated prior to 1985. Wholesalers perform various marketing functions: they transport millet from periodic markets to semi-urban or urban centers or from surplus to deficit areas; they store millet to satisfy demand during the hungry season and to take advantage of seasonal price movements; and they finance dependent assemblers to purchase millet on their behalf.

2.1.3.4 The Food Security Commissariat (CSA)

The CSA is a public organization responsible for stabilizing the millet markets by providing a market outlet for farmers and a source of domestic food supply for consumers. The price stabilization role of the CSA is not very successful, and may even increase uncertainty for some market participants (Ndoye and Ouedraogo, 1987). The limited effectiveness of the CSA is due to three main reasons: limited financial resources, which prevent the CSA from purchasing all the market releases farmers are willing to sell; the administrative policy, which does not allow the CSA to buy in small quantities; and the CSA intervention is spread over many markets, rather than concentrating on a few in order to reduce costs (Ndoye and Ouedraogo, 1987). Beside its price stabilization role, the CSA also manages food aid, and operates (since 1987) a market information system to increase the transparency of the cereal markets in Senegal. The capacity of the storage facilities owned by the CSA was 84,000 tons in 1983 (MPC, 1983), of which facilities located in the Peanut Basin account for 68,000 tons (81 percent).

2.1.3.5 The Government

The government attempts to maximize votes from citizens and has strong relationships with religious leaders to help ensure vote maximization. The government designs policies aimed at influencing the structure and conduct of the millet market, thereby influencing the opportunity sets of participants. In order to reiterate their support for the rural population, government officials make regular trips in rural areas and distribute food aid when the presidential election approaches. Depending on the timing of its distribution, food aid can have a negative impact on storage undertaken by private traders. Because of the importance of peanuts in the Senegalese economy, many government officials and their political allies own trucks used for peanut transport. An hypothesis is that they enter politics, get rich, buy trucks and pass laws to restrict entry into trucking. This gives them substantial rent, and may explain why transportation costs are the most important component of marketing costs in the Peanut Basin.

2.1.4 Performance of the Millet Subsector

Economic performance "is the outcome of the behavior of the sum of participants acting within the constraints of their perceived opportunity sets" (Shaffer, 1980). Market performance "is the attributes of production and exchange in a segment of the economy that directly influence the welfare of the participants and the society" (Sosnick, 1964). Thus economic performance encompasses market performance and is the concept emphasized in this section. The most difficult task for the analyst is to define the relevant dimensions of performance, appropriate performance indicators, and meaningful performance measures which will be compared to a norm "or standard to which actual values can be compared" (Jesse, 1978). The norm will enable to "deplore results that are detectably less favorable than unavoidable circumstances permits" (Sosnick, 1964). Even

though Jesse (1978) argued that specifying a norm was not necessary since having an agreement with what is particularly good or bad with respect to a performance dimension would be easier, it is worthwhile to attempt to specify it as an intellectual exercise for Senegal. Table 2.1 presents the performance objectives, indicators, measures and norms for the millet subsector in Senegal. The table is adapted from Jesse (1978), based on the list of performance objectives and indicators suggested by Shaffer (1972) and applied to the objectives set forth in the New Agricultural Policy (NPA) and the Cereals Plan defined by the GOS. The remainder of this section discusses the performance objectives, indicators, measures and norms for the millet subsector in Senegal.

2.1.4.1 To Assure an Adequate and Reliable Supply of Millet at an Economical Price

The government's objective of encouraging millet consumption in Senegal requires that millet production be more than adequate for the needs of producing households, so that a surplus for urban consumption can be generated. However, supply should keep pace with effective demand, i.e., the ability of the population to get access to the quantity supplied. This suggests that prices should reflect in part the purchasing power of the population. If effective demand grows faster than domestic supply, either imports increase or prices increase. Effective demand can increase due to income or population growth. Reliability of millet supply affects the feasibility and sustainability of achieving the objective of encouraging millet production for consumption. If millet supply is not reliable, farmers and consumers will shift to other substitutes (especially rice). The performance indicators of an adequate and reliable supply of millet are based on the quantity of millet produced, the quantity of millet marketed and the level of

Table 2.1. Performance Objectives, Indicators, Measures and Norms for the Millet Subsector in Senegal.

Performance Objectives	Performance Indicators	Performance Measures	Performance Norms
1.To assure an adequate and reliable supply of millet at economical prices	11.Quantity of millet produced	111. Millet production per adult equivalent worker (AEW)	200 kg of millet per AEW
	12.Quantity of millet marketed	121. Percentage of millet production marketed	The lower, the thinner the market
	13.Fluctuation of millet supply	131. Coefficient of variation of supply	
2.To stimulate millet production and distribution to facilitate its substitution for imported rice	21.Millet Price Response	211. Millet supply response	The higher, the more uncertain is production
	22.Price level and stability	221. Intermarket price correlation	Greater than 0.77
		222. Seasonal price rise	Should cover storage cost with a 0.8 probability
		223. Inter-year price stability	The more stable are year-to-year price fluctuations, the more accurate becomes forecasted prices
	23.Marketing costs and margins	231.Comparison of return to capital with interest rate	Return to capital must be equal to the interest rate
3.To increase millet productivity	31.Level of millet productivity	311. yield per hectare; yield per person-day of labor	yield gap1 and yield gap2
4.To increase farmer income	41.Level of farmer agricultural income	411. Comparison of farmer agricultural income to the minimum wage	The wider the gap, easier will be to pull farmers out of agriculture.

Source:Adapted from Jesse (1978) based on Shaffer (1972).

fluctuation of national production.

For the first performance indicator, millet production per adult equivalent worker

(AEW) is retained as a performance measure. It is obtained by dividing millet production by the total number of active workers in the household. This measure gives an indication of labor productivity and the ability of the household head to feed the members in his household. However, not being able to feed the members will not be labeled inefficient, but would give an indication of the challenge the government is facing as a prerequisite to achieving millet production for consumption. The success of that objective at the national level depends among other things on the ability and willingness of the household head to produce beyond what is necessary to feed his members. The performance norm to which millet production per adult equivalent worker is to be compared is 200 kg of millet per AEW per household. This is the number of kilograms to assure food security for an adult for one year defined by FAO.

For the second performance indicator, the percentage of millet production sold is used as a performance measure. This measure is an indirect measure of the percentage of millet production consumed in the household and a direct measure of the importance of the millet market and the quantity of millet that will eventually reach semi-urban and urban markets. The smaller this percentage, the thinner (i.e., more residual) the market, and hence the more risky it will be.

For the third performance indicator, the coefficient of variation (both in the sample and from national statistics) of millet production will be used as a performance measure. The coefficient of variation of millet production from the actual sample will shed light on the degree of homogeneity of households, whereas the coefficient of variation of national millet production based on year-to-year fluctuation of aggregate supply sheds light on the reliability of domestic production in meeting home consumption needs for the rural population, and the potential supply that may serve semi-urban and

urban areas. It is difficult to come up with a specific norm.

2.1.4.2 To Stimulate Millet Production and Distribution

The objective of encouraging millet for consumption in Senegal requires also that millet production respond favorably to prices and non-price factors, such as the availability of seed, fertilizer and the way other markets are instituted. Equally important are the channels and markets through which millet flows from farmers to consumers, the costs of production and of performing the various marketing services and the level of profits for market intermediaries. The performance indicators developed for this second objective are millet price response, millet price level and stability and marketing costs and margins.

For the first performance indicator, the price elasticity of millet supply is selected as a performance measure. An elastic supply would imply that a 10 percent increase in the price of millet would lead to more than 10 percent increase in millet production. An inelastic supply would imply that a 10 percent increase in the price of millet would lead to less than 10 percent increase in millet production. No performance norm is defined.

For the second performance indicator, three performance measures are selected: price correlation between markets, the seasonal price rise of millet and inter-year price stability of millet. Price correlation between markets sheds light on the degree of integration among markets, i.e., the presence of stable price differential between markets. Barry (1989) used a correlation coefficient of 0.77 as a norm to indicate a well-integrated marketing system in Mali. A correlation coefficient of 0.77 between two markets implies that 60 percent of the price variation in one market can be explained by the price variation in the other market. Lele (1971) and Jones (1968) used a correlation coefficient of 0.9 as a norm to indicate a well-linked marketing system in India and in

Nigeria. A correlation coefficient of 0.9 between two markets indicates that 81 percent of the price variation in one market can be explained by the price variation in the other market. The seasonal price analysis is another technique to assess the competitiveness of the millet markets through time. A common procedure used by economists is the moving average technique (see Goetz and Weber, 1986). The performance norm is that the seasonal price rise must cover the cost of storage with a probability of 0.8 (i.e., the seasonal price rise should cover the cost of storage 80 percent of the times that storage is undertaken) to stimulate market participants to undertake the storage function. Inter-year price stability of millet sheds light on the degree of stability of prices from one year to the next. The performance norm is that the more stable are the year-to-year price fluctuations, the more accurate become forecasted prices.

For the third performance indicator, the rate of return to capital is chosen as a performance measure. The rate of return to capital is the ratio of net margin to capital invested expressed as a percentage. By comparing it to the interest rates which the private sector faces, the analyst gets an indication of whether the rate of profit is normal. The performance norm is that the return to capital must be equal to the prevailing interest rate. In Senegal, the majority of private traders do not have access to official financial markets. As a result, the official interest rate is not the relevant variable and its use may lead to the conclusion that the rates of profits of private traders are above normal.

2.1.4.3 To Increase Millet Productivity

Millet productivity as an indication of progressiveness in the millet subsector is an important variable that allows one to formulate hypotheses about the availability of improved technologies, the rate of farmers' adoption and the supporting institutions

necessary to increase production incentives. Furthermore, millet productivity (defined here as yield per person-day of labor and yield per hectare) allows one to obtain an indication of the return to labor, and to estimate the yield gap for millet. The literature has identified two types of yield gaps: the yield gap 1, which is the difference between yield obtained under experiment station trial and that achieved under researcher-managed field trials; and the yield gap 2, which is the difference between yield under farmers' field trials and actual yield obtained by farmers (Gomez, 1977; Dillon and Hardaker, 1984; Wehelie, 1989). While the yield gap 1 is difficult to overcome, due to the non-transferability of conditions that prevail at the experiment station, the yield gap 2 can be narrowed or eliminated because it is caused by various bio-physical and socio-economic constraints (Wehelie, 1989). The yield gap 1 and 2 will be used to assess the performance of farmers in the sample.

2.1.4.4 To Increase Farmer Income

Gross revenue derived from agricultural production is the product of the price of the commodity times quantity sold. Thus increasing farmer income can be obtained via a price increase or a quantity increase. Price as an instrument for improving the livelihood of farmers has been a major policy advocated by the GOS and by many donors. Recently, the limits of such policy have been challenged by the empirical evidence from many countries in Sub-Saharan Africa, in which a large proportion of farm households were shown to be net buyers of staples (Weber et al., 1989). An approach which is more sustainable in the long run is technological innovation, which will enable farmers to maintain a given amount of income even if prices fall. However, the relationship between farmers' income and millet output will depend on the price elasticity of demand as well as changes in the unit cost of production. The performance

indicator selected is the level of farmer income. The performance measure proposed here to assess the level of farmer income is to compare farm agricultural revenues with revenue earned by workers who are paid the minimum wage. The wider the difference, easier will be to pull farmers out of agriculture.

2.2 Some Market-Related Concepts

Markets are institutions where suppliers of one or many commodities interact with demanders such that the outcome yields a price. The magnitude of the price depends on many factors such as the degree of thinness of the markets and other market structure variables and government policy. One thing all markets have in common is that they "are all politically instituted in the sense that the rules of the game governing the market are political" (Shaffer, 1983). Thus, the way a market is instituted defines its legal environment, i.e., what has to be taken into account by market participants in making their decisions. This section discusses the rules defining the legal environment of markets, the types of transaction costs that can be identified in the millet subsector of Senegal and some market coordination concepts.

2.2.1 Rules Defining the Legal Environment of Markets

The necessary and sufficient functions for a government to institute markets can be summarized under four headings: the rules of the game, contracts and their enforcement, protection of property rights, and an adequate market information system, of which grades and standards are one element.

2.2.1.1 The Rules of the Game

A rule is "a specific prohibition, requirement or permit defining a limit of appropriate action for a position situation" (Schmid and Shaffer, 1964). Many aspects of the rules can be distinguished. The first aspect is the nature of the rule i.e., what it just

says. Strict compliance with the rule may create disincentives for market participants such that the outcome of the system is lower than it otherwise would have been. For example, if the government fixes pan-territorial and pan-seasonal prices, private traders have to incur financial losses if they comply with official prices in purchasing and moving commodities from surplus to deficit zones, or to store for sale at a future date. Traders will not follow such behavior and most of them would either not engage in trade or would rely on the parallel market and use prices different from those officially set by the government.

The second aspect is whether or not market participants have the same interpretation of the rule as those who set it. This results in the ambiguity of the rule. For example, in the 1984-85 marketing season, "the official price of millet was applied as a floor price under some circumstances and sometimes as a fixed price" (Newman, 1987). This created lot of uncertainty for market participants regarding which price should dictate their transactions.

The third aspect is the feasibility of the rule. If the government defines a floor price, it has to be supported effectively if the objective is to increase the incentives of farmers to generate a marketable surplus. But if the government agency that has the mandate for providing market outlets to farmers does not have the required financial resources, its credibility is seriously challenged and this will have an impact on the performance of the system. For example in Senegal, the Food Security Commissariat (CSA), which had the mandate to defend the floor price up to 1988, failed to do so because it never had the financial resources required and it depended on external funds to implement that policy. Probably its intervention would have had a better impact if there was a mechanism to adjust the floor price according to the size of the crop.

The fourth aspect is to move from rules related to specific commodities to those that affect the whole marketing system. Most of the debate about the legal environment of markets centers mostly on rules defining participants who are allowed to participate in the trade of a specific commodity (the licensing procedure), restrictions on the flows of commodities that can be moved within regions and from one region to another, and prices and margins that should guide transactions among market participants. The debate has seldom covered other rules that may have an important implication for the participants' ability to perform key marketing functions better. For example, in the Peanut Basin, transportation cost is the most important cost of marketing services (Ouedraogo and Ndoye, 1988b), and yet nothing is known with precision about the impact on transport costs of who is allowed to import trucks or spare parts, or the level of duties imposed on imports by the government. Given the importance of the peanut subsector to the Senegalese economy, investment in the trucking business becomes highly profitable such that political considerations may dictate who can own a truck. This may prevent private traders from integrating the transportation function into their business.

So far, the discussion of regulation has focussed on what de Soto (1989) calls "the impact of bad laws". Another useful concept he discussed is what he calls "the absence of good law" to facilitate trade in the economy. According to de Soto, a good law should provide property rights, contracts and an extracontractual legal system. The presence of inappropriately defined property rights reduces aggregate investment, and properties cannot be transferred easily or used as collateral. The lack of security of contracts increase the cost of transactions so that many do not take place. In order to reduce the impact of opportunistic behavior since contracts cannot be enforced or are too costly to enforce, many transactions are carried out among people who know each other (de Soto,

1989). In Senegal, traders devote lot of resources to buy grain. Yet the scale of their operation could have been larger and cost of transfer per unit lower, if they pooled their resources in joint ventures. But they are reluctant to combine their financial resources beyond their immediate family because of the absence of good law that would help assure enforcement of contracts governing their pooling of capital.

Another consequence of the absence of good law is the absence of an extracontractual law. According to de Soto, an extracontractual law is "a law which relates to damages not covered by contracts, and thus protects everybody's interests". For de Soto, good law is a key determinant of development by providing facilitative legal instruments that lower costs of transaction, that is, a good law creates incentives, facilitates specialization and interdependence of individuals and resources.

2.2.1.2 Contracts and Their Enforcement

Contracts can be defined as binding agreements that must be fulfilled by the parties involved in a transaction. In the millet subsector of Senegal, contracts are not written and are mostly based on familial or personal relationships. This makes government or court adjudication difficult to implement, and participants involved in a contract have to rely on the extended family or common friends in case of a conflict. For that reason, the majority of the contracts in the millet subsector involve direct two-party enforcement of implicit contracts, with an eventual possibility of third-party enforcement. The types of contracts in the millet subsector can be specified as within the firm and between firms. Contracts within the firm are those that take place between the household head and his dependents. The nature of the contract is as follows: the dependent adult agrees not to migrate during the rainy season and to work during certain days of the week on the fields that are directly controlled by the household head.

In return, the household head agrees to feed the dependent and to give him peanut seed, which he is free to grow. The dependent also has a direct control of the revenue derived from the sale of the crop. Like most inputs, once the peanut seed given by the household head is sown, it cannot be taken out of the soil. Thus if the contract is broken, i.e., if for some reasons the dependent decides to leave the household and to migrate before the end of the rainy season, the peanut field is abandoned and the peanut seed lost if nobody in the household takes it over. In most situations, an agreement can be reached within the household or by directly involving immediate family members in case the household head feels the contract may be broken. Similar intra-firm contracts exist between traders and their employees (agents), many of whom are members of the traders' family.

Contracts between firms in the millet subsector are related to those between assemblers and wholesalers, between farmers and private traders (assemblers, retailers, wholesalers), between wholesalers and between wholesalers and retailers. As mentioned previously, when the wholesaler arrives at the market he distributes money to assemblers with whom he has familial or personal relationships to buy millet on his behalf. The assembler may behave opportunistically by deciding to purchase millet with the money financed by the wholesaler and sell to another wholesaler. But this may not be the case, since the enforcement mechanism will be provided by the threat of termination of any future contractual relationships between the assembler and the wholesaler. Assuming wholesalers in a given market communicate among themselves without major costs, then if such a situation occurs all wholesalers in the market will learn about the opportunistic behavior, which will prevent the assembler from getting future contracts from other wholesalers. Contracts between farmers and private traders with respect to millet are in

terms of borrowing by the former, especially during the hungry season. Even though the interest rates can be very high, the risk of contract failure due to partial or non-reimbursement is also very high. Private traders do not have any other recourse in such situations (Newman et al., 1987). Contracts between wholesalers and between wholesalers and retailers are of the form of future delivery of millet after both parties are satisfied with the characteristics of the millet to be delivered.

2.2.1.3 Protection of Property Rights

"Property rights describe the relationship of one person to another with respect to a resource or any line of action" (Schmid, 1987). The concept of property rights can be singled out at several levels in the millet subsector, namely between the farmers and the government with respect to land, between market participants (farmers, private traders, consumers) and the government, and among market participants.

a) Property rights between market participants and the government

Before the liberalization of the millet market, the government specified that it was illegal for farmers to sell millet above the pan-territorial price. At the same time, farmers were not guaranteed that price, since the Food Security Commissariat (CSA), which was supposed to offer market outlets to farmers, did not have the financial resources to purchase all the millet farmers were willing to sell. Government regulatory officials did seize quantities of millet that were traded above the pan-territorial price (Newman, 1987). Similar actions were also taken against private merchants by not allowing them to sell at higher prices than those specified by government regulations. The whole point of the pan-territorial pricing was to put limits on farmers' and private traders' ownership rights to millet. However, whose rights count is a political decision.

b) Property rights with respect to land

In Senegal, the government owns the land and farmers have only a use right. The government can claim the land at any future period. The lack of private ownership in the land results in households' not wanting to invest heavily in it since it can be appropriated by the government at any time. The result is that soil degradation occurs and everybody expects the government to solve it. The lack of private ownership in land also denies households an important source of collateral. Other sources of collateral exist (grain stocks, livestock, equipment, and the residence of farmers) but there are some constraints: grain stocks are not important for many farmers; the residence of many farmers is not worth very much because of the material it is constructed and its site specificity; equipment and livestock are subject to collateral-specific risk, i.e., they may be lost, broken, sick, or stolen at the time of seizure (Tuck, 1987).

c) Property rights between market participants

When a farmer sells millet to another market participant (or when a market participant who is not a farmer sells to another market participant) he transfers the ownership of the grain to the other market participant. Property rights are protected as long as each party gets what they think they are getting. However, if the buyer thinks he is getting clean grain and it turns out to be infested with insects, or to be full of rocks, his property rights have been violated.

2.2.1.4 Grades and Standards

Grades and standards are important functions that help improve the efficiency of the marketing system. They enable market participants to express more precisely their preferences relative to their budget. In rural markets of the Peanut Basin, newly harvested millet sells at a price slightly higher than millet harvested in the previous crop

year. However, the government has never officially specified a grading system for millet, except to express the percentage of impurity tolerated in order to sell to public organizations. But since a small percentage of the millet marketed is sold through official channels, such specification does not have any major impact on the majority of market participants. In Senegal, millet is produced under different conditions related to the distribution of rainfall, soil type and input use. These factors give millet different characteristics with respect to size, weight and density.

A major consequence of not specifying different grades for millet in Senegal is that visual inspection is required, which jeopardizes the potential for trading at distance. The time involved in inspecting the grain and to being physically present increases transaction costs for market participants and may disadvantage the millet market compared to the market for imported rice.

In the millet subsector, the problem of standardization of the different instruments used to weigh the commodity may arise only in transactions among farmers, and between farmers and assemblers in the sense that cans ("pots") may be used beside the small roman scale ("balance"). However, for each type of can used there is a common agreement on the weight. Transactions between assemblers and wholesalers are carried out using the platform scale (or "bascule"). Before the liberalization of the millet market, the regulatory enforcement officials used to inspect the weighing instruments used in the markets on a regular basis to reduce potential fraudulent practices. Currently, with the elimination of the office of economic control, the weighing instruments are no longer inspected.

2.2.2 Transaction Costs

2.2.2.1. Transaction Costs in the Millet Subsector

In the millet subsector, transactions are carried out within firms, between firms and across markets. Transactions within firms are those carried out within the household, particularly between the household head and his dependents, and between wholesalers and his employees. The challenge for transactions within firms is how will the head of the household (the wholesaler) motivate his dependents (his employees) to act in the self-interest of the head of household (the wholesaler). This is the principal-agent problem. Transactions between firms are those that take place between households, between households and other market participants (assemblers, retailers, wholesalers), and among assemblers, retailers and wholesalers.

Transactions between households can be monetary or non-monetary. Non-monetary transactions are motivated by social (customs) or religious considerations, or by economic concerns, particularly in situations where people have little cash. Vercambre (1974) described them as including:

i) gifts given at harvest by the household head to women and children who helped harvest and transport the millet from the field to the village.

ii) gifts received by women when they visit their in-laws, and their uncles.

These transactions are non-monetary due to the relatively low level of liquidity in the households, which makes it easier to give gifts in kind rather than in monetary units. Transactions dictated by Islam ("assaka" or "zakat") are based on the fact that one-tenth of the production from all crops must be given away by all adult members in the household who possess a field crop.

Monetary transactions between households are often dictated by motives other

than profit i.e., frequently, social solidarity outweighs profit consideration in these transactions. As will be discussed in chapter 5, when a farmer sells millet to another farmer, he charges a lower price than what he would have charged when selling to an assembler, a retailer or a wholesaler. In return, when a farmer buys from another farmer, he pays less than he would have paid to an assembler, a retailer or a wholesaler. The amount of price subsidy provided is smaller when the transactions are carried out at the market compared to when transactions are carried out at the village. This phenomenon is discussed in more detail in chapter 5.

Transactions across markets refer to those between markets within the same agro-ecological zone and those between markets in surplus and deficit regions. The degree of importance of transactions across markets can be investigated through spatial market integration studies. Transactions between households and other market participants (assemblers, retailers, wholesalers), those among assemblers, retailers, and wholesalers and transactions across markets are monetary in nature.

Transaction costs are "the costs of specifying and enforcing the contracts that underlie exchange and therefore comprise all the costs of political and economic organization that permit economies to capture the gain from trade" (North, 1984). Transaction costs are incurred because in the real world information is not costless as assumed in neoclassical economics. Rausser et al. (1987) distinguish different types of transaction costs, which apply to the millet subsector of the Peanut Basin:

a) information costs: In buying and selling agricultural commodities, market participants want to obtain the best possible outcome. For example, the buyer wants to pay the lowest price possible, whereas the seller wants to get the highest price possible. Therefore both the buyer and the seller engage in market search to achieve their goals.

The search is not costless. In the absence of a market information system, which could be privately provided, market participants have to visit different markets to get a whole range of price information. Furthermore, within a single market they have to monitor different transactions to get the range of prices for a given market day. The costs to get information can be measured in terms of the money spent (transport costs to the markets for example) or in terms of the opportunity cost of the time spent to get the information. If a market participant cannot be physically present at the market, he may be informed by a more knowledgeable market participant. Since 1987, the government of Senegal has initiated through the Food Security Commissariat (CSA) a price reporting system to increase the transparency of markets. Prices of major agricultural commodities are reported weekly on the radio using local languages. The cost of that information to market participants is the cost of acquiring a radio or getting close to one at broadcast time.

b) bargaining costs: "In a bargained exchange system, transactions are governed primarily by a set of impersonal rules within which exchange rates are established by the bargaining processes" (Schmid and Shaffer, 1964). In rural markets of the Peanut Basin, these exchange rates are determined by the haggling process for transactions between farmers and assemblers. That is the reason why it was decided through the data collection procedure for this study that each enumerator should record prices from many transactions so that an average is computed as representing prices farmers get for a given market day. The haggling process can be more understood since "in any transaction there is a reservation price for both the buyer and the seller. For the buyer, it is the most he would have paid. Had he been charged more, he would have walked away from the transaction. The seller's reservation price is the smallest amount he

would have accepted" (Frank, 1988). Then bargaining exists because each party involved in a transaction wants to get a price as close as possible to the other party's reservation price.

c) enforcement costs: according to Rausser et al. (1987), these are "the cost of entering a legally binding contract in order to permit enforcement by the state, litigation costs and the cost of remedial actions". In the millet subsector the enforcement costs are in terms of the lost of opportunity for both assemblers and farmers who behave opportunistically in their relationships with wholesalers, and the opportunity cost of the time that may be spent by the wholesaler in case of a contract violation with an assembler, and during the multiple visits to villages for recovering farmers' debt.

Other types of transaction costs arise because of the wedge created by both selling and buying, and inspection costs due to non-specification of grades, which requires visual inspection.

2.2.2.2 Transaction Costs and Household Behavior

Bromley and Chavas (1989) argue that the economic problems in the semiarid tropics are partially attributable to the existence of a restricted domain for transacting, which increases transaction costs. Transaction costs (information costs, contracting costs, enforcement costs) will be lowered with an establishment of the "legal foundation of the economy." This requires the existence of implicit and explicit contracts. Such contracts are either contingent contracts and/or unconditional contracts. Since explicit insurance contracts do not exist in the semiarid tropics, the authors imply that risk allocation must be dealt with either privately, or through implicit insurance schemes. But since private risk management has severe limitations, the authors emphasize the necessity of implicit and explicit (contingent) contracts and risk spreading as necessary conditions to improve

economic development in the semiarid tropics.

De Janvry et al. (1991) argue that the internal instability of the household (scarcity of labor and/or food) and its external stability (non-response to price incentives), and response to other external shocks are caused by selective market failures for labor and/or food. By selective market failures the authors mean a situation where in general markets exist, but transaction costs are so high that trade is not profitable for particular households, making the commodity a non-tradable for them.

2.2.2.3. Impact of Social Closeness on Human Behavior

Robison and Schmid (1991) argue that although it is generally assumed in economics that the relationship of parties to a transaction is irrelevant, this can be refuted based on experience from the real world. They argue that when individuals make sales decisions, they are influenced by some element of personal obligation, affection or respect. For these authors, relationships between economic agents matter in real life, and yet little has been done to formalize the implications of relationships in economic models.

Three aspects of relationships are assumed to influence the outcomes of economic transactions, according to the authors: the first is "social distance", which for two individuals A and B is a measure of A's knowledge of B. The second is social preferences: if A receives satisfaction from B's consumption of goods, and A is socially close to B, A is said to have a sympathetic relationship with B. Antipathy is the opposite of sympathy and also requires social closeness, according to the authors. The third aspect is relative wealth, which becomes important in economic models when the economic agents experience antipathy or sympathy. According to the authors, wealth level and sympathetic relationships are variables that affect the willingness of the seller

to offer a subsidy to the buyer. According to the authors, economists need to cooperate more closely with sociologists and psychologists to understand better behavioral relationships. Furthermore, when the seller and the buyer know each other, no one can predict the outcome accurately without considering the relationship between the economic agents. In addition, if the reservation prices between the parties involved in a transaction are affected by sympathy-antipathy and relative wealth, location of resource ownership can be expected to affect prices and resource allocation.

Robison (1987) argues that social closeness and relative endowments matter in economic transactions. Therefore, they lead to important alterations in economic models. According to the author, social distance changes the consequences of economic transactions when the buyer and the seller are known to each other. The results of the model proposed by the author indicate that social closeness increases total output between trading partners, increases investments in public goods, and increases horizontal integration of production; furthermore, complete social closeness (distance equals zero) is a sufficient condition for the optimal extraction of service from a commonly owned resource and is sufficient to maintain the production of externalities at socially optimal levels.

Robison and Schmid (1992) argue that it is social failure rather than technological failure which explains why the Twenty-first Century fails to provide a decent living for many people. According to the authors, many of the world's current and future economic and social problems stem from too little social closeness between individuals. Free riding and high transaction costs cannot be solved without a sense of community. For the authors, without trust and caring, it will not be possible for any governments to be able to obtain economies of scale in the provision of public services.

According to the authors, each economy has a social capital base, and a caring economy would have more equal income. The invisible hand, the authors argue, cannot guide selfish individuals to beneficent outcomes. For the authors, sellers offer price subsidies to those with whom they feel social closeness and who have lower incomes, and this explains why people offer favors and gifts without expecting repayment. For the authors, feelings of sympathy and social closeness are often required for funding community development projects. Furthermore, there are increasing signs of potential gains from cooperation and trade which are not being realized. For example, economies of scale in providing public services are often missed because each rural community wants to provide its own. According to the authors, conscience or how one feels about one's own actions is also important, and this establishes the need for individuals to find conformity between their beliefs and their actions.

2.2.3 Market Coordination

Markets are one of the many forms of institutional arrangements that coordinate the food system. Market coordination refers to the process whereby supply is matched with future demand at prices consistent with costs of production (Shaffer, et al., 1987). Thus markets coordinate production, distribution and consumption. Poor coordination reduces the incentives of market participants to transform and move agricultural commodities from the farm-gate to the consumer. Market coordination is important in developing countries' food system because of the rapid increase in urbanization and commercial exchange. However, markets do not perfectly coordinate actions when transaction costs are present. According to Williamson (1985), transaction costs are explained by bounded rationality, opportunism, asset specificity and uncertainty. Bounded rationality means that "it will be costly for individuals to contemplate and

contract for every contingency that might arise over the course of the transaction" (Kreps, 1990). This implies there will always be gaps in contracts because of bounded rationality. Opportunism means self-interest seeking with guile (Williamson, 1985). Opportunism can be dealt with by providing the appropriate institutions to constrain behavior. Asset specificity refers to assets specialized in a particular use. According to Kreps (1990), "a transaction has high levels of asset specificity if as the trade develops, one side or the other or both becomes more tied to and in the power of the other side". For uncertainty, Williamson (1986) distinguishes 2 types: primary uncertainty is caused by random acts of nature and by the changes in consumer preferences. Secondary uncertainty is caused by a lack of information/communication. Due to uncertainty, market participants may make an incorrect choice in reaching their goals.

This chapter has discussed various concepts to evaluate selected components of the millet subsector in Senegal. The first step of the discussion defined some performance indicators, measures and norms based on the general performance objective set forth in the New Agricultural Policy and the Cereals Plan by the government of Senegal. This discussion was carried out bearing in mind that the millet subsector evolves in an environment, which can be broken down into a physical, an institutional and a socio-economic components. These three components of the environment determine participants' objectives and behavior and the performance of the millet subsector.

The second step of the discussion was based on the argument that one cannot evaluate the performance of the millet subsector without understanding the necessary and sufficient functions for instituting markets. The legal environment of markets, which emerges from the process, defines what has to be taken into account by market

participants in making their decisions. Therefore, the legal environment of markets needs to be understood in order to suggest changes that will improve the future performance of the millet subsector.

The third step of the discussion examined other elements of behavior which understanding may help in the design of institutions that will improve the future performance of the millet subsector. In a subsistence economy where risk and uncertainty enter into the objective function of the decision makers, participants in the millet subsector may develop some risk-sharing mechanisms to reduce transaction costs. For this reason understanding social solidarity among people who feel close to each other becomes important. This solidarity based on traditional mechanisms that exist in rural areas may suggest that a traditional safety net is already in place, which if explored, can improve the future performance of the millet subsector. For example, the cooperatives have not been successful in Senegal because they were created by the government without taking into account the socio-cultural identity of farmers and their willingness to get organized in such a way. This resulted in massive debt forgiveness and the elimination of the agricultural credit program. Social closeness based on the solidarity among farmers who feel close to each other can be a major factor in the design of future cooperatives to improve the future performance of the millet subsector.

CHAPTER 3

DESCRIPTION OF THE PEANUT BASIN AND REVIEW OF THE DATA COLLECTION PROCEDURE

The main objective of this chapter is to review the data collection procedure used in this dissertation. The first section describes the Peanut Basin; the second section discusses the data collection procedure; and the third section describes the seasons in a given marketing year.

3.1.The Peanut Basin of Senegal

The Peanut Basin is composed of 5 administrative regions (Diourbel, Louga, Thies, Kaolack, Fatick) among 10 in Senegal. It contains more than half of the country's population. The Peanut Basin is a zone of rainfed agriculture, and rainfall from June to September varies between 350 millimeters in the North (Louga) to 813 millimeters in the South (Kaolack, Fatick). The average land per rural person is 0.54 ha, and population density per planted hectare was 2.6 persons in 1990 (USAID, 1991). As the name implies, the Peanut Basin is the zone where peanuts are mostly produced in Senegal. It is also in the Peanut Basin that millet is mostly produced since independence in 1960. During the period 1960-1986, the annual rate of growth of millet area and production were 0.07 and 2.1 percent in the Peanut Basin, compared with 0.05 and 1.2 percent for the entire country[4]. These figures imply that the rate of growth of millet production

[4] These figures are obtained by a time-trend regression of the natural logarithm of millet production and area on time. The parameter associated with the time variable gives a direct estimate of the annual rate of growth of millet production or area.

lags behind the rate of growth of population, which is more than 3 percent per year. Furthermore, the rate of growth of millet area is very low, probably implying the limits of extensive cultivation in Senegal.

The Peanut Basin is dominated by two major ethnic groups, the Woloff and the Serer. The Woloff are scattered throughout the Peanut Basin, while the Serer are concentrated in the Thies, Kaolack and Fatick regions.

3.2. Methods of Data Collection

3.2.1. Selection of Villages in the Study

Since the beginning of ISRA's cereal marketing research program in the Peanut Basin in 1984 and up to 1986, the research effort focussed on understanding the behavior of rural markets. The research program did attempt to carry out village surveys, but those were only one-shot in nature, and they aimed at understanding household marketing behavior and farmers' reactions to the New Agricultural Policy (NPA). The director of the Macroeconomic Analysis Bureau of Senegal Agricultural Research Institute (ISRA) recommended in 1985 studying in more depth the transaction behavior of farmers. He believed, based on his experience from the Southern Peanut Basin, that transactions carried out by farmers in the villages were more important than those carried out in the markets. In 1986, the research team decided to initiate surveys on household production and marketing behavior, to be linked with the other surveys (price collection and marketing behavior of traders) that were still being carried out in rural markets.

The process of village selection started with several exploratory surveys, where in each village visited, the research team (including the enumerators of the program) held an informal meeting with the village head to explain the general objectives of the

research and the mandate of ISRA in terms of promoting agriculture in the country. Usually, the head of the village called upon other village members to assist the meeting.

The exploratory surveys served as a basis for developing different criteria to select the villages to be included in the study, as follows:

i) access to rural and/or semi-urban markets: one hypothesis was that farmers with good market access would receive better prices than those with poorer market access. Another related hypothesis was that poor-market-access farmers sell mostly at the village to reduce transaction costs associated with the time involved in marketing their crops.

ii) peanut seed credit received: the underlying hypothesis was that if the head of household receives peanut seed credit, it will increase his ability to prevent dependents from migrating to the city, by giving them seed. Furthermore, the availability of peanut seed credit at the household increases the complementary nature between food crops and cash crops. Growing peanuts enables the head of the household to get peanut hay for his draft animals, which are used to cultivate food crops.

iii) production contract with a parastatal organization: the underlying hypothesis was that farmers who are under production contract are more in a position to reduce production uncertainty than farmers who are not, because of the former's possibility to integrate input and output markets and to obtain technical advice.

iv) ethnic background: the underlying hypothesis was that the Woloff are more integrated in the markets than the Serer due to their traditional involvement in the peanut markets.

v) the number of households in the village: this was an important factor in the decision to select or reject a village. For example, if a given village had fulfilled all of the above criteria, but had less than 10 households, the village was not selected.

vi) the willingness to participate in the research program until the end: this was not a problem and could be assured by the village head alone, without prior consultation with the other members.

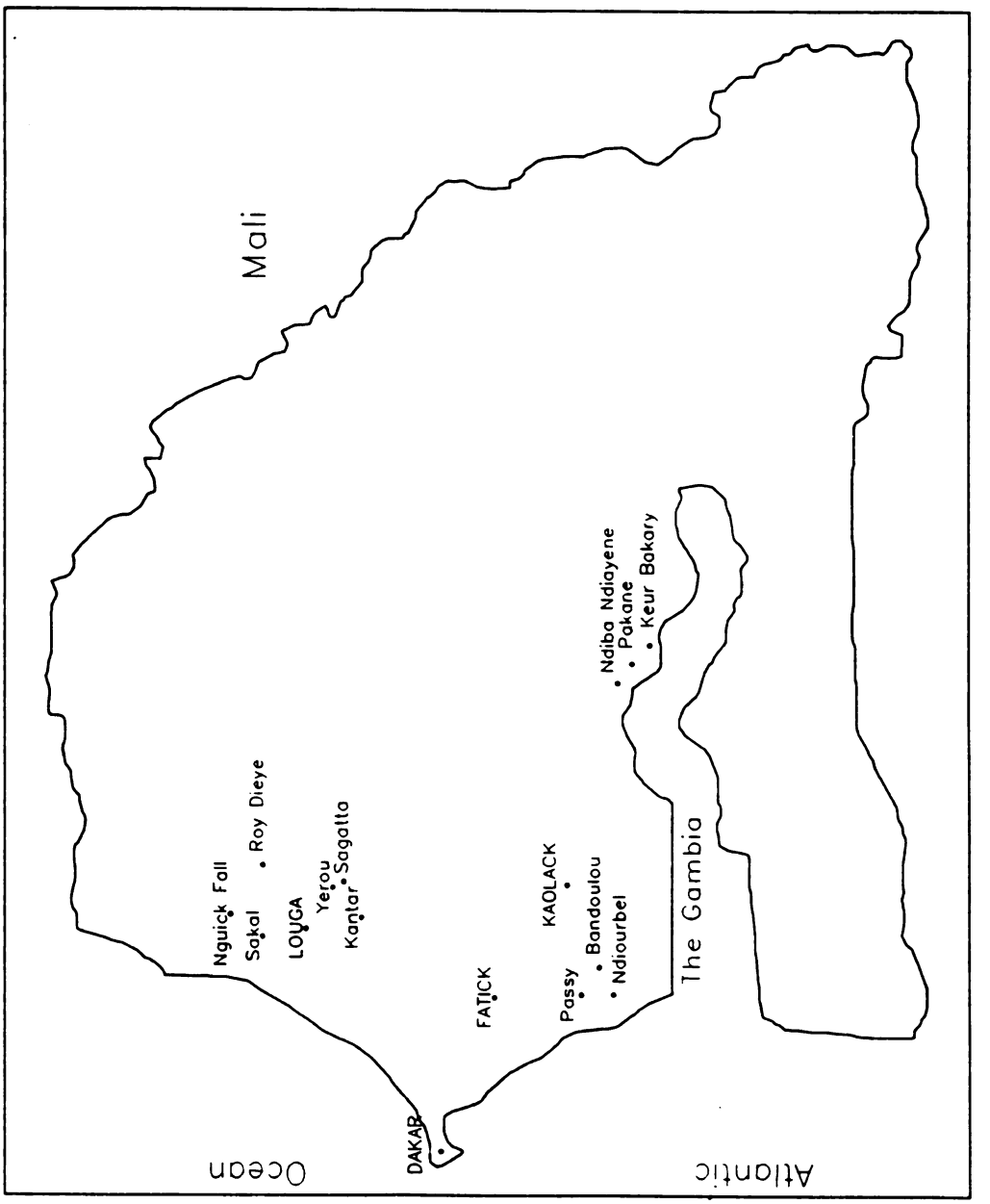
The informal visits, along with the criteria developed, served as a basis for selecting the villages upon which the different surveys were to be carried out. A list of villages in the Peanut Basin was obtained from the "Direction de l'Aménagement du Territoire" to guide the selection of villages to assure representativeness of the sample villages. Given the financial resources the research program had, and the human resources available, a pragmatic approach guided the decision about how many villages to select. Twelve villages were finally selected and grouped into four triads. A triad is a set of three villages linked by a common rural or semi-urban market. For each triad, the first village selected was the one where the market was located and the other two were the easy access and the difficult access villages to the main market. The average distance between the main market and the easy access market was 3.75 kms, while that separating the difficult access market and the main market was 11.5 kms.

The twelve villages selected belong to three regions (Kaolack, Fatick, Louga) among the five regions in the Peanut Basin. Geographically, these villages were located in the Northern, the Central, the Southeast and the Southwest Peanut Basin (see map). In the Northern Peanut Basin, the triad selected was located in the department of Louga and was composed of Sakal, Nguick Fall, and Roy Dièye. The main market was Sakal, which operated on Tuesdays. Nguick Fall, the easy access village, was 4 kms away from Sakal, and Roy Dièye, the difficult access village, was 11 kms away from Sakal. In the Central Peanut Basin, the triad selected was located in the department of Kebemer (in the Louga region) and was composed of Sagatta, Yerou and Kantar. The main market

was Sagatta, which operated on Wednesdays. Yerou, the easy access village, was 5 kms away from Sagatta, and was on a paved road. Kantar, the difficult access village was 13 kms away from Sagatta.

In the Southeast Peanut Basin, the triad selected was located in the department of Nioro (in the Kaolack region) and was composed of Ndiba Ndiayène, Pakane and Keur Bakary. The main market was Ndiba Ndiayène, which operated on Thursdays. Pakane, the easy access market, was 3 kms away from Ndiba, whereas Keur Bakary, the difficult access market was 12 kms away from the main market. In the Southwest Peanut Basin, the triad selected was in the department of Foundiougne (in the Fatick region) and was composed of Passy, Bandoulou and Ndiourbel. The main market was Passy, which operated on Saturdays. Bandoulou, the easy access village, was 3 kms away from Passy, whereas Ndiourbel, the difficult access village, was located 10 kms away from Passy.

VILLAGES SELECTED IN THE STUDY



3.2.1.1. Selection of Households

The concept of household or "Njeul", i.e., a group of individuals sharing all meals under one head of household or "Borom Njeul", was retained for the study. The "Borom Njeul" has dependents for whom he is responsible. He provides them food and allocates land to them. In order to prevent his dependents from migrating to urban areas, the head of households gives them peanut seed to compensate for the eventual loss of income, assuming the dependent adult can in many occasions earn the minimum wage, when he migrates to the city. According to Waterbury (1987), citing Pélissier (1966), Hopkins (1975) and Benoit-Cattin (1982), the Njeul or household is the meaningful operative production unit in the Peanut Basin.

For each village selected, the list of the "Borom Njeul" was obtained from the village head. The main objective was to facilitate the selection of the sample of households for the study. For each triad, a total of 40 households were selected: 20 households in the village where the market is located, 10 in the easy access village and 10 households in the difficult access village, for a total of 160 households. Among the 20 households selected in the main market, 10 received peanut seed credit or were under production contract with a parastatal agency and the remaining had none of those characteristics. The other 20 households selected from the easy access and the difficult access villages may or may not have received peanut seed credit or be under production contract with a parastatal organization. The sample of households was selected at random in front of the village head and other village members. The village heads were included in the sample, whether selected randomly or not. This was to get their collaboration and to facilitate the execution of the surveys. Although the total sample was therefore 172 households, the village heads were not included in the analysis.

For some households, only the "Borom Njeul" was surveyed, but for others all the members possessing a field were interviewed. The households surveyed in depth were selected at random from the list of households already chosen. The purpose of the in-depth survey of some households was to compare the behavior of the household heads and the other members, and to investigate the role of women in household transactions. It would have been ideal to study all the 160 households in depth, but the busy schedule of enumerators made it unfeasible. Again, a pragmatic approach guided the research. Forty-eight households were surveyed in depth in the 12 villages (6 households in each of the 4 market villages and three households in each of the 8 remaining villages).

3.2.1.2. Questionnaire Design, Pretesting and Manual for the Enumerators

All the questionnaires were designed by the principal researchers of the program and then circulated to other researchers in the research institute to get further comments before the pretesting phase. Each questionnaire was pretested before implementation. The first pretest was with the enumerators of the program, to foresee any difficulties they might have with the questions, especially with respect to the translation into Woloff. The second pretesting was done in the villages with farmers. These pretests were very useful and led to major revisions or rewording of the questionnaires.

For each questionnaire developed, a set of instructions were written to enhance the enumerators' understanding of each question. The instructions were included in a manual for the enumerators. The understanding of that manual was frequently verified during the supervision by the principal researchers.

3.2.1.3. Surveys Implemented at the Producer Level

The following surveys were implemented at the producer level:

a) Census of households retained in the sample: the questionnaire developed aimed

at obtaining for each member of the households included in the sample, his or her sex, age, relation with the head of the household, status in the household, possession of an individual field, level of education and other occupations beside farming.

b) Production of agricultural commodities: for each member of the household who possessed an individual field, this questionnaire asked the commodities produced during the crop year 1986/87 and the total production. Most farmers provided the estimate of their production in local units, which were then converted into kg according to the estimates provided by farmers. For example, Ramon (1972) estimated that the "diokh" of millet weighted on average 13 kg. But according to farmers, this may no longer be true because actual millet is not as dense as millet before the suppression of the agricultural credit program. Farmers estimate that on average one "diokh" currently weights 10 kg. The program did not directly weigh these local measures to get conversion rates to kg because of various reasons: a) the opportunity cost of the time spent to get conversion rates to kg for all households in the sample was very high for both the researchers and the enumerators; b) the fear that the accuracy obtained by weighing farmers production might lead them to be suspicious about the overall purpose of the research program (for example, the collection of information for future increase in head taxes).

c) Equipment ownership: this questionnaire asked each head of household the types of equipment (plow, seeder, cart) and draft animal (horse, donkey, pair of oxen) he owned, their actual working status, and whether they were purchased or acquired through the pre-1984 government agricultural credit program "programme agricole."

d) Sales of agricultural commodities: this was a multiple visit survey whose objective was to obtain detailed information on producer sales behavior. The questionnaire asked

each head of household (and the other members for households who were surveyed in depth) who sold an agricultural commodity, the date, the quantity, the unit, to whom it was sold, the reasons for sales, the origin of the commodity, the location of sales, the price in CFA Francs per kg and the total value of the sales.

e) Purchases of agricultural commodities: this was also a multiple visit survey collecting information on the date, the quantity, the unit, from whom it was purchased, the reasons for purchases, the source of income, the location of purchases, the price in CFA Francs per kg and the total expenditures.

f) Gifts given: for each head of household (and the other members for households who were surveyed in depth) who provided a gift in kind, this questionnaire asked the type of commodity given, the quantity given, the unit, to whom the commodity was given, the reasons for the gift and the origin of the commodity.

g) Gifts received: for each head of household (and the other members for households surveyed in depth) who received a gift in kind, the questionnaire asked the commodity received, the quantity received, the unit, from whom it was received, the reasons for the gift, and how it was to be used in the future.

h) Constraints to millet production and marketing: this survey was carried out in January 1991 from a sub-sample of the 160 households selected in 1986/87. The sub-sample was randomly selected and was composed of 71 households, 20 in the Northern Peanut Basin, 15 in the Central peanut Basin, 20 in the Southeast Peanut Basin, and 16 in the Southwest Peanut Basin. The main objectives of this survey was to investigate the effects of the decrease in official producer prices of peanuts on household crop mix, and to understand better farmers' millet production and marketing constraints, and what the farmers thought the government could do to enable them to generate marketable

surpluses in the future.

i) Residual effects of fertilizer on millet production: this survey was also carried out in January 1991, from 24 farmers who obtained a confectionery peanuts contract in the Southern Peanut Basin, to investigate the residual effects of fertilizer on millet following peanuts in the rotation. Each contract farmer received an adequate amount of peanut seed and fertilizer for one hectare. The main objective of this survey was to show the importance of credit on household food security in that part of the Peanut Basin, at a moment when IMF and the World Bank were discouraging the GOS from providing credit to farmers. In this survey, each contract farmer was asked to provide information on the amount of credit received, the quantity of peanut production from the field under contract, the quantity of millet production from a field that was under peanut contract during the previous year, and the quantity of millet from another field that was not under peanut contract during the previous year.

3.2.2. Selection of Markets

The selection of markets goes as far back as 1984, when ISRA's cereal marketing research program was launched. In the absence of a complete list of rural markets to guide the selection process, a census of rural markets of the Peanut Basin was undertaken. Approximately, over 200 rural markets were found to be operating actively. Since it was not possible to include all of them in the study, many criteria were developed to select the most important among them, in terms of assembly and distribution of local cereals (Ndoye, 1984). Those criteria are reviewed below:

a) the number of market participants in the market: the underlying hypothesis was that the number of participants in the market is highly correlated with the number of transactions. In other words, the more participants in the market, the more there are

transactions and vice-versa.

b) presence of wholesalers in the markets: since in Senegal, specialized rural wholesale markets do not exist for local cereals, the presence of wholesalers in the market can give an indication of the importance of the market as a wholesale assembly and distribution point.

c) products available in the market: these products were local cereals, vegetables, fertilizer, animal products. The cereal marketing program was mainly interested in the availability of local cereals in the market. Fertilizer, vegetables and animal products were also considered, to enable other BAME programs to know the markets that play a major role in the assembly and/or distribution of those products.

d) quantity of local cereals collected in the market: this information provided an indication of the volume of grain exchanged and the quantity that left the market for other rural, semi-urban, and urban markets. The method developed at this early stage of the research was to count the number of cereal bags in the market to have a rough idea on the volume of transactions.

e) amount of tax revenue collected in the market: the amount of tax revenue collected gave an indication of the importance of the market in providing revenue for the local administration. In markets of the Peanut Basin (both rural and urban), each seller who occupies a stall or a small space in the market must pay taxes called "diouty".

f) seasonality of the market: the seasonality of the market gave an indication on whether the market was functional all year round or not. In the Peanut Basin, some markets are only active during the first three months following harvest, although the majority of markets are operational throughout the year. Furthermore, the seasonality of the market was demonstrated by obtaining the months when the market was active as

an assembly point and the months of the year when the market served as a reception point for a reverse flow of local cereals back into rural areas.

g) market infrastructure: these were the number of stalls, weighing instruments, storage facilities, and telephone in the markets, and the connection of the market to its surrounding areas (paved roads and secondary roads to other villages). This market infrastructure reduces transaction costs (information and contracting costs).

h) religious influence: religious influence enabled the program to capture the importance of smuggled products (mainly from The Gambia) in certain markets where the power of the religious leaders obliged public authorities to tolerate smuggling.

These criteria served as a basis for selecting the 18 markets that are considered in this study. One market from the Gambia (Farafégné) was included to capture the cross-border trade between Senegal and The Gambia.

3.2.2.1. Relevant Market Prices to Collect

In the Peanut Basin, market participants can have different market outlets when they buy or sell agricultural commodities. For example, a farmer may sell to another farmer, an assembler, a wholesaler, a parastatal, or a consumer; the assembler may sell to another assembler, a consumer, a wholesaler, or a parastatal; the wholesaler may sell to another wholesaler, a semi-wholesaler, a retailer, or a consumer.

Given all these possibilities, the research program decided to base its price collection effort on the outlets the most common in the markets. The decision was also guided by the necessity to obtain prices at the different levels of the marketing channel. As underlined by Ouedraogo and Ndoye (1988a), prices were collected at three different levels in rural markets:

a) prices received by farmers when they sell to assemblers: this was the estimate of the producer price in the markets. When producers come to the markets, they usually sell small quantities at a time and for that reason they mostly contract with assemblers who either buy in cans or with the small roman scale ("balance").

b) prices received by assemblers when they sell to wholesalers: this served as an estimate of the wholesale price at the market. All sales made by assemblers to wholesalers concern quantities at least equal to 50 kg and are weighed with the platform scale ("bascule").

c) prices received by traders (semi-wholesaler, wholesaler, retailer) when they sell to a consumer in their shops: this was an estimate of the retail price in the market.

In semi-urban and urban markets, only retail prices were collected.

At the beginning of the cereal marketing research program in 1984, market prices were collected every week. But as the enumerators became more busy doing other surveys, the weekly price collection was reduced to once every fortnight. Beside this pragmatic consideration, another factor was that in most occasions, prices did not vary much within a given fortnight, which suggested the research program did not lose much in giving from 4 data points to 2 data points per month.

3.2.2.2. Methods of Market Price Collection

Prices in rural markets can be collected using different procedures (Ouedraogo and Ndoye, 1988a):

a) interview market participants: one method of obtaining price information is to ask market participants who finished their transactions the price per kg they paid or received for a given commodity. This approach is simple, but it is inadequate since the true price may not be revealed by the parties in the transactions.

b) act as a buyer or seller of the product: beside the danger of biasing the prices, the major problem with this method is that the enumerator cannot act as a buyer of the commodity and still carry on successfully his other activities in the market. Other problems relate to how much financial resources per market day should be allocated and what should be done with the quantities purchased.

c) observe the transactions to note prices: this method allows the enumerator to collect market prices by watching the transactions between a buyer and a seller, listening and recording the price. This method is preferable to the other two above, and was used by the research program. With this method, the enumerator had to be very careful in watching, especially if the transaction was carried out with a can. Once he identified the type of can, he could automatically obtain the price per kg since he knew already how much each type of can weighs if it contains local cereals, peanuts or cowpeas.

The enumerators of the cereal marketing program were supposed to collect market prices during the busiest period of the market. They were also supposed to record three prices for each commodity, reflecting prices which prevailed most during that day. The average of those three prices was then taken to represent the price for that particular fortnight. Furthermore, enumerators were given instructions to be consistent in their price collection. For example, since they were required to give one set of prices for each market every two weeks, they were to do the price collection either the first and the third week of each month, or the second and the fourth week of the month. However, this was not followed strictly all the time by the enumerators, because they sometimes had problems with their motorcycles or were busy doing other survey activities.

3.2.2.3. Questionnaire for Collecting Market Prices

The questionnaire used to collect prices in the markets was designed in such a way as to obtain the gross assembly margin in the same market day, by collecting prices producers received from assemblers and prices assemblers received from wholesalers. Furthermore, the retail prices of local cereals were collected from the permanent shops at the market or at the village where the market was located. The enumerators were also supposed to note for each market visited the approximate number of assemblers, which served as an indication of the degree of competition for the commodities farmers brought at the market. Enumerators were also required to note if the CSA (Food Security Commissariat) was present at the market or not. If the CSA was present, its role as a buyer or as a seller was to be reported. This information was to be used to test the impact of the CSA presence on prices received or paid by farmers. Prices collected were those of local cereals (millet, sorghum, maize), cowpeas, peanuts (shelled, unshelled), "artisanal" peanut oil, peanut cake, peanut hay, legally imported rice into Senegal from Asia, and imported rice smuggled from The Gambia to Senegal.

3.2.3. Selection of the Sample of Traders

During the first two years (1984-85 and 1985-86) of the cereal marketing research program in the Peanut Basin, censuses of both assemblers and wholesalers were carried out during each year in the markets selected. The census served as a basis for selecting a random sample of assemblers and wholesalers to survey in more depth. The primary objective of the 1985-86 census was to capture whether the liberalization of local cereals markets had increased the entry of private traders since the 1984-85 census. During the first two years, the research program had established a positive working relationships with traders. In 1986-87, a census of traders was not done, and an emphasis was placed

on the willingness of traders to participate in the surveys. A total of 43 assemblers, 66 wholesalers and 5 semi-wholesalers expressed their willingness to collaborate with the program. During the first two years of the cereal marketing program, the information on purchases, sales, and prices asked to traders were based on their recollections. In 1986-87 the marketing program initiated the collection of quantity and price information by providing traders with notebooks to record their transactions.

During its collaborative work with traders, the marketing program has learned that most of them did not have an organized method of record keeping. For example, for most traders, it was difficult if not impossible to trace precisely what they did a year ago, due to the ways they kept their records. The objective of the notebooks was to remedy this deficiency. Traders were to record their transactions in French, in Woloff using Arabic alphabet, or in Arabic, depending on in which language they felt most comfortable. In the early months, many traders were complaining about how cumbersome the method was. A few months after the beginning of this method, traders found it very helpful in improving their record keeping. According to traders, this procedure enabled them to recall precisely what they did few months before, which they could not do previously.

The notebook was to be kept by traders, although the marketing program had provided it to them. During their visits to traders, the enumerators copied on their questionnaires the information already in the notebook. After each visit, the enumerators marked the date and signed, to make sure there would not be any duplication of information during their next visits to traders.

Beside the information collected from traders' notebooks, other surveys gathered information on the characteristics of traders and their marketing costs and margins.

3.3 Description of the Marketing Seasons

In the Peanut Basin, the marketing year goes from October to September and can be divided into 4 seasons: the harvest season, the official peanut marketing season, the field preparation season, and the hungry or the rainy season.

a) the harvest season or "lolli"

The harvest season or "lolli" (October-December) corresponds to the period where the new millet is available to the household and starts to enter the market. Millet prices are low during the first part of this season, and in the areas of highest millet production (the Southern Peanut Basin), it is common to observe prices below the floor price, which was 70 CFA Francs in 1986. The second part of this season, from mid-November to December, is devoted to peanut harvesting, assembly and threshing.

b) the official peanut marketing season

This season is also called the dry season and covers January-March. It is characterized by the continuation of peanut threshing, bagging and sales at the cooperative. Since the farmers' activities shift to peanuts during this season, the supply of millet in the markets is lower, which increases its price.

c) the field crop preparation season

This season, which is also called the hot season, covers April-June and is the period when farmers start to get ready for the cropping season. During this period, fertilizer and peanut seed are badly needed, and it is usual to observe that farmers sell millet to buy those inputs, which lowers millet prices compared to those that prevailed during the official peanut marketing season.

d) the rainy season

This season (July-September) is characterized by a reduction in farmers' level of food stocks while they must work harder to increase their productivity. Millet prices reach their maximum, and financial resources to buy food are low for most farmers.

CHAPTER 4

HOUSEHOLD MILLET PRODUCTION AND CONSTRAINTS

The extent to which local cereals consumption will increase in Senegal depends among other things on the level of production, the quantity marketed, and the processed form in which local cereals are available to consumers. Millet is the most important local cereal grown in Senegal. Therefore, its availability in terms of the quantity produced can shed light on the feasibility and the challenges the country faces as a prerequisite for achieving the government objective of encouraging local cereals consumption.

A central question this chapter attempts to address is whether the majority of households in the Peanut Basin are capable of producing enough millet as a prerequisite to facilitating local cereals consumption in Senegal. If not, what are the major constraints that households face, and how can the household be helped to reduce these constraints?

The chapter describes the characteristics of households in the study regions in section 4.1, investigates household millet production and constraints in section 4.2., and examines policies and institutions that may help households improve their millet production in section 4.3. Section 4.4 summarizes the findings of the chapter and discusses their policy implications.

4.1. Characteristics of the Households in the Study Regions

This section describes household resource base and literacy, by focussing on household size and labor, area cultivated, equipment ownership, sources of incomes and non-farm employment opportunities and level of education.

4.1.1 Household Size and Labor Availability

The size of the household is an important variable which determines total labor available and the number of individuals the household head is obligated to feed. This implies there is a tradeoff between household size on the one hand and the household food consumption requirement on the other hand. Bigger households put pressure on the household heads to supply more food to feed the members, but at the same time the larger size enables household heads to have greater access to labor. As mentioned in chapter 2, the household head has the obligation to feed all the dependents in the household, and in turn the dependents have the obligation to devote a few working days during each week to the fields of the household head. Then the question becomes one of comparing millet production per adult equivalent worker (AEW) to the amount of millet necessary to feed each active worker by the household head. This gives an indication of the extent to which the head of the household is capable of producing enough millet to feed the dependents. Such a comparison is made in section 4.2.

Table 4.1 indicates that households in the Northern and the Central Peanut Basin are slightly bigger than households in the Southern Peanut Basin. However, the difference in household size and labor available is not statistically significant at the 5 percent level.

4.1.2 Area Cropped by Household Heads

Table 4.2 shows the number of hectares cropped by household heads in the study regions. In Senegal, the tenure system does not allow households to have an ownership claim on the land. The government owns all the land and farmers have only a use right. This does not, however, prevent farmers from passing the land to other generations, as long as the government does not claim it.

Table 4.1 Household Size and Labor Available in the Study Regions.

	Northern Peanut Basin	Central Peanut Basin	Southeast Peanut Basin	Southwest Peanut Basin
Number of Households	40	39	40	40
Mean Household Size	14	12	10	10
Standard deviation	7.1	6.5	5.0	4.8
Mean AEW (a)	5.6	4.9	4.1	4.2
Standard deviation	3.2	2.3	2.3	2.1

Source: ISRA/BAME Surveys, 1986/87.
(a) AEW means adult equivalent worker.

Table 4.2. Number of Hectares per AEW Cultivated by Household Heads in the Study Regions in 1986.

Study Regions	Hectares per HH (a)	Hectares per HH per AEW	Std Deviation of hectares per AEW	Valid N
Northern Peanut Basin	5.45	1.20	1.2	39
Central Peanut Basin	6.84	1.64	1.1	33
Southeast Peanut Basin	5.76	1.60	0.8	39
Southwest Peanut Basin	4.99	1.40	1.0	36
Total Sample	5.73	1.45	1.0	147

Source: ISRA/BAME Surveys, 1986/87.
(a) HH means household head.

Even though data on total land at the household's disposal are not available, comparison based on the number of hectares cropped by each household head showed no significant difference (at 5 percent) in land cultivated among the study regions. Furthermore, comparison based on the number of hectares per adult equivalent worker does not show any significant difference across sub regions. On average the number of

hectares cropped by each household head amounts to 5.7.

4.1.3. Equipment Ownership

The households in the sample were classified into three different categories: fully equipped, semi-equipped, and non-equipped, based on the types of equipment and draft animals they have at their disposal. Fully equipped households are those that possess at least one draft animal (pair of oxen, horse or donkey), plus a seeder and a plow. Semi-equipped households possess a draft animal, but have only either a seeder or a plow but not both. Non-equipped households are those that either own a seeder or a plow, but do not possess a draft animal, or those that own a draft animal, but possess neither a seeder nor a plow. Table 4.3 reveals that the majority of households in the study regions are fully equipped. This is not surprising since the agricultural credit program ("Programme Agricole") underway from independence to 1982 was highly concentrated in the Peanut Basin. Ninety-seven percent of households in the Northern Peanut Basin are equipped and only 3 percent are semi-equipped. In the Central Peanut Basin, 76 percent of households are fully equipped and 21 percent are semi-equipped. In the Southeast Peanut Basin, 81 percent of households are fully equipped. Among the study regions, the Southwest Peanut Basin has the lowest percentage of households that are fully equipped and the largest percentage of households that are not equipped.

There is a need to point out that being fully equipped or semi-equipped does not imply that the draft animals are in excellent health, or that the implements are in good condition. The data presented do not provide such information. Since the end of the agricultural program, blacksmiths in rural areas have been very active in providing repair services to farmers to help them maintain their equipment (Gaye, 1989). The draft animals are fed mainly with the peanut hay the farmer gets from cultivating peanuts.

Table 4.3 Household Equipment Ownership in the Study Regions.
(Percentage of Households)

Study Regions	Fully Equipped	Semi-Equipped	Non Equipped
Northern Peanut Basin	97	3	0
Central Peanut Basin	76	21	3
Southeast Peanut Basin	81	11	8
Southwest Peanut Basin	71	17	12

Source: ISRA/BAME Surveys, 1986/87.

Table 4.4 Rank Orderings of Sources of Cash Incomes for Household Heads in the Study Regions.

Sources of Income	Northern P. Basin (Rank)	Central P. Basin (Rank)	Southeast P.Basin (Rank)	Southwest P.Basin (Rank)
Livestock	2	2	4	4
Poultry	6	7	-	-
Cereals	5	6	-	-
Vegetables	-	8	5	7
Borrowing	7	5	5	6
Salary	4	3	3	3
Remittance	1	1	3	2
Peanuts	8	9	2	1
Petty Trade	3	4	1	5

Source:ISRA/BAME Surveys, 1986/87.

4.1.4 Sources of Cash Incomes in the Study Regions

For both the Northern and the Central Peanut Basin, the most important sources of cash income are remittances from relatives in urban areas or outside Senegal (table 4.4). Sales of livestock and petty trade ("banabana") are also important sources of incomes. Sales of peanuts do not represent a major source of income for those households. In the Southeast and the Southwest Peanut Basin, the most important sources of income are revenues from sales of peanuts, petty trade and remittances. Sales

of livestock and poultry are less important than in the Northern and the Central Peanut Basin. This finding that the Northern, drier area has more diverse, non-agriculturally based incomes is consistent with findings of Reardon, Matlon and Delgado (1988) for Burkina Faso and Steffen (1992) for Mali.

4.1.5 Non-Farm Employment Opportunities in the Study Regions

Non-farm employment opportunities are important sources of income that enable farmers to improve their food security. Given the seasonal nature of farming in the Peanut Basin, the ability of farmers to earn income during the off-season becomes important. Table 4.5 reveals that the majority of household heads in the study regions do not have any other employment opportunities, except farming. Those household heads have to rely more on remittances from relatives and borrowing to survive until the next harvest season. For household heads who have non-farm employment opportunities, their activities revolve around petty trading, manual work performed on an occasional basis in rural or in urban areas, and religious work ("marabout" or the teaching of Arabic and the Coran). A small percentage of household heads either earn a salary, own a shop, or have herding as a second source of employment.

4.1.6 The Level of Education for Household Heads in the Study Regions

The level of education of household heads sheds light on their ability to read and write, and the feasibility of requiring written contracts for transactions among farmers.

Table 4.6 reveals that in the Central and the Southwest Peanut Basin, the majority of household heads are not able to speak or read any other languages but Woloff, while in the Northern and the Southeast Peanut Basin, at least half of household heads can read Woloff using Arabic alphabet. Furthermore, more household heads in the Central and the Southwest Peanut Basin have ability to read French than those in

Table 4.5 Non-Farm Employment Opportunities for Household Heads in the Study Regions (Percentage of Household Heads).

Job Opportunities	Northern Peanut Basin	Central Peanut Basin	Southeast Peanut Basin	Southwest Peanut Basin
None	62.5	69.0	37.5	55.0
Petty Trading	15.0	7.7	17.5	12.5
Manual Work	12.5	7.7	7.5	15.0
Religious Activities	7.5	2.6	20.0	-
Herder	-	2.6	7.5	2.5
Salary earner	-	2.6	2.5	2.5
Shop Owner	-	-	2.5	2.5
Others	2.5	7.8	5.0	10.0

Source:ISRA/BAME Surveys,1986/87

Table 4.6. The Level of Education for Household Heads in the Study Regions (Percentage of Household Heads).

Education	Northern Peanut Basin	Central Peanut Basin	Southeast Peanut Basin	Southwest Peanut Basin
No Education	32.5	56.4	32.5	67.5
Woloff/French (a)	5.0	-	-	-
Woloff/Arabic (b)	50.0	23.1	67.5	7.5
Arabic	5.0	-	-	5.0
French	7.5	20.5	-	20.0

Source:ISRA/BAME Surveys, 1986/87.
(a) Woloff using French alphabet.
(b) Woloff using Arabic alphabet.

the Southeast and the Northern Peanut Basin. Forty-seven percent of the total sample cannot speak or read any other language but Woloff, while 53 percent can read or speak French, Arabic, or Woloff using the Arabic or French alphabet. This has important implications if the government wants to enforce contracts if they are written in French, Arabic or Woloff using Arabic or French alphabet. Currently, most of the contracts among farmers are not written, which makes enforcement more difficult.

4.2 Household Millet Production and Constraints

This section reviews previous studies on millet output response and discusses millet production in the study regions, the ability of household heads to feed the members with the millet they produce, and the constraints that farmers face to increase millet production.

4.2.1 Review of Selected Studies on Millet Output Response in Senegal

In 1985, the government of Senegal (GOS) increased prices received by farmers for local cereals (millet, sorghum, maize, paddy rice). According to the government, the cereal price increase will stimulate output. The implicit assumption of the government was that the majority of farm households are, or would become, net sellers of cereals. As shown by Weber et al. (1988), Crawford (1988), Goetz (1990), few households tend to be net sellers in Senegal. For that reason many households will not be able to respond to the floor price set as an incentive to increase production (Goetz, 1990). Besides, there is the issue of whether the price increase can be made effective.

Prices anticipated or received can shed light to the degree of responsiveness of farmers. Many empirical studies have shown a positive price response of agricultural production in developing countries (Bateman, 1965; Dean, 1965; Oni, 1969). For Senegal, the empirical evidence to date has shown that the price response is low for millet. Gaye (1983), using time series data from the period 1960 to 1981, found a price elasticity of supply of millet of 0.60 at the mean values of price and quantity, and 0.28 using the last sample observation; he found a cross price elasticity with respect to rice of 0.41 at the mean values and 0.20 using the last sample observation.

According to Commander et al. (1989), price policy did not bring about increase in aggregate supply response in Senegal, but may along with other non-price factors

(reduction in seed credit, etc.) have an impact on area allocation between millet and peanuts. Braverman and Hammer (1986) estimated from their model that a 25 percent increase in the consumer price of rice would increase millet output by 11.3 percent. This yields a cross price elasticity of supply of millet with respect to rice of 0.45, which is in the same order of magnitude as the cross-price elasticity at the mean estimated by Gaye (1983). In 1984, the GOS increased the consumer price of rice by 23 percent. During that crop season, millet production increased by 34 percent compared to 1983. From 1985 to 1987 average millet production equaled 125 percent more than that 1983 production. In 1988, the GOS decreased the price of rice by 18.75 percent. Compared with the 1987 crop year, millet production declined by 26 percent. These relationships seem to indicate there is a positive correlation between the consumer price of rice and millet production. Nevertheless one has to be cautious since many other factors, such as rainfall, have a strong impact on millet production.

Freud et al. (1988) built an agricultural sector model for Senegal and simulated the impact of four scenarios over the period 1986 to 1995: a base scenario, a comparative advantage scenario, a self-sufficiency scenario, and an intensification scenario. In all four scenarios, only the prices of millet and maize received by farmers were endogenous, whereas the price of paddy received by farmers, the consumer price of imported rice and population were exogenous. The principal results were:

a) for the base scenario in which the reference prices are those that officially prevailed in 1986 (i.e., 70 CFA F/kg for millet and maize, 85 CFA F/kg for paddy, and 160 CFA F/kg for imported rice), millet and maize production are projected to increase by 41 and 42 percent between 1986 and 1995, paddy production to increase by 78 percent, and rice imports to increase by 8.6 percent.

b) for the comparative advantage scenario, in which the reference prices are 50 CFA F/kg for both millet and maize, 60 CFA F for paddy and 150 CFA F/kg for imported rice, millet and maize production are projected to decrease by 38.8 and 28.3 percent, paddy production does not change, and rice imports increase by 51.6 percent.

c) for the self-sufficiency scenario, where the reference prices are 70 CFA F/kg for millet, maize and paddy and 200 CFA F/kg for imported rice, millet and maize production are projected to increase by 18.8 and 34.9 percent, paddy production does not change and rice imports decrease by 25.6 percent.

d) for the intensification scenario, where the reference prices are 60 CFA F/kg for millet and maize, 75 CFA F/kg for paddy and 180 CFA F/kg for imported rice, millet and maize production are projected to increase by 6.3 and 7.2 percent, paddy production remained unchanged, and rice imports decrease by 4.96 percent.

The simulation results seem to indicate that rice imports decrease whenever the reference price differential between millet and imported rice reaches 120 CFA F/kg. Rice imports increase if the price differential is less than 120 CFA F/kg.

Martin (1988) also simulated the impact of various price policies on the supply of millet, maize and paddy rice. He projected that if the 1986-87 official price of millet fixed by the government for farmers were increased by 40 percent, millet output would increase by only 2 percent. If the price fixed by the government for farmers were increased by 80 percent, millet output would increase by only 8 percent. For rice, Martin (1988) projected that if the price fixed by the government for farmers were increased by 40 or 80 percent, production would in either case increase by only 2 percent. For maize, if the price fixed by the government for farmers were increased by 40 percent, production would increase by 101 percent, whereas production would increase by 137

percent if the price fixed by the government for farmers were increased by 80 percent.

From the simulation made by Martin (1988), it appears there is a significant positive correlation between price and output for maize, but not for millet and rice. Many reasons explain the lack of significant price response for millet and rice: the lower profitability of millet compared to peanuts, even at higher millet prices (Martin, 1988), lack of improved technology, land constraints and high costs of expanding irrigated rice production (Shapiro and Berg, 1988).

One lesson to be learned from Martin's simulation is that price policy (on the output side) is a necessary but not a sufficient condition in increasing supply of local cereals. It is important to understand the interaction between price policy, technology and institutions (Martin, 1988; Martin and Crawford, 1989; Crawford et al., 1988).

The foregoing review has indicated that the supply response of millet is low in Senegal according to Martin, but moderate according to the other studies. Since the supply response in the studies reviewed is obtained at the aggregate level, it may overlook important differences in output response for different categories of households. For example, it may be that Martin's simulation had a tendency to show a typical response from small and low resource households, whereas the other studies had a tendency to show a typical response from larger and more well-endowed households. The very low supply response can be defended in the absence of an effective interaction between price policy, technology and institutions. However, given that there is a yield gap, one can expect that the supply response of millet in Senegal can be raised moderately with some technical help to farmers. This will likely come about only if there is an effective interaction between price policy, technology and institutions. The remaining of this section discusses millet production by category of households, the

inability of many household heads to satisfy the consumption needs of their dependents with the millet they produced during the 1986/87 crop season, and the constraints to millet production.

4.2.2 Millet Production for Household Heads in the Study Regions

Only 147 (92 percent) of the 159 household heads in the study regions could be contacted during the production survey. All 147 produced either coarse grains (millet, sorghum, maize), cowpeas, groundnuts, or a combination of these crops during the 1986/86 crop season. The 12 households not contacted are not included in subsequent analysis. Among the 147 households for which production data is available, 131 (or 89 percent) produced millet during the 1986/87 crop year.

Millet is grown in the Peanut Basin in rotation with groundnuts and cowpeas. In the Northern and the Central Peanut Basin, millet has been traditionally grown for home consumption in rotation with groundnuts. With the current lower level of rainfall in these regions compared to the sixties and the seventies, the government has attempted to persuade farmers to switch from groundnuts to cowpeas. As shown by Martin (1988), groundnuts are financially more attractive to farmers from these regions than cowpeas. Furthermore, groundnuts produce more hay to feed livestock than cowpeas (Martin, 1988). In the Southern Peanut Basin, millet is grown in rotation with groundnuts. Like in the Northern and the Central Peanut Basin, millet is a subsistence crop primarily grown for home consumption. For this reason, it will continue to be grown. Groundnuts are mainly grown for the market and the hay feeds the draft animals used for cultivation.

Table 4.7 describes mean millet production per household and per hectare cultivated. As the table shows, there is much variability in millet production in the study regions, which indicates the heterogeneity of the Peanut Basin, especially between the

Southern and both the Central and the Northern Peanut Basin. Consequently, millet production is lower the more one moves from the Southern to the Northern Peanut Basin, due to lower and more uneven distribution of rainfall. Household heads in the Southern Peanut Basin, which constitute 54 percent of total households in the sample (that produced millet), produced 91 percent of the total millet produced. Millet production per hectare is also lower in the Northern and the Central Peanut Basin than in the Southern Peanut Basin. Both millet production per household head and per hectare were significantly different at the 5 percent level between each study region in the Southern Peanut Basin and the Northern and the Central Peanut Basin. It is important to note that both the Northern and the Central Peanut Basin experienced a total crop failure in 1986/87 because of low rain and many replanting due to insect attacks.

Agronomic research has introduced different improved varieties of millet in the Peanut Basin. For the Northern and the Central Peanut Basin, IBV 8004, which is a variety of 75-85 days cycle, is recommended to farmers. Its potential yield under optimal conditions at the experiment station is 3,100 kg/hectare. For the Southern Peanut Basin two varieties are currently recommended:

a) Souna 3, with 85-95 day production cycle, has a potential yield of 3,200 kg/hectare.

b) IBV 8001, with 75-85 day production cycle, has a potential yield of 3,100 kg/hectare.

The extent to which IBV 8001 and IBV 8004 are currently used by our sample of households was not directly asked in the survey, but there is indication that some farmers in the Southern Peanut Basin use Souna 3, which has been recommended since

Table 4.7 Mean Annual Millet Production per Household Head and per Hectare in the Study Regions in 1986 (Standard Deviation).

Study Regions	Production per Household Head (kg)	Production Per Hectare (kg)	Valid N
Northern P.Basin	174 (225)	71 (83)	30
Central P.Basin	217 (225)	74 (61)	30
Southeast P.Basin	1828 (1157)	527 (315)	35
Southwest P.Basin	1627 (1270)	696 (545)	36
Total	1033 (1187)	365 (430)	131

Source:ISRA/BAME Surveys, 1986/87.

1972. Thiam (undated) considered Souna 3 as representing current farm practices in a millet trial he carried out in the Southern Peanut Basin under farmers' conditions.

As specified in chapter 2, ways to evaluate millet yields obtained in the study regions include comparing the yields obtained under experiment station conditions and researcher managed field trials (yield gap 1), and the yields obtained under researcher-managed field trials and current farmers' yields (yield gap 2). Unfortunately, this comparison will only be possible for the Southeast Peanut Basin where we have results from an agronomic trial in farmers' fields. Four scenarios are considered:

a) comparison of millet yield between the Southeast Peanut Basin and conditions at the experiment station.

The difference between current yields obtained at the experiment station and those achieved under researcher managed field trials is called the yield gap 1 in the agronomic literature (Gomez, 1977; Dillon and Hardaker, 1984). This comparison shows

that the average yield obtained from the Southeast Peanut Basin under researcher-managed field trial (Thiam, undated) is 47 percent of the potential yield that can be obtained under experiment station conditions.

b) comparison of millet yield between the Southeast Peanut Basin and yield from an agronomic trial (Thiam, undated) under farmers' conditions using organic fertilizer.

The difference between yields obtained by farmers and yields obtained from farmers' field trials is called the yield gap 2 (Gomez, 1977; Dillon and Hardaker, 1984). This comparison shows that the average yield obtained by our sample of farmers is 35 percent of the yield obtained under farmers' conditions using organic fertilizer.

c) comparison of millet yield between the Southeast Peanut Basin and yield from an agronomic trial (Thiam, undated) under farmers' conditions without fertilizer (organic or mineral).

This difference can be called the yield gap 2 without fertilizer. The comparison reveals that the average yield obtained by our sample is 74 percent of yield obtained under farmers' conditions without use of fertilizer. This comparison seems the most realistic since the suppression of the agricultural credit program in Senegal has reduced farmers' ability to acquire fertilizer.

d) comparison of millet yield between the Southeast Peanut Basin and the rest of Senegal

This scenario compares the average yield for our sample from the Southeast Peanut Basin to the average yield obtained from national statistics for the 1986 crop season. It shows that the yield obtained from our sample represents 90 percent of the

yield obtained at the national level[5].

The foregoing discussion demonstrates that, at the farm level, actual millet yields are less than those that could be obtained at the experiment station and at farmers' field with the supervision of agronomist. This yield gap needs to be narrowed by assisting farmers with improved inputs (seed, fertilizer) so that their circumstances become closer to those prevailing at the experiment station. An hypothesis is that the yield gap 2 is mainly due to socio-economic factors rather than farmers' lack of knowledge of fertilizer. Kelly (1988) reported that according to farmers in the Southeast Peanut Basin (department of Nioro), on average one kilogram of fertilizer can increase millet production by 9.5 kilograms. This implies that farmers are aware of the added benefits of using fertilizer and suggests that the future supply of millet might respond to price with some technical help. Kelly (1988) estimated also value-cost ratios using 1986/87 prices that range from 2.6 to 5.6, which are more than 2, the level of economic returns which researchers have considered sufficient to incite farmers to invest in improved technology.

4.2.3 Millet Production in the Study Regions By Equipment Level

Table 4.8 indicates that the level of equipment for households in the study regions does not have any significant impact on yields. Multiple comparisons using the

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[5] Note that this comparison is based on the average yield obtained in the Southeast Peanut Basin. The yield obtained at the national level during the 1986 crop year is 585 kg per hectare, compared with 696 kg per hectare obtained in the Southwest Peanut Basin.

Table 4.8 Mean Annual Millet Production Per Hectare and Equipment Level for Household Heads in the Study Regions (kg).

Study Regions	Per Hectare	Valid N	Standard Deviation
Northern P.Basin			
Non Equipped	N/A	N/A	N/A
Semi-Equipped	48	1	.
Fully Equipped	76	25	87
Central P.Basin			
Non Equipped	99	4	251
Semi-Equipped	95	5	69
Fully Equipped	66	20	58
Southeast P.Basin			
Non Equipped	513	4	202
Semi-Equipped	454	4	152
Fully Equipped	522	26	343
Southwest P.Basin			
Non Equipped	554	6	251
Semi-Equipped	864	4	374
Fully Equipped	595	25	277
Total Sample			
Non Equipped	412	14	279
Semi-Equipped	414	14	389
Fully Equipped	330	96	337

Source:ISRA/BAME Surveys, 1986/87.

Tukey B procedure[6] did not show any significant difference (at the 5 percent level) in millet production per hectare, between fully equipped, semi-and non-equipped households in each study region and for the total sample. However, for fully equipped households tested across sub-regions, there was a significant difference in millet production per hectare at the 5 percent level, between the Central Peanut Basin and both regions in the Southern Peanut Basin on the one hand, and between the Northern Peanut Basin and both regions in the Southern Peanut Basin on the other hand.

[6] The Tukey B test or Tukey's alternate test is a multiple comparison test to determine the statistical significance in the means of all sub-groups in a sample, compared by pair. Multiple comparison was not performed for the Northern Peanut Basin since all households are either semi-equipped or fully equipped. The Tukey B procedure cannot do multiple comparisons for fewer than 3 categories. An analysis of variance test (ANOVA) was used instead.

Furthermore, for semi-equipped households tested across sub-regions, there was a significant difference in millet production per hectare between the Central and the Southwest Peanut Basin. For non-equipped households tested across sub-regions, there was a significant difference in millet production per hectare between the Central Peanut Basin and both regions in the Southern Peanut Basin. This difference was due to the crop failure mentioned previously.

Many factors can explain the lack of statistical significance in millet production per hectare between fully equipped, semi and non equipped households in each study region and for the total sample.

i) factors linked with the natural environment:

a) the low level of rainfall and its erratic distribution in the Central and the Northern Peanut Basin introduce the same level of uncertainty for fully equipped, semi- and non-equipped households in those regions, such that millet production for semi- and fully equipped households shows less response to equipment than it otherwise would have.

b) other random events such as crop failures, insects and rodent damages do not differentiate between fully, semi and non-equipped households.

ii) factors linked with the institutional environment:

a) no matter how well-equipped the household is, millet production is less likely to be high if the household does not use enough fertilizer, particularly if soil fertility is low. Under the former agricultural program ("programme agricole"), farmers were able to get fertilizer on credit at a highly subsidized price. Currently, they have to purchase it. Kelly (1988) found that low fertilizer use in the Southern Peanut Basin was due to the low level of farm income, low and uncertain fertilizer response, lack of credit

and farmers' preference for less risky alternative investments (p. 254).

b) lack of extension program may decrease the willingness of farmers to invest in high yielding inputs.

4.2.4 Ability of Households to Produce Sufficient Millet for Their Own Consumption

As mentioned in previous sections, a major goal of the GOS is to encourage local cereals consumption. Millet being the most important local cereals in Senegal, the feasibility of that objective can be judged by examining the number of household heads in the study regions who produce enough millet for their dependents, i.e., at least 200 kg of millet per adult equivalent worker (AEW), the annual consumption norm defined by FAO. It appears from table 4.9 that in both the Northern and the Central Peanut Basin, household heads were not able to produce enough millet to feed their dependents. Only 16 percent of the household heads in those regions were able to feed their members at least for 6 months with the millet they produced. By contrast, the majority of household heads in the Southern Peanut Basin were able to feed their members with the millet they produce. Only 18 percent of household heads in those regions did not produce enough millet to feed their dependents, but 46 percent of them were able to feed their members for at least 6 months with the millet they produced. As a result, households in the Northern and the Central Peanut Basin had a more pressing need for finding alternative sources of incomes to buy food than household heads in the Southern Peanut Basin. The results indicate that the government's objective of encouraging local cereals production for consumption in Senegal is more challenging than the government assumes. There is a major aggregate supply constraint (among others) that needs to be resolved as a prerequisite for that objective to have any chance of being achieved.

Table 4.9. Households Able to Feed Themselves with Their Own Millet Production in the Study Regions. (1986 Production by Household Heads).

Study Regions	Number of HHs Sufficient	Percentage of Total	Total Number of HHs
Northern Peanut Basin	0	0	30
Central Peanut Basin	1	3.3	30
Southeast Peanut Basin	31	88.6	35
Southwest Peanut Basin	27	75.0	36
Total	59	44.7	131

Source:ISRA/BAME Surveys, 1986/87.

Apparently, for most household heads in the Peanut Basin, millet production per adult equivalent worker, which can be a proxy for the average labor productivity in the household (since all members of the household are obligated to work in the millet fields owned by the household head), did not cover the consumption needs of individual members, at least during the survey year.

4.2.5 Constraints to Increasing Millet Production

This section investigates millet production constraints by analyzing the results of a survey undertaken in January 1991 in the Peanut Basin, for a sub-sample of 71 household heads who were interviewed during the 1986/87 marketing year. These household heads were selected at random from the list of households selected during the 1986/87 crop year. The whole sample of 160 household heads could not be considered, due to human and time constraints. This section is important since it addresses the constraints to increasing actual millet production from the household heads' point of

Table 4.10. Household Heads' Perceptions of the Constraints to Increasing Millet Production in the Study Regions (percentage of household heads).

Constraints	Northern Peanut Basin	Central Peanut Basin	Southeast Peanut Basin	Southwest Peanut Basin	% Total Sample
1. Insect Attacks	27.8	40.0	5.0	5.9	18.6
2. Lack of Inputs	50.0	53.3	75.0	76.5	64.3
3. Low Rain	38.9	33.3	-	11.8	20.0
4. High Input Prices	22.2	6.7	65.0	35.3	34.3
5. Lack of Credit	-	13.3	15.0	17.7	11.4
Total	138.9	146.6	160.0	147.2	

Source:ISRA/BAME Surveys, January 1991

Notes:

1. Total percentages do not add up to 100 due to multiple responses.
2. The results in the table are based on a sub-sample of household heads from the 1986/87 sample. The sub-sample consisted of 20 household heads in the Northern Peanut Basin, 15 household heads in the Central Peanut Basin, 20 household heads in the Southeast Peanut Basin and 16 household heads in the Southwest Peanut Basin, for a total of 71 household heads.

view. As table 4.10 indicates, the lack of inputs is the most important factor that prevents household heads in the study regions from increasing actual millet production. The lower level of soil fertility in the Peanut Basin compared to many years ago makes the use of adequate inputs more necessary than ever to increase yields. The lack of inputs appears to be more problematic in the Southern Peanut Basin in the sense that it is a concern for more than 75 percent of household heads in that region. The lack of inputs may not be a worse absolute problem in the Southern Peanut Basin, but it may rank higher there among constraints because rainfall is less of a constraint than in the Northern Peanut Basin. The second most important factors for both the Central and the Northern Peanut Basin are various kinds of insect attacks, from millet planting to maturation, and the low and uneven distribution of rainfall. While it is more difficult for

the government to increase the amount of rainfall in that region, at least entomological research is necessary in the short run to reduce the impact of insect attacks.

The second most important factor contributing to low millet production in the Southern Peanut Basin is the price of inputs, especially fertilizer. According to household heads, fertilizer prices are increasing at a greater rate than the prices of millet (or other agricultural commodities), leading to a decline in their terms of trade.

Another factor mentioned by household heads as a constraint to increasing millet production is the lack of credit (fertilizer, seed, equipment). This was mentioned in the Central and the Southern Peanut Basin.

From the technical researchers, the constraints to millet production are drought stress, low soil fertility, insects and bird attack, and diseases such as Striga, millet downy mildew, smut, and ergot (van Veen, 1989). In an answer to the question "what are the major problems that prevent farmers from increasing agricultural production?", the technical scientists at a meeting in Bambey (Senegal) mentioned the following reasons (Mbaye, 1991):

a) drought and irregularity of rainfall.

b) low level of soil fertility.

c) insects, diseases and bad weeds.

d) non-availability of seeds, labor bottleneck, low purchasing power, access to credit limited, and difficulty to renew agricultural equipment.

e) lack of coordination between agricultural research and extension.

The foregoing discussion indicates that the constraints to millet production as mentioned by farmers in the sample are comparable to the constraints identified by technical scientists.

4.3 Policies and Institutions to Increase Farmers' Ability to Improve Millet Production

This section discusses policies needed to help farmers increase their millet production, and to facilitate the government's goal of substitution of local cereals for imported rice. The first sub-section analyzes the point of view of farmers about what the government must do to enable them to increase marketable surpluses. The second sub-section addresses the central role of contract farming on farmers' well-being by analyzing the impact of the carry-over effects of fertilizer (used on confectionery peanuts) on household millet production and food security. The third sub-section discusses the lessons learned from the confectionery peanut contracting and how they can help create a new institutional innovation to improve farmers' millet production and well-being.

4.3.1 Farmers' Assessment of the Need for Government Intervention

This sub-section discusses farmers' opinions about what the government should do to enable them to increase their millet production in the future. The analysis is based on the same sub-sample of 71 household heads surveyed and discussed in the previous section. The results are presented in table 4.11. In what follows, we discuss the different policies farmers advocate and their implications:

a) Reduction of the prices of inputs

The reduction of the prices of inputs (especially fertilizer and seed) is the most important policy farmers think the government must implement to help them increase millet production. Sixty-nine percent of farmers in the sub-sample think this is a priority. For the sub-samples in the individual study regions, the responses are 75 percent, 47 percent, 90 percent and 56 percent in the Northern, the Central, the Southeast and the Southwest Peanut Basin respectively. The reduction of the prices of inputs relative to

Table 4.11 Household Heads' Assessment of Policies Needed to Increase Millet Production and Marketable Surpluses in the Peanut Basin (Percentage of Responses).

Policies	Northern P.Basin	Central P. Basin	Southeast P. Basin	Southwest P. Basin	% of total sub-sample
1.Maintaining Soil Fertility	10	6.7	-	-	4.2
2.Combat Insect Attacks	15	26.7	-	6.2	11.3
3.Agricultural Credit	30	60	45	93.8	54.9
4.Reduce Prices of Inputs	75	46.7	90	56.2	69
5.Food Credit during Rainy Season	20	-	-	-	5.6
6.Food Aid during Rainy Season	20	26.7	-	18.8	15.5
7.Health Assistance	5	-	-	-	1.4
8.Reduce Uncertainty of Rainfall	-	6.7	-	6.2	2.8
9.Others	5	20	35	6.2	16.9
Total	180	193.5	170	187.4	

Source: ISRA/BAME Surveys, 1991

Notes:

1. The sub-sample consists of 71 household heads of which 20 are located in the Northern Peanut Basin, 15 in the Central Peanut Basin, 20 in the Southeast Peanut Basin, and 16 in the Southwest Peanut Basin.
2. Total does not add up to 100 due to multiple responses.
3. Row total represents the sum of responses per study region; column total represents the total number of responses for each category for all study regions expressed in percentage terms of the total sub-sample.

prices in The Gambia and their availability when farmers dispose of cash resources will stimulate millet production in the future. For example, Kelly (1988) found that fertilizer is most likely to be purchased when it is available during the official marketing of peanuts. Furthermore, fertilizer is sold to farmers at 90 CFA Francs per kg, whereas the official price of millet (which the farmer may not get when he sells his millet at the

market) is 70 CFA francs per kg. This implies the terms of trade between millet and fertilizer is 0.78, meaning one kg of millet buys less than one kg of fertilizer. This need not be a serious constraint if fertilizer-responsive varieties are available. A key question is whether the government would be better off investing its scarce resources in developing such varieties or in subsidizing fertilizer. Another factor is that farmers, especially those in the Southern Peanut Basin, are aware that fertilizer is sold at 60 CFA Francs per kg in The Gambia. When asked about the price they would be willing to pay for fertilizer, the majority of farmers in the sub-sample reported prices of 50 and 60 CFA francs per kg. Because the price of fertilizer per kg is currently higher than the official prices of millet, sorghum, maize and peanuts, farmers conclude they are being exploited by the government.

b) Agricultural credit

Fifty-five percent of household heads interviewed from the sub-sample reported the need for agricultural credit to increase millet production in the future. For the sub-samples in the individual study regions, the responses are 30 percent, 60 percent, 45 percent and 94 percent in the Northern, the Central, the Southeast and the Southwest Peanut Basin respectively. Credit is very important to get agriculture moving, especially in a low-income country like Senegal. However, the bad experience from the agricultural credit program ("Programme Agricole") in the past had led the government to discontinue the provision of massive credit to farmers. Furthermore, since Senegal is undergoing Structural Adjustment Lending (SAL) with the World Bank and IMF, a credit program similar to the "programme agricole" will be difficult to restore. The establishment of a new credit program, which assumes that farmers do not view credit as a gift, is discussed in sub-section 4.3.3.

c) Food aid during the rainy season

Fifteen percent of household heads in the sub-sample reported the need for the government to assist them with food aid during the rainy season. Most of the responses come from the Northern and the Central Peanut Basin. The rainy season corresponds to the time of the year when food stocks are low, and financial resources scarce. The lack of food during that period implies farmers will not have enough strength to work full-time on their fields.

d) Other needs expressed by farmers are the needs for maintaining soil fertility, prevention of insect attacks, food credit during the rainy season, and health assistance. With the deforestation, soil degradation and the threat caused by the progression of the Sahara desert, the need for maintaining soil fertility becomes evident. Given the delimitation of property rights with respect to land, which give farmers a use right and not full ownership of the land, farmers anticipate a high risk for undertaking a significant investment to maintain soil fertility. Since the government is the sole owner of the land, as defined in the "loi sur le domaine national", farmers believe the restoration of soil fertility is the responsibility of the government.

The Northern and the Central Peanut Basin have been affected these past years by insect attacks, from the period in which millet starts to grow to when it matures. The attacks during the early period of growth lead farmers to replant several times, which because of the length of the rainfall, lead to a situation where millet has difficulty to complete its growth cycle. The attacks of millet during the period of maturity are caused by locusts, which devastate the crop so that no grain is harvested. The government has a major responsibility for preventing these insect attacks through more research on entomology.

4.3.2 Role of Contracting on Farmers' Well-being: Impact of Carry-Over Effects of Fertilizer on Household Millet Production and Food Security

This sub-section discusses the important role of contract farming on farmers' well-being, by analyzing the carry-over effects of fertilizer on millet following peanuts (under previous contract) in the rotation, to determine its impact on production and household food security. The analysis is based on 24 farm households which got confectionery peanuts contracts ("arachide de bouche") in one village in the Southern Peanut Basin. Each farmer who got a contract received credit for seed and fertilizer for one hectare from SEPFA, a parastatal organization which was supposed to be privatized during the 1991-92 crop year. The nature of the contract will be discussed in sub-section 4.3.3.

For the purpose of this analysis, the farmers who got contracts were asked to provide an estimate of millet production from one hectare that followed (in the rotation) peanuts under contract the previous year, and from another hectare of millet that did not follow peanuts under contract. In order to compare millet production under the two scenarios, we assume the type of soil for the two fields are the same, so that the only difference is one field benefits from residual fertilizer, and the other does not. There is a rationale for assuming similar soil type since farmers in the Southern Peanut Basin do not usually have their fields far apart, so that within a reasonable distance there is not a significant difference in the type of soil. Nonetheless, there is the possibility that farmers allocated their best fields to the contract production, which would bias upward the results of the analysis presented in table 4.12.

It appears that obtaining a peanut contract enables farmers to increase millet production significantly, compared to millet production on a field that was not used

previously for a contract. On average, the residual effects of fertilizer enable farmers to improve their millet production by 650 kg, with a minimum increase of 200 kg and a maximum of 1300 kg. This implies that in addition to the income effect of the contract resulting from the sales of confectionery peanuts to the contracting organization, farmers are able to improve their food security, if the contracted field is produced in millet during the subsequent year. The main reason is that the contracted field receives an adequate dosage of fertilizer, which most farmers may not afford to buy. Even the minimum increase of 200 kg obtained by the most unfortunate contract farmer makes a difference, since it can feed one adult member in the household for one year, using FAO norm.

4.3.3 The Experience of Confectionery Peanut Contracting

4.3.3.1 How the Program Works

The villages in the confectionery peanut program are selected according to the level of current rainfall in order to minimize the risk of crop failure due to weather, past records of peanut cultivation, and how they behaved in the past during the agricultural credit program. The number of hectares allocated to each village is function of the total hectares the parastatal is able to finance, and how it decides to allocate them among villages. However, one village can obtain more hectares in the subsequent years as a result of its performance in repaying its debts satisfactorily. The village head is responsible for the number of hectares allocated to his village, and the distribution among farmers is decided in a village meeting. In order to get a contract, a farmer has to be committed (i.e., agrees to get a contract), and have a good record in repaying his credit on time. The contracts are on a one-hectare basis, i.e., one farmer cannot have more than one hectare. The contracts are signed before planting time, and they specify

Table 4.12. Estimates of the Residual Effects of Fertilizer on Millet Production for 24 Contract Farmers in the Southern Peanut Basin (kg).

Millet with Residual Fertilizer	Millet without Residual Fertilizer	Difference
550	40	510
600	250	350
670	360	310
700	500	200
800	520	280
900	500	400
900	500	400
900	400	500
920	120	800
940	50	890
1000	400	600
1000	450	550
1000	300	700
1050	415	635
1100	730	370
1200	500	700
1260	800	460
1300	650	650
1300	80	1220
1300	400	900
1350	435	920
1350	530	820
1350	230	1120
1900	600	1300
1046*	406*	650*

Source: ISRA/BAME Surveys, 1991.
* these numbers are the corresponding averages.

the amount of the credit, other assistance the parastatal will provide (for example, technical advice), and the prices at which it will buy the commodity at harvest, based on two grades (labelled first and second choice). The third choice is not bought by the parastatal, because it implies that either the farmer who got the contract has not used the required inputs adequately, or that he has not followed the cultural practices properly. A farmer who has peanuts graded third choice must sell them to the oil mills. During the 1990-91 crop year, prices received by farmers were 105 CFA Francs per kg

for the first choice and 85 CFA Francs for the second choice. The price of the third choice was 70 CFA Francs, which was the price other peanut growers received from the oil mills. The parastatal commits itself to buy all the output farmers are willing to sell. Each farmer who gets a contract receives the quantity of fertilizer, seed and insecticide required to grow one hectare of peanuts. During the 1990-91 crop year, these inputs were priced at 33,535 CFA francs. The farmer who gets a contract receives those inputs on time and the parastatal assures delivery to the village. The whole village is responsible for the debt contracted, although the credit is individualized. This is done to provide self-reinforcing mechanisms that will shape the behavior of individual farmers who get a contract. In order to investigate to what extent the farmers who got contracts are able to pay back their debts, the sales from their production are calculated.

The results are presented in table 4.13. It appears that only 2 farmers were not able to cover their debts from the sales of their production, which implies that 92 percent of the farmers considered in the sub-sample earned more than enough to cover their debts. Two options may be possible for those farmers who are not able to cover their debts from peanut sales (first and/or second choice):

a) complete their credit payments by selling their third choice peanuts to the oil-mills, selling grain, livestock, or by borrowing from more successful farmers who got contracts.

b) decide not to pay back. In this situation the farmers who do not cover their debt from the sales of peanuts will not only be barred from future credit programs, but will have some of their belongings (draft animals, equipment...) seized and sold to clear-up their debts. Given all the risk associated with deciding not to pay back, it is most likely the first option was taken by the 2 farmers.

Table 4.13 Value of Peanut Sales for 24 Contract Farmers in the Southern Peanut Basin.

Quantity of Peanuts:first grade (kg)	Quantity of Peanuts:second grade (kg)	Total Value of Production(CFA francs)
10	225	20,175
150	150	28,500
150	250	37,000
350	250	58,000
500	205	69,925
600	300	88,500
600	400	97,000
700	400	107,500
700	300	99,000
700	400	107,500
725	325	103,750
742	300	103,410
780	208	99,580
800	225	103,125
800	238	104,230
850	650	144,500
900	500	137,000
925	NA	97,125
996	304	130,420
1000	500	147,500
1100	500	158,000
1150	400	154,750
1350	500	184,250
1400	500	189,500
749*	335*	107,093*

Source:ISRA/BAME Surveys, 1991

* These numbers are the corresponding averages.

4.3.3.2 Lessons Learned from the Program

As described above, the confectionery peanut program is successful in enabling farmers who get contracts to improve their food security and to increase their income earnings, thereby raising their well-being. This success is due to several factors which are summarized below:

a) the program is administered at the village level, where there is a solidarity, since families know each others and members share common beliefs and values.

b) contracts are individualized, but the whole village is responsible for the consequences of not paying back the debts contracted.

c) the credit is based on one hectare, which makes it manageable by the individual farmers, reduces the risk of non payment and limits transaction costs.

d) the parastatal promises to purchase all the production the farmers who get contracts are willing to sell provided it meets quality specifications.

e) the parastatal specifies appropriate grades and standards to discipline the contracting farmers.

f) the manageability of the credit allows the program to maintain the self-enforcement mechanism among village members and enables them to increase their millet production.

4.4. Chapter Summary and Policy Implications

There was no significant difference among households in the study regions in terms of the number of active workers and the number of hectares cultivated by each head of household. The majority of households in the study regions are fully equipped, i.e., they possess at least one draft animal plus a seeder and a plow.

Household heads in the Central and in the Northern Peanut Basin have more diversified sources of incomes than household heads in the Southern Peanut Basin. Household heads in the Central and in the Southwest Peanut Basin are more educated than those in the Northern and in the Southeast Peanut Basin, but a low percentage of the household heads have an ability to speak or read French.

Household heads in the study regions are heterogeneous with respect to millet production, and as expected, household heads in the Southern Peanut Basin produced more during the survey year than household heads in the Central and the Northern

Peanut Basin. As mentioned previously, the survey year was almost a total crop failure in the Northern and the Central Peanut Basin.

An assessment of the yield gap was made based on the data from the Southeast Peanut Basin. The results indicate that the yield gap 1, i.e., the difference between potential yield and yields from farmers' field trials is 53 percent. The yield gap 2, i.e., the difference between the yield from farmers' field trials and yield obtained by the sample of farmers was lower if no fertilizer was used, which better reflected the conditions of farmers since the end of the agricultural credit program. Given that farmers in the Southeast Peanut Basin know the benefits of using fertilizer (Kelly, 1988), one can hypothesize that the yield gap 2 is mainly due to socio-economic factors (for example, lack of financial resources to buy fertilizer, weeding not done on time etc...). This implies that the future supply of millet might respond to price if farmers' access to supporting institutions (credit, extension) is facilitated.

There was no significant difference in millet production by equipment level among household heads within each study region and for the total sample of household heads. Factors that may explain the lack of statistical significance are the amount of rainfall and its erratic distribution, which introduces the same level of uncertainty for fully equipped, semi-equipped and non-equipped households in each study regions, low fertilizer use, low farm income and lack of extension program. That is, the lack of equipment was not the binding constraint on millet production in the survey year.

The majority of household heads in the Northern and the Central Peanut Basin were not capable of producing enough millet to last them even for 6 months. In the Southern Peanut Basin, the majority of household heads could feed their members at least for a year with their millet production. The implication is that the government's

objective of encouraging local cereals production for consumption is in reality more challenging than the government may think. There are major technological and institutional factors that need to be addressed to enable farmers to increase their millet production significantly.

The constraints farmers face to increase millet production were investigated from a sub-sample of the household heads. In addition to the lower profitability of millet compared to peanuts (Martin, 1988), the results indicate that lack of inputs is the most important factor that prevents household heads from increasing their millet production. Other factors are insect attacks, low and uneven distribution of rainfall, the current prices of inputs and the lack of credit.

CHAPTER 5

HOUSEHOLD MILLET TRANSACTIONS AND THE IMPACT OF RELATIONSHIPS ON FARMERS' BEHAVIOR

In the Peanut Basin, farmers may sell millet coming from different sources such as from previous year's production, the current year's production, gifts received from other relatives, the quantity bought for resale at a future date, and the portion of consumption given to women by the household head. Furthermore, farmers may buy millet for different purposes such as for their own consumption, for trade at a later period, for delivery to a private trader and for gifts to their relatives. In addition, farmers may have different behavior when they make transactions with other farmers compared to when they make transactions with other market participants (assemblers, retailers, wholesalers).

This chapter attempts to provide a better understanding of farmers' millet transactions and to discuss few issues that affect farmers' behavior. In particular, the chapter will investigate household involvement in the millet markets and its impact on farmers' behavior, and the role of relationships among farmers in the Peanut Basin.

It has been argued that in developing countries many farmers sell at harvest at low prices and to buy back at higher prices during the hungry season (Couty, 1965; CILSS, 1979; Dioné, 1989). Important reasons that explain farmers' sales behavior at harvest are reimbursement of loans and payment of taxes. In both the 1985/86 and the 1986/87 crop years, Dioné (1989) found that the most important reason for selling

coarse grains in Northern Mali (the OHV zone) was to pay head taxes. Goetz (1990) found that the hypothesis of "forced" sales (i.e., selling at harvest at low prices and buying back at higher prices) was not confirmed in Southeastern Senegal.

The first section of the chapter discusses the degree of market involvement of household heads in the millet market; the second section discusses the percentage of millet production sold in the study regions by household heads and by their dependents; the third section tests the hypothesis of "forced sales" in the study regions; the fourth section analyzes the relationships between peanut seed credit, millet production, millet sales and millet and rice purchases; section five investigates the role of relationships on farmers' millet transactions. The last section summarizes the key findings of the chapter and their policy implications.

5.1 The Degree of Market Involvement in the Study Regions

The degree of market involvement is an important variable that sheds light on the role of markets in shaping the behavior of household heads in the study regions. Markets influence the incentive of farmers to increase their production and to improve their bargaining power for a better price through the variety of outlets they bring about. In that sense markets increase the opportunity set of farmers. Furthermore, competition from other market participants for farmers' millet allows a move to a price closer to the competitive equilibrium price. Two major questions will be answered in this section:

a) What is the net market position of household heads in the Peanut Basin?

b) What is the seasonality of sales and purchases of millet?

5.1.1. The Net Market Position of Household Heads in the Peanut Basin

Household heads in the Peanut Basin were classified using two criteria (Sherman, 1984; Weber et al., 1988; Goetz, 1990): the nature of the transactions they make (do not

trade millet, sell only, buy only, buy and sell), and whether they are net sellers of millet, net buyers, or neither.

Table 5.1 shows that farmers in the Peanut Basin are highly integrated in the millet market in the sense that 89 percent of the sample either sell only, or buy only, or do both, unlike Southeastern Senegal where 40 percent of households are not involved in the coarse grains markets (Goetz, 1990). In both the Central and the Northern Peanut Basin, the majority of household heads (94 percent) were net buyers of millet in the survey year (table 5.2). This was due to the crop failure discussed in chapter 4. In the Southern Peanut Basin, the majority of household heads (83 percent) entered the millet market, either as buyers or sellers. However, only 26 percent of household heads were net sellers and 55 percent were net buyers. According to de Janvry et al. (1991), household heads not involved in the market are those for whom the shadow price of millet falls within the band created by the sale and the purchase price. As a result, those household heads do not trade, which makes the commodity a non-tradable good for them.

For the study regions as a whole, it appears that 74 percent of household heads were net buyers of millet. This has several implications for government policy:

i) As pointed out by Weber et al. (1988), higher millet prices will hurt the majority of household heads in the Peanut Basin in the very short run.

ii) Given that unstable prices depress consumption, designing effective policy to shift consumption patterns to millet becomes necessary in both urban and rural areas if the government objective of encouraging millet consumption is to be achieved.

iii) Technological improvement is necessary to change the net market position of household heads, such that the majority becomes net sellers. As mentioned in

Table 5.1 Millet Transactions Behavior in the Peanut Basin
(October 1986-September 1987).

Study Regions	Buy and Sell	Sell Only	Buy Only	Not in the Market	Total
Northern and Central Peanut Basin	-	-	74	4	79
Southern Peanut Basin	39	14	13	14	80
Total Sample	39	15	87	18	159
Percentage of Total	24.5	9.5	54.7	11.3	100

Source:ISRA/BAME Surveys, 1986/87
Notes:
1. Southern Peanut Basin refers to the Southeast and the Southwest Peanut Basin.

previous sections, this is a prerequisite (among others) to achieving the government objective of encouraging millet consumption in Senegal.

iv) Since the majority of household heads in the Peanut Basin rely on the market, improving its efficiency becomes a necessary condition for increasing the performance of the millet subsector. This will benefit both the net sellers and the net buyers, as lower marketing and transaction costs (information, contracting and enforcement cost) for private traders translate into higher prices for net sellers and lower prices for net buyers, assuming the millet market is competitive.

5.1.2 Sales and Purchases of Millet in the Study Regions

This section describes millet sales and purchases behavior of household heads in the study regions. As tables 5.3 and 5.4 indicate, there is much variability in millet sales and purchases in the study regions, which reflects the heterogeneity among household

Table 5.2 Net Market Position for Household Heads in the Peanut Basin: (October 1986-September 1987).

Study Regions	Net Buyers	Net Sellers	Even	Not in the Market	Total
Central and Northern Peanut Basin	74	1	-	4	79
Southern Peanut Basin	44	21	1	14	80
Total Sample	118	22	1	18	159
Percentage of Total	74.2	13.9	0.6	11.3	100.0

Source:ISRA/BAME Surveys, 1986/87

heads, particularly in the Southwest Peanut Basin. Millet sales were much lower in the Northern and the Central Peanut Basin than in the Southern Peanut Basin. In contrast, millet purchases were more important in the Northern and the Central Peanut Basin. This reflects the lower level of millet production in the Northern and the Central Peanut Basin, which led the majority of household heads to be net buyers of millet (table 5.2). Contrary to previous findings (Waterbury, 1987), tables 5.3 and 5.4 also indicate that the Serer of the Southwest Peanut Basin are more involved in the millet market than the Woloff of the Southeast Peanut Basin. As a result, they behave more like private traders than the Woloff of the Southeast Peanut Basin.

Furthermore, tables 5.5 and 5.6 show that millet purchases occur throughout the year in the Northern and the Central Peanut Basin, and they are almost evenly distributed by season. In the Southern Peanut Basin, household heads sell millet throughout the year, which is consistent with the fact that market prices at the producer

Table 5.3. Millet Sales per Household Head in the Study Regions (October 1986-September 1987).

Study Regions	Sales per Household Head (kg)	Standard Deviation	Valid N
Northern Peanut Basin	-	-	40
Central Peanut Basin	14	87	36
Southeast Peanut Basin	204	444	38
Southwest Peanut Basin	645	2424	40
Sample Average	221	1272	154

Source: ISRA/BAME Surveys, 1986/87.

level can be collected throughout the year. The bulk of millet sales and purchases occur during the first six months after millet is harvested (tables 5.7 and 5.8).

With the exception of millet purchases in the Central Peanut Basin, the transaction data (as indicated by tables 5.5 through table 5.8) are consistent with the fact that millet prices for both sales and purchases are highest in the dry season (January to March), i.e., during the period of the official peanut marketing. These patterns of seasonality are comparable to what Steffen (1992) found for the low and high rainfall areas of Northern Mali: stable market participation in low rainfall areas and more seasonal participation in high rainfall areas.

The analysis thus far has focussed on sales and purchases of millet from various origins and for many purposes, including household heads who behave like traders or who purchase millet on behalf of some private traders. In order to determine the percentage of millet production sold by household heads and to test if the hypothesis of

Table 5.4. Millet Purchases per Household Head in the Study Regions (October 1986-September 1987).

Study Regions	Purchases per Household Head (kg)	Standard Deviation	Valid N
Northern Peanut Basin	562	530	40
Central Peanut Basin	703	432	36
Southeast Peanut Basin	273	509	38
Southwest Peanut Basin	629	1417	40
Sample Average	541	846	154

Source:ISRA/BAME Surveys, 1986/87.

"forced sales" is verified in the study regions, some of these sales transactions must be excluded from the analysis.

5.2. Percentage of Millet Production Sold in the Study Regions

This section analyzes the percentage of millet production sold in the study regions by first considering the behavior of heads of households, and then comparing the behavior of heads of households to that of the dependents.

5.2.1. Percentage of Millet Production Sold by Household Heads

Millet is a subsistence crop, mostly consumed in the household. According to Holtzman (1989), it is likely that 90 percent of millet production is consumed in the household. This would leave 10 percent of millet production to be allocated between monetary transactions such as sales, and non-monetary transactions, dictated by social obligations such as gifts given to other relatives. While it is important to give an

Table 5.5 Annual Millet Transactions by Household Heads in the Northern Peanut Basin.

	Oct-December Harvest Season	Jan-March Dry Season	April-June Hot Season	July-September Wet Season
Millet Purchases per Household Head (kg)	149	120	171	122
Percentage of Total Annual Purchases	26.5	21.3	30.4	21.8
Average Purchase Price (CFA F/kg)	91.6	107.0	104.9	100.1
Net Sales (kg)	-149	-120	-171	-122

Source: ISRA/BAME Surveys, 1986/87.

Notes:

1. Household heads in the Northern Peanut Basin did not report any millet sales.
2. There are 40 household heads in the Northern Peanut Basin.

estimate of the percentage of millet production sold at the aggregate level of the sample, this may overlook important differences in household behavior, so it is a good idea to also provide an estimate of the percentage of millet production sold by categories of households (fully equipped, semi-and non-equipped, and between household heads who received peanut seed credit and those who did not) and to compare the percentage of millet production sold by heads of households with that sold by their dependents. Table 5.9 provides an estimate of the percentage of millet production sold by household heads in the study regions. The following observations can be made:

a) None of the household heads in the Northern and the Central Peanut Basin reported any sales of millet from 1986 production. This is consistent with the low level of production in those regions. As shown in table 5.3, millet sales in the Central Peanut Basin came from millet purchased for trade at a future date. Surprisingly,

Table 5.6. Annual Millet Transactions by Household Heads in the Central Peanut Basin.

	Oct-December Harvest Season	Jan-March Dry Season	April-June Hot Season	July-September Wet Season
Millet Sales per Household Head (kg)	13.0	1.4	-	-
Percentage of Total Annual Sales	90.3	9.7	-	-
Average Sale Price (CFA F/kg)	85.0	115.0	-	-
Millet Purchases per Household Head (kg)	210	133	184	176
Percentage of Total Annual Purchases	29.9	19.0	26.1	25.0
Average Purchase Price (CFA F/kg)	88.7	95.4	102.2	103.4
Net Sales (kg)	-197	-132	-184	-176

Source:ISRA/BAME Surveys, 1986/87.
Note:
The computation is based on 36 household heads.

Josserand (1984) found that in Layabe, located in the Central Peanut Basin, 24 households sold 8.6 percent of their millet production during the first 7 months following the harvest of the 1984 millet production. In another village of the Central Peanut Basin (Thienthie) included in the study carried out by Josserand, there was not any sale of millet from 1984 production. The difference in behavior between our sample from the Central Peanut Basin and that of Josserand may be explained by better millet production

Table 5.7. Annual Millet Transactions by Household Heads in the Southeast Peanut Basin.

	Oct-December Harvest Season	Jan-March Dry Season	April-June Hot Season	July-September Wet Season
Millet Sales per Household Head (kg)	93	22	48	41
Percentage of Total Annual Sales	45.6	10.8	23.5	20.1
Average Sale Price (CFA F/kg)	55.4	74.9	68.5	60.1
Millet Purchases per Household Head (kg)	93	102	31	47
Percentage of Total Annual Purchases	34.1	37.4	11.3	17.2
Average Purchase Price (CFA F/kg)	66	79.2	69	56.3
Net Sales (kg)	0	-80	+17	-6

Source:ISRA/BAME Surveys, 1986/87.
Note:
There are 38 household heads in the Southeast Peanut Basin.

in 1984, compared to 1986, by Josserand's not carefully differentiating between sales from own production and those coming from millet purchased for resale at a future date, or by not differentiating millet sales between the household heads and the dependents.

b) Household heads in the Southern Peanut Basin sold on average 12.6 percent of their millet production.

c) The analysis of variance test did not show any significant difference at 5

Table 5.8. Annual Millet Transactions by Household Heads in the Southwest Peanut Basin.

	Oct-December Harvest Season	Jan-March Dry Season	April-June Hot Season	July-September Wet Season
Millet Sales per Household Head (kg)	312	275	6	53
Percentage of Total Annual Sales	48.3	42.6	0.9	8.2
Average Sales Price (CFA F/kg)	68.4	87	68	64.5
Millet Purchases per Household Head (kg)	291	90	70	178
Percentage of Total Annual Purchases	46.3	14.3	11.1	28.3
Average Purchase Price (CFA F/kg)	67.4	84.4	82.5	69.4
Net Sales (kg)	+21	+185	-64	-125

Source: ISRA/BAME Surveys, 1986/87.
Note:
There are 40 household heads in the Southwest Peanut Basin.

percent in the percentage of millet production sold between household heads in the Southeast and the Southwest Peanut Basin.

d) As discussed in chapter 2, the household heads cannot afford to sell a high percentage of their millet production because of the level of uncertainty in farming, and the fear of loss of power in the household. Indeed if the household head is not capable of feeding his dependents, then it is less likely he will be able to prevent them

Table 5.9. Percentage of Millet Production Sold by Household Heads in the Study Regions (October 1986-September 1987).

Study Regions	Number of HHs growing millet	% of HHs selling from Own Production	Sales as % of production
Northern P. Basin	30	0	0
Central P. Basin	30	0	0
Southeast P.Basin	35	34	15.2
Southwest P. Basin	36	67	11.2
Total Sample	131	51	12.6

Source:ISRA/BAME Surveys, 1986/87.

Table 5.10. Percentage of Millet Production Sold by Equipment Level

Study Regions	Sale per Household Head			Sale as Percentage of Production		
	1	2	3	1	2	3
Southeast Peanut Basin	258	192	N/A	17.5	10.8	N/A
Southwest Peanut Basin	114	55	70	9.9	2.6	20.4
Total Sub-Sample	166	110	70	12.7	5.9	20.4

Source:ISRA/BAME Surveys, 1986/87.

Notes:

1=Fully Equipped. There are 25 household heads in this category.
2=Semi-Equipped. There are 5 household heads in this category.
3=Non-Equipped. There are 5 household heads in this category.

from migrating, especially if they are adults.

Table 5.10 presents the percentage of millet production sold by equipment level. The table seems to indicate that the percentage of millet production sold by household heads is not identical across levels of equipment ownership. However, there was not a significant difference in the percentage of millet production sold by equipment level for the total sub-sample and for each study region. However, there was a significant difference in the percentage of millet production sold for semi-equipped households

between the Southeast and the Southwest Peanut Basin.

Table 5.11. Percentage of Millet Production Sold by Credit Received.

Study Regions	Sale per Household Head (kg)	Total Sales for the Sample (kg)	Sales as % of Production
Southeast P.Basin			
With Credit	234	2805	15.2
Without Credit	N/A	N/A	N/A
Southwest P.Basin			
With Credit	83	1508	9.6
Without Credit	140	840	16.3
Total Sub-sample			
With Credit	143	4313	11.8
Without Credit	140	840	16.3

Source: ISRA/BAME Surveys, 1986/87.

The influence of peanut seed credit on the percentage of millet production sold by household heads was also investigated for the Southeast and the Southwest Peanut Basin. The results are presented in table 5.11. The analysis of variance tests did not show any significant difference at the 5 percent level for the percentage of millet production sold between household heads who received peanut seed credit, and those who did not for each study region and for the total sub-sample.

A multivariate analysis is carried out to assess the importance of the variables that affect the percentage of millet production marketed by household heads as follows:

$$\text{PMILMAR} = \alpha_0 + \alpha_1\text{AEW} + \alpha_2\text{CREDIT} + \alpha_3\text{EQUIP} + \alpha_4\text{ACCES} + \alpha_5\text{ZONE}$$

where PMILMAR is the percentage of millet production marketed by household heads; AEW is the number of adult equivalent workers in the household; CREDIT is a dummy variable, which takes the value of 1 if the household head received peanut seed credit

and 0 otherwise; EQUIP is a dummy variable, which takes a value of 1 if the household head is equipped and 0 otherwise; ACCES is a dummy variable, which takes a value of 1 if the household head is located in the main market village and 0 otherwise; Zone is a dummy variable, which takes a value of 1 if the household head is located in the Southwest Peanut Basin and 0 otherwise. The estimated equation is presented below:

$$\underset{}{PMILMAR} = \underset{(-1.2)}{30.4} - \underset{(1.1)}{1.4}AEW - \underset{(-1.4)}{13.5}CREDIT$$

$$-\underset{(-0.8)}{5.0}EQUIP - \underset{(-1.2)}{8.4}ACCES - \underset{(-1.3)}{8.1}ZONE$$

$R^2 = 0.12$; Adjusted $R^2 = 0.03$; Standard Error of the Regression = 16.3; Number of observations = 36.

The regression has a poor fit as only 12 percent of the variation in the percentage of millet production marketed by the household heads is explained by the independent variables. None of the independent variables is statistically significant, which confirms the results of the analysis of variance test that there is no statistical difference in the percentage of millet production marketed according to the level of equipment and according to peanut seed credit.

5.2.2. Comparison between the Household Heads and the Dependents

As mentioned in chapter 3, it was not possible to study the transactions behavior of the heads of the household and the dependents in all the households considered in the sample due to human constraints. Instead, in each village three or six households were surveyed in depth, depending on whether 10 or 20 households were previously selected. These households were selected at random from the list of households already selected for the study. Only households surveyed in depth in the Southern Peanut Basin are considered in the analysis because of the crop failure in the Northern and the Central

Peanut Basin discussed in chapter 4. Twenty-four households were surveyed in depth in the 6 villages surveyed in the Southern Peanut Basin (6 households in each of the 2 market-villages, and 3 households in each of the 4 other villages). However, only households in which the dependents produced millet are considered in this section in order to compare their behavior with that of the household head. The dependents produced millet in 12 out of the 24 households surveyed in depth in the Southern Peanut Basin. The following questions will be addressed in this section for households studied in depth, where the dependents produced millet:

a) Is there any significant difference in the percentage of millet production sold between the head of the households and the dependents?

b) What is the seasonality of millet sales out of 1986 production for both the household heads and the dependents?

5.2.2.1 Percentage of Millet Production Sold in Households Surveyed in Depth

Table 5.12. Percentage of Millet Production Sold by the Heads of the Households and by the Dependents.

	Mean	Std Dev	Minimum	Maximum
Heads of Households	3.2	3.2	0.3	10.5
Dependents	38.4	24.9	1.9	80.0

Source:ISRA/BAME Surveys, 1986/87.

Table 5.12 shows the percentage of millet production sold for both the heads of households and the dependents. On average heads of households sold 3.2 percent of their millet production, with a minimum of 0.33 percent and a maximum of 10.5 percent. The dependents on average sold 38.4 percent of their millet production, with a minimum

of 1.9 percent and a maximum of 80 percent. There was a significant difference at 5 percent in the percentage of millet production sold between the heads of households and the dependents. For households studied in depth, on average the percentage of millet production sold by the entire household amounted to 14.8 percent. The difference between the percentage of millet production sold by the household heads and the percentage of millet production sold by the dependents has an important implication for the government objective of encouraging millet consumption in Senegal. The dependents are less constrained than the household heads in providing food in the household so that, if price uncertainty in the millet market is reduced, as it is the case in the peanut market, they may be willing to specialize more in millet production.

5.2.2.2 Seasonality of Millet Sales for the Heads of Households and the Dependents

Table 5.13. Seasonality of Millet Sales Between the Heads of Households and the Dependents.

	Marketing Seasons			
	Harvest Oct-Dec.	Dry Season Jan-March	Hot Season April-June	Wet Season July-Sept.
Heads of Households	359	28	0	124
Dependents	393	113	1109	167
Total	752	141	1109	291

Source:ISRA/BAME Surveys, 1986/87.
Households considered are those where the dependents produced millet.

Table 5.13 and figure 2 present the seasonality of millet sales by the heads of households and the dependents for households surveyed in depth, where the dependents produced millet. The table reflects the total quantity of millet sold by all the dependents and by all the heads of households. As the table indicates, millet sales out of production

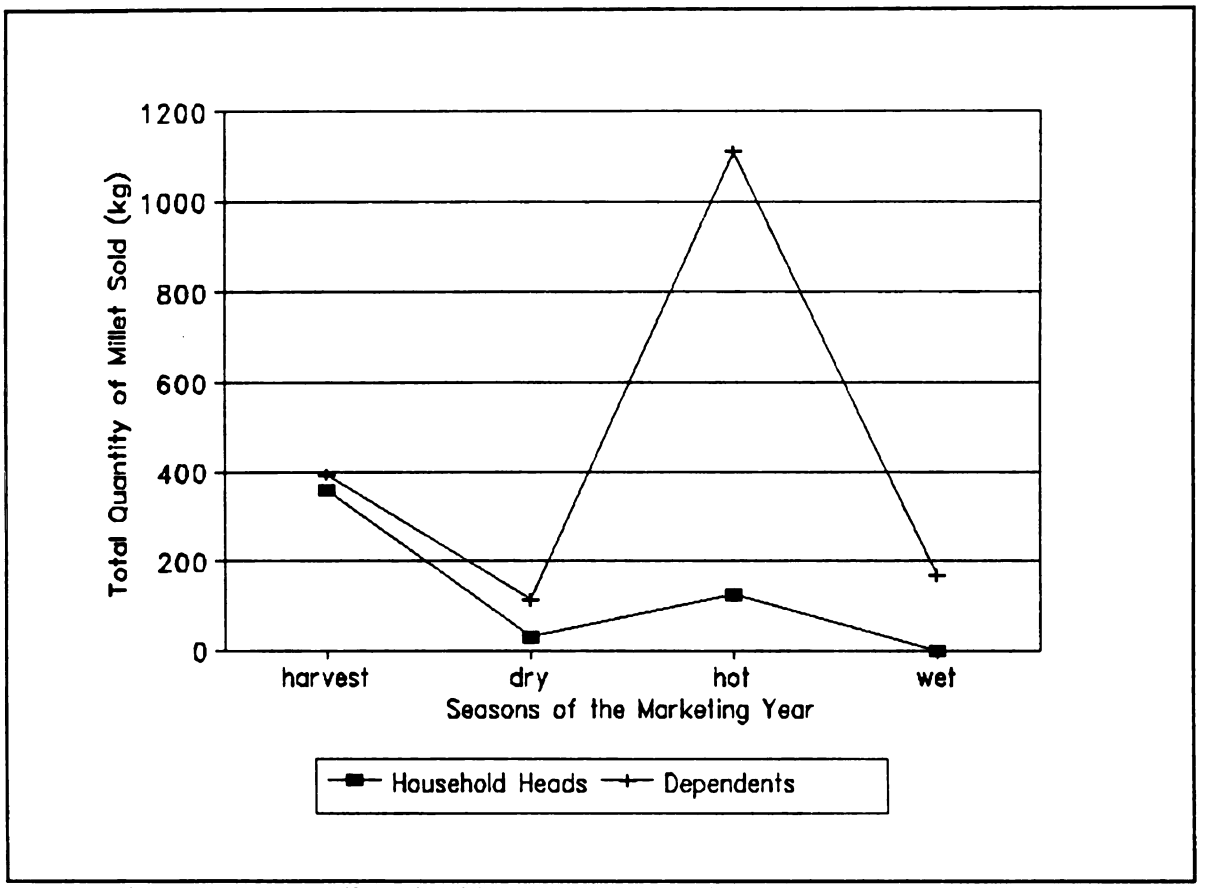

Figure 2. Seasonality of Millet Sales for Heads of Households and Dependents.

for heads of households occur throughout the marketing year, but the quantity sold is more important during the harvest season (October-December). For the dependents, millet sales also occur throughout the marketing year, but the quantity sold is more important in the hot season (April-June). The dependents sold 78 percent of the total quantity of millet marketed in the households surveyed in depth.

The foregoing discussion implies that the dependents obviously stored millet for resale at a future date. Given the percentage of millet production sold reported above, a major question is what happened to the percentage of millet production not sold by the dependents? The current data available cannot provide an answer to this question. However, one can hypothesize that the millet not marketed by the dependents might be

consumed in the households, or stored for future consumption. Another implication of the analysis is that the dependents are treating millet like a commercial (cash) crop, holding it for sale until the price rises. Hence, making millet into a cash crop does not require a major change in "mentality".

5.3. Test of the Hypothesis of "Forced Sale" in the Study Regions

It is often argued that farmers in developing countries are forced to sell their commodities at harvest at a low price because they have pressing needs they must satisfy, and buy back at a much higher price. This section investigates to what extent this hypothesis is valid for household heads in the Southern Peanut Basin. Sales and purchases exclude those engaged in trading, i.e., purchasing for resale at a future date. It appears from the data that 2 households out of 12 (or 17 percent of household heads who sold millet) sell millet at harvest and buy back in the Southeast Peanut Basin, whereas in the Southwest Peanut Basin 19 household heads out of 24 (79 percent of household heads who sold millet) follow that behavior. For that reason, this issue will only be addressed for the Southwest Peanut Basin. There are, however, no obvious reasons why one might expect such behavior to be more prevalent in the Southwest than in the Southeast Peanut Basin.

Household heads in the Southwest Peanut Basin who sell millet at harvest and buy it back can be categorized in three groups (table 5.14). The first group is composed of household heads who sell during the harvest season, and buy back three months later during the dry season. This group represents 16 percent of household heads who sell at harvest and buy back. They are responsible for 15 percent of millet sold at harvest and 97 percent of purchases made during the dry season. The second group is composed of household heads who sell during the harvest season and buy back during the hot season.

Table 5.14. Categorization of Household Heads Selling Millet at Harvest and Buying Back, Selling at Harvest and not Buying Back, and Selling Predominantly Later in the Marketing Year.

	Sell at Harvest and Buy back during Dry Season	Sell at Harvest and Buy back during Hot Season	Sell at Harvest and Buy back during Wet Season	Sell at Harvest and Buy nothing Later	Sell later in the Marketing Year
Number of Household Heads (a)	3	9	16	3	3
Millet Sales per Household Head (kg)	85	36	62	100	270
Millet Purchases per Household Head (kg)	63	123	209		
Net Sales (kg)	+22	-87	-147	+100	+270

Source: ISRA/BAME Surveys, 1986/87.

Note:

(a) The total number of household heads selling at harvest and buying back exceeds 19 because some are included in more than one category.

They represent 47 percent of household heads who sell at harvest and buy back. They are responsible for 26 percent of millet sold at harvest and 89 percent of millet purchased during the hot season. The third group is composed of household heads selling during the harvest season and buying back during the wet season or hungry season. They represent 84 percent of household heads who sell at harvest and buy back. They are responsible for 80 percent of millet sales at harvest and 90 percent of millet purchases during the wet season. The reasons for selling millet at harvest are to travel, to honor traditional ceremonies, to purchase other basic items (food, clothing,

prescription drugs), to save money for unpredictable events and to pay back debts. Thirteen percent of household heads who sold millet in the Southern Peanut Basin sell at harvest and buy nothing back. Thirteen percent of household heads sell millet predominantly later in the marketing year.

5.3.1 Gains or Losses for Household Heads Who Sell at Harvest and Buy it Back

This section investigates whether household heads who sell millet at harvest and buy back gain or lose by following such behavior. This analysis is carried out by considering situations when sales and purchases take place at the market or at the village.

Table 5.15. Gains/Losses for Household Heads Selling at Harvest and Buying Back in the Southwest Peanut Basin (October 1986-September 1987).

	Sell at Harvest and Buy back during the Dry Season		Sell at Harvest and Buy back during the Hot Season		Sell at Harvest and Buy back during the Wet Season	
CFA F	Market	Village	Market	Village	Market	Village
Average sale price at Harvest	70.7	64.5	70.7	64.5	70.7	64.5
Average purchase price*	85	N/A	82.9	N/A	69.3	80
Margin per kg	-14.3		-12.2		+1.4	-15.5

Source:ISRA/BAME Surveys, 1986/87

* The average purchase price refers to the price during the corresponding season.

Table 5.15 reveals that during the survey year the average sale price of millet at harvest was higher at the market than at the village. For transactions that took place at

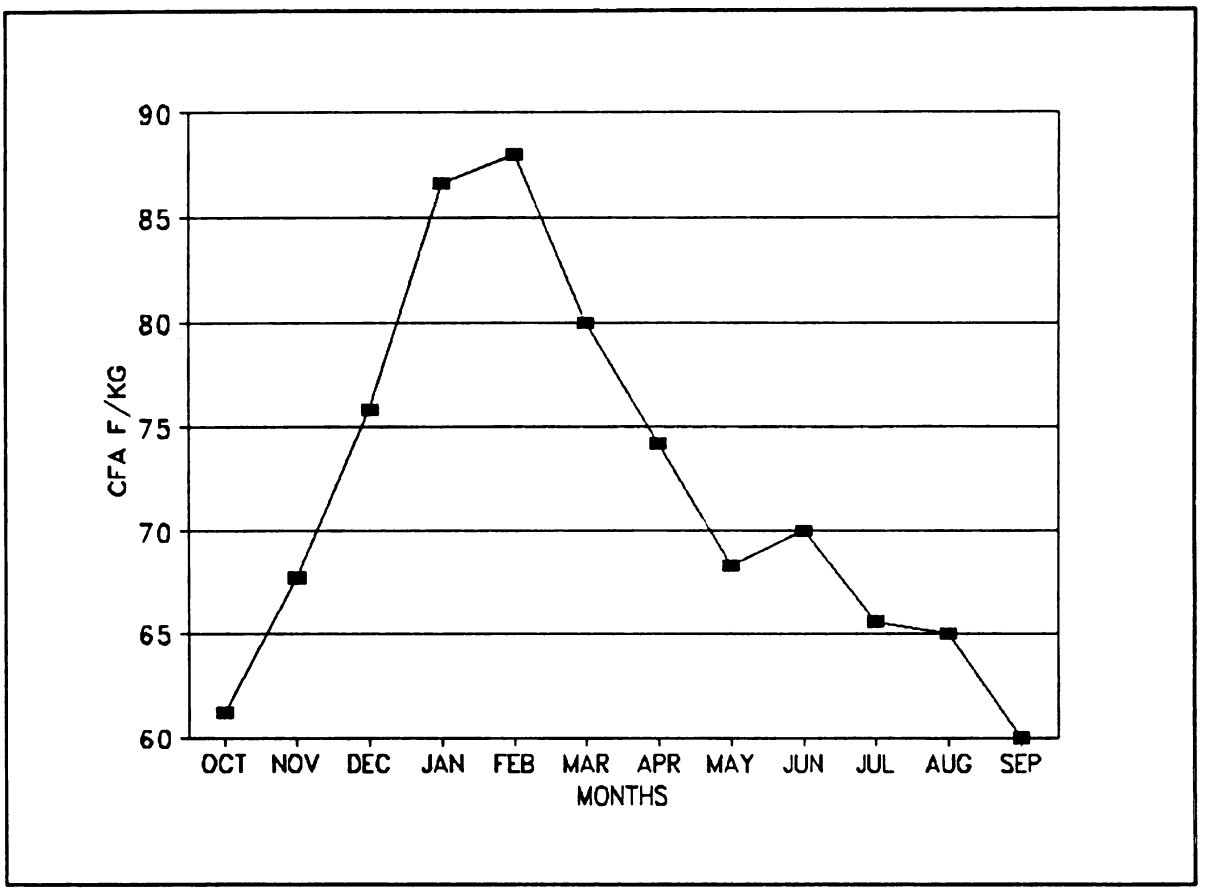

Figure 3. Millet Prices Received by Household Heads in the Southwest Peanut Basin: October 1986-September 1987.

the market, household heads who purchased back during the dry season were in absolute terms worse-off than those purchasing in subsequent seasons. The dry season (January to March) coincides with the official marketing of peanuts, which reduces the quantity of millet supplied by farmers in the market, thereby increasing its price (see figure 3).

In the Southwest Peanut Basin, the existence of household heads who sell at harvest and buy back is verified for transactions carried out at the market during the dry and the hot seasons. Farmers following this behavior in those seasons incurred financial losses of 14 and 12 CFA F per kg respectively during 1986/87. The existence of household heads who sell at harvest and buy back is also verified for transactions carried

out at both the market and at the village during the wet season. Household heads who carried out their transactions at the market were better-off than those who carried out their transactions at the village. The windfall gain of 1.4 CFA F per kg obtained by household heads who bought millet back at the market during the wet season implies that millet prices had fallen in rural markets of the Southwest Peanut basin during the wet season of the 1986/87 marketing year. This is consistent with previous findings by Ouedraogo and Ndoye (1988a, figure 1), who showed millet prices for August and September 1987 to be lower than the floor price (i.e., 70 CFA F/kg). This is also confirmed with the farmer transactions data used in this chapter (see figure 3). Apparently farmers' expectations of a good crop harvest in 1987 may have increased the supply of millet in the market. Data from the BCEAO monthly reports indicate that millet production in 1987 increased by 26 percent compared to 1986. Furthermore, the table indicates that during the 1986-87 marketing year, household heads who were able to hold their millet and sell it at the market during the dry and the hot seasons were better-off, while household heads who purchased during those period were worse off.

One caveat to the analysis presented thus far is that it is based only on one year millet transactions data of household heads in the Southwest Peanut Basin. In order to see if the pattern observed in 1986/87 was typical, there is a need to use multiple-year price data to put the discussion of seasonal pattern of millet sales in 1986/87 in perspective. In the absence of a panel of household heads, the prices observed in the main market for the village triad in the Southwest Peanut Basin are used to investigate the gains and losses resulting from selling millet at harvest and buying it back during the 1985/86, 1987/88 and 1988/89 marketing years. The only difference with the 1986/87 analysis is that the prices reported in 1986/87 were those actually reported by household

heads when they sold or purchased their millet at the market or at the village. The results of the analysis are reported in table 5.16.

It appears that household heads selling at harvest and buying back later in the year lose money in all marketing years except those who sold at harvest and bought back during the hot season of 1985/86. However, the magnitude of the losses varies among the marketing years. This analysis implies that when markets are uncertain and volatile, the behavior of prices may provide losses as well as occasional windfall gains for household heads who sell and buy back.

5.3.2 Characteristics of Household Heads Who Sold Millet at Harvest and Bought it Back during the 1986/87 Marketing Year

This section describes the characteristics of household heads who sold millet at harvest and bought it back during the 1986/87 marketing year. As table 5.17 indicates, household heads who sold millet at harvest and bought it back had lower millet yield per hectare than household heads in the Southwest Peanut Basin who did not sell at harvest and buy back. Their millet yield represents 65 percent of the average yield obtained by household heads who did not sell at harvest and buy back. Furthermore, household heads who sold and bought back had lower millet production per adult equivalent worker (AEW) than household heads in the Southwest Peanut Basin who did not sell at harvest and buy back. The former's millet production per AEW represented 53 percent of the average millet production per AEW obtained by household heads who did not sell at harvest and buy back. Seventy-four percent of household heads who sold at harvest and bought back were equipped, 10 percent were semi-equipped and 16 percent were not equipped. Seventy-nine percent of household heads who sold millet at harvest and bought back received peanut seed credit before the rainy season of 1986; sixty-eight

Table 5.16. Gains/Losses for Household Heads Selling Millet at Harvest and Buying Back in the Southwest Peanut Basin during the 1985/86, 1987/88 and 1988/89 Marketing Years.

	CFA/KG	Sell at Harvest and Buy back during the Dry Season	Sell at Harvest and Buy back during the Hot Season	Sell at Harvest and Buy back during the Wet Season
		Market	Market	Market
1985/86	Sale Price at Harvest	67.5	67.5	67.5
	Purchase Price*	71.5	64.2	75.2
	Margin per kg	-4.0	+3.3	-7.7
1987/88	Sale Price at Harvest	48.3	48.3	48.3
	Purchase Price*	63.3	51.4	62.5
	Margin per kg	-15.0	-3.1	-14.2
1988/89	Sale Price at Harvest	57.5	57.5	57.5
	Purchase Price*	73.3	74.2	78.3
	Margin per kg	-15.8	-16.7	-20.8

Source:ISRA/BAME Price Collection, 1985-89.
* The purchase price refers to the price during the corresponding season.

percent of household heads who sold at harvest and bought back did not have any other activities but farming and 79 percent did not have any formal education (French, Arabic, Woloff using French alphabet, or Woloff using Arabic alphabet). For household heads who did not sell at harvest and bought back, 69 percent were equipped, 25 percent semi-equipped and 6 percent not equipped. Seventy-one percent of household heads who did not sell at harvest and bought back received peanut seed credit before the rainy season of 1986. Fifty-seven percent of household heads who did not sell at harvest and bought back did not have any formal education (French, Arabic, Woloff using French alphabet, or Woloff using Arabic alphabet).

Table 5.17. Characteristics of Household Heads Who Sell Millet at Harvest and Buy it Back.

	Household Heads Selling at Harvest and Buying Back	Household Heads not Selling at Harvest and Buying Back
Millet Yield (kg)	553**	856**
Millet Production per AEW (Kg)	342**	649**
Household Size	12**	9**
Number of AEW	4.92*	3.5*
Fully Equipped (%)	74	69
Semi-Equipped (%)	10	25
Non Equipped (%)	16	6
Received Peanut Seed Credit (%)	79	71
Land Cultivated per Household Head	5.1	4.8
No Formal Education (%)	79	57
No Other Activity But Farming (%)	68	43

Source:ISRA/BAME Surveys, 1986/87.

* Difference between household heads who sell at harvest and buy back and household heads who do not sell at harvest and buy back significant at 5 percent.

** Difference between household heads who sell at harvest and buy back and household heads who do not sell at harvest and buy back significant at 10 percent.

5.3.3. Storage Credit to Help Household Heads Who Sell Millet at Harvest and Buy it Back

The government can enable farmers to store the millet they otherwise would have sold at harvest by giving them financial credit that will be reimbursed (in cash or in kind), for a maximum duration of twelve months, i.e., from one harvest to the next or by fostering the development of a private capital market that would help farmers in that direction. The price that could be used to value the grain could be the average price that prevailed in the Southern Peanut Basin during the previous 5 years, based on the prices collected from the market information system carried out by the Food Security Commissariat. Such a policy would have several merits:

i) it would enable farmers who sell at harvest and buy back to get a lower

interest rate compared to if they were borrowing from the informal market.

ii) it would enable surplus farmers to take advantage of the seasonal price rise.

Each household head who received storage credit would deposit the equivalent amount of grain in a storage facility located in the village and managed by the village head or other designated village members. This would serve as a collateral for the government. Each household head who received storage credit would use a name tag to identify his grain. This implies all the grain would have to be bagged. For the policy to have a better impact, the government should not impose the types of reimbursement (in cash or in kind) farmers have to make. If farmers sell their millet, they would reimburse in cash by adding the official interest rate to the amount of loan received. If they realize they would get a price lower than the loan plus the amount of interest, they would use the quantity deposited as payment. The total quantity of millet that would be reimbursed can be calculated based on the price referred to above plus the official interest rate.

Table 5.18 illustrates the welfare impact of such policy from the household transaction data in the Southwest Peanut Basin. The illustration is based on the following assumptions:

a) The amount of loan the government gives per kg is based on the millet price at harvest time.

b) The sale price is the price that obtains in a later season.

c) Storage losses at the farm are 5 percent per year, following Hays (1975) for his study in Northern Nigeria.

Table 5.18. Welfare Impact of Storage Credit in the Southwest Peanut Basin.

	Hold Millet at Harvest and Sell during the Dry Season		Hold Millet at Harvest and Sell during the Hot Season		Hold Millet at Harvest and Sell during the Wet Season	
	Market	Village	Market	Village	Market	Village
Amount of Loan	70.7	64.5	70.7	64.5	70.7	64.5
Sale Price	85	N/A	82.9	N/A	69.3	80
Gross Margin	14.3	N/A	12.2	N/A	-1.4	15.5
Storage Cost	3.8	3.5	7.2	6.6	10.7	9.8
Net Margin	10.5	N/A	5.0	N/A	-12.1	5.7

Source:ISRA/BAME Surveys, 1986/87.

Notes:

1. Amount of loan refers to the amount of credit the government is giving per kg to farmers to prevent them from selling millet at harvest.
2. The calculation of the storage cost is based on Goetz and Weber (1986) as follows: $C=(R+I)P(H)/12 + D$ (p. 125) where C= monthly cost of storing one kg of millet per month; P(H) is the producer price of millet at harvest which is in this context the amount of government loan per kg; R is the rate of storage losses per year; I is the official rate of interest which is 15 percent per year; D is the amount of depreciation per kg of millet stored per month calculated using the assumptions above.
3. The numbers representing the amount of loan and sale price are taken directly from table 5.15.

d) The household head builds his own storage facility, and it costs him 8,000 CFA F.

e) The life expectancy of the storage facility is 10 years.

f) Household heads can store up to 1,120 kg of millet in the storage facility (Hays, 1975).

g) Depreciation per kg per month = Investment/(Life Expectancy multiplied by Capacity multiplied by Number of months stored) following Goetz and

Weber (1986).

As the table indicates, based on the observed data, such a policy would have resulted in a transfer of income to farmers, if they sold millet at the market during the dry and the hot season, and at the village during the wet season.

5.4. Relationships between Peanut Seed Credit, Labor Availability, Millet Production, Millet Sales, and Rice Purchases

The objective of this section is to investigate the relationships between peanut seed credit, labor availability, millet production, millet sales, and rice purchases by testing the following hypotheses:

a) If a household head receives peanut seed credit, he attracts more labor than a household head not receiving peanut seed credit. The rationale is that the household head provides peanut seed to the dependents to prevent them from migrating to urban areas during the rainy season. But for this to happen, the head of the household must have enough peanut seed at hand.

b) If a household head receives peanut seed credit, he produces more millet than a household head not receiving peanut seed credit. As stated in hypothesis a), if the household head receives peanut seed credit, he attracts additional labor to his fields, since the dependents will owe him a few working days each week.

c) If a household head receives peanut seed credit, he markets more millet (excluding purchases for resale) than a household head not receiving peanut seed credit.

d) However, access to peanut seed credit has an independent offsetting

effect on millet sales. By being able to produce peanuts, farmers have access to an additional source of cash income, which will free them from the need to sell millet for cash.

e) If a household head receives peanut seed credit, he purchases less imported rice than a household head not receiving peanut seed credit.

If these hypotheses are verified, then peanut seed credit will be an important variable in household behavior, and it will contribute to facilitating the substitution of millet for imported rice at the household level.

5.4.1 Relationship between Peanut Seed Credit, Labor Availability, Millet Production and Millet Sales

The formulation of hypotheses a), b), c) and d) above requires using a recursive system of three equations, which can be estimated each by Ordinary Least Squares to capture the effect of peanut seed credit on the availability of labor in the household, millet production and millet sales of the household head according to the following specifications:

$$AEW = \alpha_0 + \alpha_1 CREDIT + \alpha_2 ZONE + \alpha_3 EQUIP + \alpha_4 ACCES + \epsilon_1 \quad (1)$$

$$MILPROD = \beta_0 + \beta_1 AEW + \beta_2 ZONE + \beta_3 EQUIP + \beta_4 ACCES + \epsilon_2 \quad (2)$$

$$QMILMAR = \delta_0 + \delta_1 GROUNDNUTS + \delta_2 POPU + \delta_3 MILPROD + \delta_4 ZONE + \delta_5 CREDIT + \delta_6 EQUIP + \epsilon_3 \quad (3)$$

where AEW is the number of adult equivalent workers in the household; CREDIT is a dummy variable, which takes the value of 1 if the household head received peanut seed credit and 0 otherwise; ZONE is a dummy variable, which takes the value of 1 if the household head is located in the Southwest Peanut Basin and 0 otherwise; EQUIP is a

dummy variable, which takes the value of 1 if the household head is fully equipped and 0 otherwise; ACCES is a dummy variable, which takes the value of 1 if the household head is located in the main market village and 0 otherwise; MILPROD is the quantity of millet produced by the head of the household in kg; QMILMAR is the quantity of millet marketed by the head of household in kg; GROUNDNUTS is the quantity of groundnuts cultivated by the head of the household; POPU is the number of people in the household, which serves as a proxy for household consumption demand; ϵ_1, ϵ_2, ϵ_3 are the error terms for each equation respectively. The estimated equations are presented below:

$$\underset{}{AEW} = \underset{(2.8)}{2.2} + \underset{(1.8)}{1.1}CREDIT + \underset{(0.04)}{0.02}ZONE + \underset{(2.2)}{1.4}EQUIP + \underset{(1.1)}{0.6}ACCES \qquad (4)$$

$R^2 = 0.12$; Adjusted $R^2 = 0.07$; SER = 2.2; Number of observations = 78;

$$\begin{aligned} MILPROD = {} & \underset{(2.7)}{835} + \underset{(4.2)}{216.7}AEW \\ & - \underset{(-1.4)}{327.2}ZONE + \underset{(0.07)}{19.1}EQUIP + \underset{(0.5)}{128.1}ACCES \end{aligned} \qquad (5)$$

$R^2 = 0.25$; Adjusted $R^2 = 0.21$; SER = 934.1; Number of observations = 78;

$$\begin{aligned} QMILMAR = {} & \underset{(0.8)}{105.7} - \underset{(-0.3)}{0.006}GROUNDNUTS + \underset{(2.5)}{16.4}POPU - \underset{(-0.2)}{0.0064}MILPROD \\ & -\underset{(-2.5)}{173}ZONE - \underset{(-0.01)}{1.2}CREDIT - \underset{-0.2}{11.2}EQUIP \end{aligned} \qquad (6)$$

$R^2 = 0.39$; Adjusted $R^2 = 0.25$; SER = 163.6; Number of observations = 36;

From equation 4, it appears that household heads who received peanut seed credit have higher adult equivalent workers than household heads who did not receive peanut seed credit. Furthermore, household heads who are fully equipped attract more

labor in their households than household heads who are not fully equipped. The accessibility to a main market and the zone in which the household head is located do not have significant effects on the availability of labor for the household head.

From equation 5, only the constant term and the adult equivalent worker variable are statistically significant. The significant effect of the adult equivalent worker variable implies that access to peanut seed credit affects millet production indirectly through the labor availability. Everything being equal, a one unit increase in the number of adult equivalent workers in the household raises millet production of the household approximately by 217 kg. That is, the marginal product of a worker is slightly more than his subsistence (consumption) requirements, leaving little left over for non-agricultural workers (e.g., young kids and old people) in the household.

In equation 6, only millet sales from the 1986 production is considered. The main reason is to eliminate millet sales from household heads who behave like traders (i.e, household heads who purchase millet for resale at a later date), or who purchase on behalf of another trader. The results indicate that, everything held constant, household heads located in the Southwest Peanut Basin sold on average 173 kg less millet than household heads located in the Southeast Peanut Basin. The variable POPU (the number of people in the household) is statistically significant, but it has the wrong sign because it is collinear with MILPROD (total millet production). The variables GROUNDNUTS and CREDIT have the expected sign, but they are not statistically significant.

5.4.2 Relationship between Peanut Seed Credit and Rice Purchases

A multivariate analysis is carried out to investigate the effect of peanut seed credit on the quantity of rice purchased by the head of the household according to the

following specification:

$$RICEPUR = \alpha_0 + \alpha_1 AEW + \alpha_2 ZONE + \alpha_3 CREDIT + \alpha_4 EQUIP + \alpha_5 ACCES + \alpha_6 MILPROD$$

where RICEPUR is the quantity of rice purchased by the household head in kg; and the other variables are as defined earlier. The estimated equation is presented below:

$$RICEPUR = \underset{}{85.7} + \underset{(1.2}{6.8} AEW + \underset{(0.6)}{125.0} ZONE + \underset{(2.8)}{14.4} CREDIT + \underset{(0.3)}{22.7} EQUIP + \underset{(0.4)}{106.0} ACCES + \underset{(2.3)}{0.05} MILPROD$$
$$(1.9)$$

$R^2 = 0.30$; Adjusted $R^2 = 0.23$; SER = 169.8; Number of observations = 72;

Only the variables ZONE, ACCES and MIL are statistically significant. The results indicate that other things equal, household heads located in the Southwest Peanut Basin purchase 125 kg more rice than household heads located in the Southeast Peanut Basin. Furthermore, household heads who reside in the village where the main market is located purchase 106 kg more rice than household heads not residing in the village where the main market is located. The results emphasize the importance of market access (lowering transaction costs) in increasing the demand for rice. This supports the idea that rice consumption will grow as villages become more integrated into the national market. The results of the analysis also reveal that as millet production increases, so do rice purchases by the household head. Therefore increasing millet production is associated with an increase in rice purchases.

In summary, peanut seed credit appears to enable the household heads in the Southern Peanut Basin to attract more dependents. More household labor in turn

increases the household heads' millet production. It was found that the marginal product of a worker was slightly more than his subsistence (consumption) requirements. There was no supporting evidence that more millet production (resulting from peanut seed credit and more labor availability) increases millet sales, probably because the variable POPU, which was a proxy for household consumption demand was collinear with the variable MILPROD (total millet production). There was not a significant difference in rice purchases between household heads who received peanut seed credit and those who did not.

5.5. The Impact of Relationships (or Social Closeness) on Household Behavior in the Peanut Basin

By liberalizing the local cereals markets, the government believed farmers would take advantage of the diversified market outlets that the increased competition among market participants would legally open for them. Therefore it becomes important to understand the choice of market outlets for farmers. This issue will shed light on factors that motivate the transaction behavior of farmers.

In a subsistence economy where risk is a major factor, the relationship between the parties matters for the choice of contractual relationships to minimize transaction costs. As a result, farmers may be behaving rationally in entering into relational contracts with other farmers. The answer to this issue will clarify the importance of social closeness, sympathetic relationships, personal obligation, affection and respect in entering the decision of an individual farmer when he trades with another farmer. The implication of this behavior is that farmers' price responsiveness may be lower when social closeness is taken into account than if it does not constrain their behavior. In terms of policy, the major challenge that faces the government is how to enable a larger

proportion of farmers to increase their productivity, and to expand their domain of exchange such that more impersonal contracts are added to their existing personal contracts. Overall, the answer to the above issue will enable policy makers in Senegal to understand the importance of social closeness and its effects on the well-being of farmers.

This section attempts to study the implications of social closeness for farmer behavior in the Peanut Basin. The specific objectives are:

a) to study social closeness and farmer behavior in the Peanut Basin.

b) to do a comparative analysis of the impact of social closeness on different ethnic groups in the Peanut Basin.

c) to discuss the policy implications of the above objectives.

The following hypotheses will be tested with respect to the first two objectives:

i) there is a solidarity among farmers in the sense that when a farmer has an opportunity to sell to another farmer, he charges a lower price compared to what he charges to another alternative outlet. Conversely, when a farmer buys, he gets a better deal if he has an opportunity to buy from another farmer, compared to buying from other market outlets.

ii) the degree of solidarity described above differs by ethnic groups.

iii) the amount of subsidies resulting from the behavior described in hypotheses i) and ii) are lower when the transactions take place at the market than when they take place at the village. One reason that the subsidy may be lower in market sales is that the farmers one feels closest to live in the same village. Therefore, if a farmer sells to his closest friends, those transactions will likely occur in the village. A farmer may

also sell in the market to other farmers from a neighboring village. But because the seller does not feel as close to them, he or she offers them a smaller subsidy.

The first sub-section discusses some empirical results of social closeness and farmer behavior in the Peanut Basin, and the second sub-section discusses some implications for policy.

5.5.1. Social Closeness and Farmer Behavior in the Peanut Basin

Social closeness or solidarity among farmers can shed light on the choice of contractual relationship between a seller and a buyer of a commodity, in accordance with the prediction of transaction cost economics analysis. In Senegal, risk and uncertainty have a strong impact on agriculture. As a result, farmers have developed rules of engaging in contracts with each other, based on the self-enforcement mechanism characteristics of traditional societies and the particular relationships that prevail among individuals. In this section, we will attempt to test the implications of social closeness in the Peanut Basin when millet is traded at the village and at the market between a farmer and other market outlets including other farmers with whom he is socially close.

5.5.1.1. Millet Sales at the Village

This section concentrates only on millet sales at the village level since the sales data from the surveys do not contain any sales made by farmers to other farmers at the market, which will not allow us to assess the impact of social closeness when millet is sold at the market. This means we will not be able to test hypothesis iii) for sales, although we can test it for purchases. Furthermore, the data on millet sales among farmers at the village is available only for the Woloff ethnic group, and not for the Serer, which implies that the results reported for millet sales at the village will only concern the

Woloff.

Table 5.19. Market Outlets for Woloff Farmers Selling Millet at the Village.

Market Outlets	Average Price (CFA F per kg)
Village trader/Shop Owner	51.1
Wholesaler	74.6
Small Assembler	54.5
Another Farmer	37.0

Source: ISRA/BAME Surveys, 1986/87.

Table 5.19 summarizes the price behavior of a Woloff farmer when he sells millet at the village. It appears that when a Woloff farmer sells millet at the village, he charges the lowest price when he sells to another farmer, compared to when he sells to other market outlets. From the cross tabulation, we cannot tell definitively whether the price differentials shown in table 5.19 are due to social closeness or to other intervening variables like seasonality. In order to sort this question out, a multivariate analysis is carried out, using Ordinary Least Squares (OLS), where price is a function of social closeness, quantity, origin of the commodity and the seasons in which sales occur, according to the following specification:

$$\begin{aligned} SPRICE = {} & \alpha_0 + \alpha_1 S + \alpha_2 Q + \alpha_3 ORIG \\ & + \alpha_4 SEASON_1 + \alpha_5 SEASON_2 + \alpha_6 SEASON_3 + \epsilon \end{aligned} \qquad (7)$$

where SPRICE is the sales price of millet at the village in CFA Francs per kg; S is a social closeness variable which takes a value of 1 when the farmer sells to another farmer and 0 otherwise; Q is the quantity of millet sold by the farmer in kg; ORIG is the origin of the millet sold, and takes a value of 1 when millet sold comes from production and 0 otherwise; $SEASON_1$, $SEASON_2$, $SEASON_3$ are seasonal dummy variables for the

harvest season (October-December), the dry season (January-March), and the hot season (April-June); α_0, α_1, α_2, α_3, α_4, α_5, α_6 are the parameters to be estimated; ϵ is the error term. The estimated equation is presented below:

$$\underset{}{SPRICE} = \underset{(4.9)}{78.4} - \underset{(-1.8)}{15.8S} - \underset{(-0.7)}{0.07\,Q} - \underset{(-0.7)}{12.9\,ORIG}$$
$$- \underset{(-1.5)}{14.7SEASON_1} - \underset{(-0.2)}{3.3SEASON_2} - \underset{(-0.9)}{15.3SEASON_3}$$

R^2 =.50; Adjusted R^2 =.29; SER (Standard error of the regression)= 13.6; Number of sales analyzed = 21.

The numbers in parentheses are the t-statistics, which are statistically significant only for the social closeness variable (significant at 10 percent) and the constant term (significant at 5 percent). All the parameters have the expected signs. The sign of the parameter associated with the social closeness variable is negative, meaning that if a Woloff farmer sells millet at the village to another farmer, he will on average provide a subsidy equals to 15.8 CFA Francs for each kg sold. The non-significance of the quantity variable implies that the quantity of millet sold does not influence the price the farmer charges when sales take place at the village. The non-significance of the variable related to origin seems to imply that there is no evidence that the price level varies depending on whether the grain came from the farmer's own field or whether he bought it from someone else. This result is consistent with the hypothesis of a competitive market. Furthermore, the non-significance of the seasonal dummies imply that the harvest, the dry and the hot seasons do not influence the price that the farmer charges compared to the wet season. However, this interpretation has to be considered with caution given the small number of observations.

5.5.1.2. Millet Purchases

This section attempts to test social closeness when the farmer buys millet from another farmer, compared to buying from other alternative outlets. A distinction is made between millet purchases at the village and at the market.

5.5.1.2.1. Millet Purchases at the Village

Table 5.20 presents the prices a farmer faces when he buys millet from another

Table 5.20. Millet Purchase Prices at the Village and at the Market by Farmers (CFA Francs per kg).

Market Outlets	Prices at the Village	Prices at the Market
Village trader/Shop Owner	98.4	96.7
Wholesaler	83.0	88.1
Small Assembler	83.3	86.6
Another Farmer	71.7	80.0

Source: ISRA/BAME Surveys, 1986/87.

farmer, compared to buying from an alternative market outlet. It appears that social closeness is prevalent when the farmer buys millet from different market outlets. When a farmer buys millet from another farmer, he pays a lower price per kg compared to the price he pays from another market outlet. From the cross tabulation, we cannot tell definitively whether the price differentials shown in table 5.20 are due to social closeness or to other intervening variables like seasonality. In order to sort this question out, a regression analysis is carried out using OLS. The following equation is specified:

$$MPPRICE = \beta_0 + \beta_1 S + \beta_2 Q + \beta_3 SEASON_1 + \beta_4 SEASON_2 + \beta_5 SEASON_3 + \epsilon \quad (8)$$

where MPPRICE is the purchase price of millet at the village in CFA F per kg; Q is the quantity of millet purchased in kg; $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5$ are the parameters to be estimated;

ϵ is the error term; S is a social closeness variable which takes a value of 1 when the farmer purchases millet from another farmer and 0 otherwise; $SEASON_1$, $SEASON_2$, $SEASON_3$ are seasonal dummy variables for the harvest season (October-December), the dry season (January-March), and the hot season (April-June). The estimated equation is presented below:

$$MPPRICE = \underset{(45.8)}{98.9} - \underset{(-8.2)}{30.4S} - \underset{(-1.1)}{0.02Q} - \underset{(-0.1)}{0.5SEASON_1} + \underset{(2.8)}{13.1SEASON_2} + \underset{(1.6)}{4.8SEASON_3}$$

R^2 =.22; Adjusted R^2 =.21; SER = 23.8; Number of purchases analyzed = 350

The t-statistics (in parentheses) are significant at the 5 percent level with the exception of the quantity variable and the seasonal dummies for the harvest and the hot seasons. The results imply that at the village, if the farmer has an opportunity to buy millet from another farmer, he will be able to get on average a subsidy of 30 CFA Francs for each kg bought. Here also, the quantity purchased does not influence the price when transactions take place at the village. Furthermore, the harvest and the hot seasons do not influence the price charged compared to the wet season. The dry season price is significantly higher compared to the wet season price when transactions take place at the village.

5.5.1.2.2 Millet Purchases at the Market

From table 5.20, it appears that if the farmer buys millet from another farmer at the market, he pays a lower price compared to what he pays from another market outlet. However, the farmer pays on average a higher price when he purchases millet at the market, compared to purchasing it at the village. This may be because, as explained earlier, farmers feel socially closer to those who live in their own villages. The average subsidy the farmer receives when he buys millet in the market is estimated by a multiple

regression, where the purchase price is a function of social closeness and quantity purchased, using the following specification:

$$\begin{aligned} MMPPRICE &= \delta_0 + \delta_1 S + \delta_2 Q \\ &\quad + \delta_3 SEASON_1 + \delta_4 SEASON_2 + \delta_5 SEASON_3 + \epsilon \end{aligned} \tag{9}$$

where MMPPRICE is the purchase price of millet at the market in CFA Francs per kg; S is a social closeness variable defined as above; Q is the quantity of millet purchased in kg; $\delta_0, \delta_1, \delta_2, \delta_3, \delta_4, \delta_5$ are the parameters to be estimated; ϵ is the error term; $SEASON_1$, $SEASON_2$, $SEASON_3$ are seasonal dummies for the harvest season (October-November), the dry season (January-March), and the hot season (April-June). The estimated equation is presented below:

$$\underset{}{MMPPRICE} = \underset{(54.0)}{81.7} - \underset{(-1.9)}{5.2S} - \underset{(-2.4)}{0.01Q} + \underset{(2.1)}{4.3SEASON_1} + \underset{(8.6)}{17.8SEASON_2} + \underset{(6.6)}{13.5SEASON_3}$$

R^2 =.17; Adjusted R^2 =.16; SER = 17.2; Number of purchases analyzed = 611

The t-statistics (in parentheses) are all significant at the 5 percent level. The results of the regression imply that if the farmer has an opportunity to buy millet from another farmer at the market, he will only get an average subsidy of 5 CFA Francs per kg compared to 30 CFA Francs per kg when purchases take place at the village. Contrary to the previous regressions, the quantity purchased influences statistically the price paid by the farmer. The impact of quantity on price, however, is small. Those buying 100 kg of grain get a 1 CFA F/kg discount compared to those buying a single kg. Furthermore, the harvest, the dry and the hot season are all significantly higher than the wet season price for transactions that take place at the market.

5.5.1.3. Difference in the Amount of Subsidy by Ethnic Groups

As mentioned in chapter 3, the survey zone is characterized by the dominance of two ethnic groups: the Woloff and the Serer, which are the most important ethnic groups in Senegal. Traditionally, the Woloff have been more integrated in the peanut markets than the Serer. This section performs a comparative analysis of the difference in the amounts of price concessions or subsidies between the Woloff and the Serer, when farmers have the possibility of purchasing millet from other farmers.

5.5.1.3.1. Millet Purchases at the Village

Two regressions are run for both the Woloff and the Serer to capture the difference in social closeness when farmers from both ethnic groups have the possibility of purchasing millet at the village from different market outlets. As was done previously, the purchase price of millet is hypothesized to be a function of social closeness, the quantity purchased, and the seasonal dummies for the harvest, the dry and the hot seasons. The results of the regressions are summarized below:

For the Serer,

$$\underset{}{PRIMV} = \underset{(7.5)}{80.0} - \underset{(-4.8)}{54.8}S - \underset{(-0.08)}{0.002}\,Q + \underset{(2.6)}{40.0}SEASON_1 + \underset{(3.2)}{57.9}SEASON_2$$

R^2 = 0.56; Adjusted R^2 = 0.48; SER = 15.1; Number of purchases analyzed = 25;

For the Woloff,

$$\underset{}{PRIMV} = \underset{(43.0)}{99.7} - \underset{(-7.4)}{30.0}S - \underset{(-1.4)}{0.03}Q - \underset{(-0.1)}{0.5}SEASON_1 + \underset{(2.4)}{11.6}SEASON_2 + \underset{(1.5)}{4.6}SEASON_3$$

R^2 = 0.19; Adjusted R^2 = 0.17; SER = 24.3; Number of purchases analyzed = 325.

PRIMV is the purchase price of millet at the village in CFA F per kg; S, Q, $SEASON_1$, $SEASON_2$, $SEASON_3$ are defined same as above.

The t-statistics (in parentheses) from the Serer equation are significant at the 5 percent level except the parameter associated with the quantity variable. The parameter associated with social closeness is negative, which indicates the existence of relationships among the Serer. The purchase price of millet is higher in the harvest and the dry seasons relative to the wet season. The hot season dummy variable ($SEASON_3$) does not appear in the equation because there were no transactions among Serer farmers during that season.

In the Woloff equation, the t-statistics are significant at the 5 percent level except the parameters associated with the quantity variable and the seasonal dummies for the harvest and the hot seasons. The parameter associated with social closeness is negative, which also indicates the existence of relationships among the Woloff. In order to test whether the degree of social closeness is statistically different between the Serer and the Woloff when transactions take place at the village, a Chow test is used. The procedure is to run a pooled regression using all the data available for both the Serer and the Woloff to compare with the two separate regressions for the Serer and the Woloff. An F-test is used to test the null hypothesis that the parameters in both the Serer and the Woloff equations are the same. The F-test is distributed F (r, N-2k), where r is the number of parameter restrictions applied to the pooled regression, including the constant term; k is the number of variables in the individual regressions, including the intercept; N is the number of observations from the pooled regression (i.e., the number of observations for the Serer plus the number of observations for the Woloff). The F-test can be expressed as follows:

$$\frac{\frac{(SSE_R - SSE_1 - SSE_2)}{r}}{\frac{(SSE_1 + SSE_2)}{(N - 2k)}}$$

where SSE_R is the restricted residual sum of squares from the pooled regression; SSE_1 , SSE_2 are the unrestricted residual sum of squares from the Serer and the Woloff regressions. Numerically, $SSE_r = 194552.2$; $SSE_1 = 4548.7$; $SSE_2 = 187643.9$; $r = k = 6$; $N = 350$. Since $F_{calculated} = 0.69 < F_{.05}(6,338) = 2.1$, we fail to reject the null hypothesis and conclude that social closeness has a similar effect on price for the Woloff and for the Serer when millet purchases are carried out at the village.

A comparison between Woloff sellers and Serer buyers at the village reveals that Woloff sellers provide an average subsidy of 16.5 CFA Francs per kg when they sell to another farmer, whereas Serer buyers get an average subsidy of 55 CFA Francs per kg when they purchase from another farmer. Unfortunately, a comparison cannot be made between Woloff buyers and Serer sellers because of the data limitation discussed in section 5.5.1.1.

5.5.1.3.2. Millet Purchases at the Market

The results from the two regressions when farmers buy millet at the market are summarized below:

For the Serer,

$$\underset{}{MPM} = \underset{(50.5)}{70.1} - \underset{(-1.1)}{4.2S} - \underset{(-0.01)}{0.00005Q} - \underset{(-0.3)}{0.7SEASON_1} + \underset{(4.2)}{15.7SEASON_2} + \underset{(6.0)}{12.3SEASON_3}$$

$R^2 = 0.26$; Adjusted $R^2 = 0.24$; SER = 11.5; Number of purchases analyzed = 187.

For the Woloff,

$$\underset{}{MPM} = \underset{(44.0)}{93.7} - \underset{(-1.8)}{5.1S} - \underset{(-1.1)}{0.013Q} - \underset{(-1.1)}{2.9SEASON_1} + \underset{(2.7)}{6.7SEASON_2} + \underset{(3.3)}{8.8SEASON_3}$$

R^2 = 0.10; Adjusted R^2 = 0.09; SER = 16.3; Number of purchases analyzed = 424.

MPM is the purchase price of millet at the market in CFA F per kg; S, Q, $SEASON_1$, $SEASON_2$, $SEASON_3$ are defined same as before.

The t-statistics (in parentheses) in the Serer equation are significant at the 5 percent level with the exception of the quantity variable, the social closeness variable and the seasonal dummy associated with the harvest season. For the Woloff equation, the parameter associated with social closeness is significant at 10 percent, while the seasonal dummies associated with the dry and the hot seasons are significant at 5 percent. The parameters associated with the quantity variable and the dummy variable for the harvest season are not statistically significant. A Chow test is used to investigate whether the degree of social closeness is statistically different between the Serer and the Woloff when purchases take place at the market, using the same notation as before. Numerically, SSE_r = 176371.7; SSE_1 = 24085; SSE_2 = 108527.9; r= 6; k= 6; N= 610. Since $F_{calculated}$ = 32.9 is greater than $F_{.05}$ (6,598) = 2.1, we reject the null hypothesis and conclude that social closeness has stronger effect on price for the Woloff than for the Serer when millet purchases take place at the market.

5.5.1.4. Seasonality of Purchases and Social Closeness

Thus far it has been found that farmers who purchase millet get a better deal when they trade with other farmers, compared with purchasing from other market outlets. Furthermore, the analysis has shown that the seasons have an impact on the

price paid by the farmer. This section investigates how the price concession or subsidy due to social closeness among farmers fluctuates by season in the Peanut Basin. The analysis will be carried out from the perspective of the buyer, for purchases at the village and those at the market.

5.5.1.4.1. Seasonality of Price Concession for Millet Purchases at the Village

Table 5.21 presents the results from the tabular analysis when purchases take place at the village. It appears that when the farmer buys millet at the village from different market outlets, for each season, he always gets a lower price when he purchases from another farmer compared to buying from another market outlet. In order to

Table 5.21. Millet Purchase Prices by Farmers at the Village and by Season (CFA Francs per kg).

Market Outlets	Harvest Season (Oct-Dec)	Dry Season (Jan-March)	Hot Season (April-June)	Hungry Season (July-Sept)
1. Village Trader/Shop Owner	92.5	95.0	102.9	96.0
2. Wholesaler	N/A	100.0	100.0	71.7
3. Small Assembler	77.0	100.6	87.2	60.0
4. Another Farmer	67.7	86.1	80.8	47.5

Source: ISRA/BAME Surveys, 1986/87.

quantify the average level of subsidy implied by social closeness among farmers, a regression analysis is done for each season. The estimated equations are presented below:

$$\underset{}{MPHV} = \underset{(27.2)}{86.7} - \underset{(-4.6)}{17.5S} - \underset{(-0.97)}{0.014Q} \quad \textbf{(10)}$$

R^2 = 0.32; Adjusted R^2 = .28; SER = 13.7; Number of purchases analyzed = 56

$$\underset{}{MPDV} = \underset{(33.8)}{99.4} - \underset{(-3.4)}{12.0S} - \underset{(-0.79)}{0.011Q} \quad \textbf{(11)}$$

R^2 = 0.26; Adjusted R^2 = .22; SER = 10.8; Number of purchases analyzed = 43

$$\underset{}{MPHOTV} = \underset{(41.3)}{102.05} - \underset{(-2.4)}{19.5S} - \underset{(-0.71)}{0.02Q} \quad \textbf{(12)}$$

R^2 = 0.062; Adjusted R^2 = .043; SER = 19.3; Number of purchases analyzed = 107

$$\underset{}{MPHUV} = \underset{(33.7)}{103.8} - \underset{(-7.2)}{52.0S} - \underset{(-2.6)}{0.11Q} \quad \textbf{(13)}$$

R^2 = 0.29; Adjusted R^2 = .28; SER = 25.5; Number of purchases analyzed = 144

where MPHV is the purchase price of millet in CFA Francs per kg at the village during the harvest season; MPDV is the purchase price of millet in CFA Francs per kg during the dry season; MPHOTV is the purchase price of millet in CFA Francs per kg during the hot season; MPHUV is the purchase price of millet in CFA Francs per kg during the wet season (or hungry season).

The t-statistics (in parentheses) are significant at the 5 percent level for the variable associated with social closeness, but quantity of millet purchased is statistically significant only during the hungry season. A Chow test is used to investigate whether the degree of social closeness is statistically different from one season to the other. The expression of the F statistics is as follows:

$$\frac{\dfrac{(SSE_R - SSE_1 - SSE_2 - SSE_3 - SSE_4)}{r}}{\dfrac{(SSE_1 + SSE_2 + SSE_3 + SSE_4)}{(N - 4k)}}$$

where SSE_R is the restricted residual sum of squares from the pooled regression; SSE_1, SSE_2, SSE_3, SSE_4 are the unrestricted residual sum of squares from the separate regressions for each season; k is the number of variables in the individual regressions, including the intercept; r is the number of parameter restrictions applied the pooled regression (i.e., 3k); N is the number of observations in the pooled regression. Numerically, $SSE_r = 163367.9$; $SSE_1 = 9112.7$; $SSE_2 = 4668.6$; $SSE_3 = 37468.9$; $SSE_4 = 89078.2$; $k=3$; $r= 9$; $N=350$. Since $F_{calculated} = 6.2 > F_{.05}(9,338) = 1.88$, we reject the null hypothesis and conclude that the parameters on social closeness are statistically different from one another.

The results of the analysis indicate that at the village level, if the farmer has an opportunity to buy millet from another farmer, he will always obtain a price concession in each season, which is maximum during the hungry season. This implies social closeness among farmers is most prevalent during the hungry season. The hungry season corresponds to the period where millet is badly needed for home consumption, and yet it is the period where cash to buy it is low. The amount of subsidy the farmer receives is lower during the dry season compared to the other seasons, probably because it corresponds to the official marketing of peanuts, which influences the reservation price of the farmers.

5.5.1.4.2. Seasonality of Price Concession for Millet Purchases at the Market.

This section investigates the change in the price concession by season, when millet is traded at the market. The results of the tabular analysis are presented in table 5.22. In order to determine the average amount of subsidy the farmer gets when he purchases millet at the market, a regression equation is run for each season. The results are presented below:

$$\underset{}{MPHM} = \underset{(66.0)}{85.9} - \underset{(-2.6)}{7.3S} - \underset{(-1.9)}{0.011Q} \qquad \textbf{(14)}$$

R^2 = 0.089; Adjusted R^2 = 0.079; SER = 13.8; Number of purchases analyzed = 173

$$\underset{}{MPDM} = \underset{(70.7)}{99.99} - \underset{(-2.06)}{8.9S} - \underset{(-1.6)}{0.02Q} \qquad \textbf{(15)}$$

R^2 = 0.067; Adjusted R^2 = 0.054; SER = 13.04; Number of purchases analyzed = 143

$$\underset{}{MPHOTM} = \underset{(75.2)}{93.7} + \underset{(0.3)}{1.8S} + \underset{(0.9)}{0.01Q} \qquad \textbf{(16)}$$

R^2 = 0.007; Adjusted R^2 = -0.007; SER = 12.2; Number of purchases analyzed = 151

$$\underset{}{MPHUM} = \underset{(35.2)}{84.7} - \underset{(-0.5)}{10.2S} - \underset{(-2.06)}{0.04Q} \qquad \textbf{(17)}$$

R^2 = 0.032; Adjusted R^2 = 0.018; SER = 20.2; Number of purchases analyzed = 144

where MPHM is the purchase price of millet at the market during the harvest season in CFA Francs per kg; MPDM is the purchase price of millet during the dry season; MPHOTM is the purchase price of millet during the hot season, and MPHUM is the purchase price of millet during the hungry season.

Table 5.22. Millet Purchase Prices at the Market by Farmers by Season (CFA Francs per kg).

Market Outlets	Harvest Season (Oct-Dec)	Dry Season (Jan-March)	Hot Season (April-June)	Hungry Season (July-Sept)
1. Village trader/Shop Owner	90.4	101.4	100.6	92.5
2. Wholesaler	95.0	82.5	95.5	86.2
3. Small Assembler	81.4	97.7	91.6	64.4
4. Another Farmer	75.5	87.5	96.0	70.0

Source:ISRA/BAME Surveys, 1986/87.

The t-statistics are in parentheses. The results in general appear to be less striking than the analysis by season when transactions are carried out at the village. The parameter associated with social closeness is statistically significant at the 5 percent level only for the harvest and the dry seasons, and the parameter associated with the quantity variable is statistically significant only for the harvest and the hungry seasons. Compared with the previous results on seasonality when transactions take place at the village, it appears that farmers get a lower subsidy when they purchase at the market compared to when they purchase at the village, for reasons discussed earlier. A Chow test is used to investigate whether the degree of social closeness is statistically different from one season to the other when purchases take place at the market, using the same notation as before. Numerically, $SSE_r = 162515.9$; $SSE_1 = 31784.6$; $SSE_2 = 23625$; $SSE_3 = 22015.2$; $SSE_4 = 55922.6$; $k=3$; $r=9$; $N=611$. Since $F_{calculated} = 14.5 > F_{.05}(9,599) = 1.88$, we reject the null hypothesis and conclude that the parameters on social closeness are statistically different from one another.

5.5.2. Implications of Social Closeness for Farmer Behavior in the Peanut Basin

The analysis of social closeness in the Peanut Basin seems to reveal that the behavior of farmers who trade among themselves is affected by a social contract. As predicted by Robison and Schmid (1991), moral obligation, affection or respect also influence the reservation prices of farmers in the Peanut Basin. This implies that understanding these non-price factors is important to assess the limits of traditional neoclassical economics in situations where exchanges are personalized. The implication is that one has to be careful in analyzing elasticities of marketed surpluses (sales) when farmers have different market outlets, and if social closeness guides transactions among farmers. Not carefully sorting out these relationships will imply having elasticities without relevant economic meaning.

When farmers are producing the same crops, social closeness may be viewed as a risk-sharing mechanism to reduce transaction costs. Since explicit insurance markets do not exist in the Peanut Basin, farmers provide implicit insurance contracts through social closeness. The analysis of social closeness seems to suggest that a traditional "safety net" is already in place in rural areas. The introduction of continuous food aid might weaken the traditional mechanisms in the sense that farmers may no longer feel the moral obligation to provide price concessions to the ones they feel close to, assuming implicitly that every farmer in the village can receive food aid. In this situation, farmers may be inclined to charge a price higher than they otherwise would have in the absence of the food aid. However, the introduction of cereal banks may not weaken the traditional mechanisms already in place if farmers are willing to discriminate between farmers from their own village and farmers from neighboring villages. That is, farmers from the same village may be charged lower prices if they want to purchase from the cereal bank

compared to farmers from neighboring villages. Furthermore, the cereal banks will serve their purpose better if farmers from the village can obtain short-term credit to be reimbursed at harvest[7].

The evidence of farmer solidarity implies that the cooperatives have a better chance to succeed if they are initiated by farmers themselves, and if their boundaries are circumscribed at the village, where the solidarity among farmers is most prevalent. The failure of the former cooperatives (which were imposed on farmers) to perform the tasks the government expected of them was probably caused by the neglect of the socio-cultural identity of farmers. In fact, farmers from different villages and with different backgrounds were assigned to the same cooperative, which made it difficult to foster trust among members and to combat opportunistic behavior. The consequence was a massive debt forgiveness and the elimination of the agricultural credit program. As discussed in chapter 4, the confectionery peanut credit program is successful mainly because it is managed at the village level, where the solidarity among farmers is greater.

5.6. Chapter Summary and Policy Implications

Household heads in the study regions are highly integrated in the millet market in the sense that 89 percent of the sample either sold, bought, or did both during 1986/87. In both the Central and the Northern Peanut Basin, 94 percent of household heads were net buyers of millet during the survey year. In the Southern Peanut Basin, 83 percent of household heads entered the market either as buyers or sellers, but only 26 percent of household heads were net sellers and 55 percent were net buyers. For the study regions as a whole, 74 percent of household heads were net buyers of millet. The

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[7] The economics of cereals banks has been the subject of a lot of debate. For a recent paper on this topic, see Elliot Berg and Lawrence Kent (1991). "The Economics of Cereal Banks in the Sahel." Bethesda, MD: D.A.I., March.

analysis of the seasonality of millet sales and purchases reveals a stable market participation in low rainfall areas of the Central and the Northern Peanut Basin and a more seasonal participation in higher rainfall areas of the Southern Peanut Basin.

There was not a significant difference in the percentage of millet production sold according to equipment ownership, or whether or not peanut seed credit was received. The lack of statistical difference for the percentage of millet production sold according to the peanut seed credit received implies that the peanut seed credit received by household heads did not change the percentage of millet production they sold compared to household heads who did not receive peanut seed credit. Unfortunately, the data collected do not allow us to investigate whether the quantity of peanut seed credit received was important. The only data available is in a yes/no form.

The households studied in depth sold on average 15 percent of their millet production. For these households, the percentage of millet production sold by the dependents was much higher than the percentage of millet production sold by the heads of household. This has important implications for the government objective of encouraging millet production for consumption in Senegal. Under current farming conditions and the level of agricultural technology, targeting the dependents to specialize in millet production will likely increase the total quantity of millet marketed in the Peanut Basin. The dependents are treating millet already like a commercial (cash) crop, holding it for sale until the price rises. Therefore making millet into a cash crop does not require a major change in "mentality". Both the heads of households and the dependents sold millet throughout the marketing year, but sales were more important at harvest (October-December) for heads of households and more important in the hot season (April-June) for the dependents. The dependents sold 78 percent of the total

quantity of millet marketed in households surveyed in depth.

The extent to which household heads sell millet at harvest and buy back was investigated in the Southwest Peanut Basin. The results indicated that household heads who sold at harvest and bought back later in the marketing year incurred financial losses if they carried out their transactions at the market during the dry and the hot season, and at the village during the wet season. The analysis of the sales of millet at harvest and purchases later in the season implies that when markets are uncertain and volatile, the behavior of prices may provide losses as well as occasional windfall gains for household heads who sell and buy back. The basic problem is a liquidity constraint, i.e., poorly functioning capital markets.

Household heads who sold millet at harvest and bought back later had lower millet yield per hectare and lower millet production per adult worker than household heads who did not sell at harvest and bought back. The analysis showed that farmers would gain if seasonal credit were available to them and if the official interest rate was used. Based on the 1986 transactions data, such a policy would have resulted in a transfer of income to farmers if they sell millet at the market during the dry season (January-March) and the hot season (April-June), and at the village during the wet seasons (July-September).

The relationships between peanut seed credit, labor availability, millet production, millet sales, and rice purchases were investigated in the Southern Peanut Basin. The results indicated that peanut seed credit enabled the household heads to attract more dependents. The availability of more dependents in turn increased the household heads' millet production. Holding everything constant, a one unit increase in the number of adult workers raised millet production of household heads approximately by 217 kg.

Furthermore, household heads who were fully equipped attracted more workers than household heads who were not fully equipped. There was no supporting evidence that more millet production (as a result of peanut seed credit and more labor availability) increased millet sales. The analysis indicated that household heads located in the Southwest Peanut Basin marketed less millet than household heads located in the Southeast Peanut Basin. Finally, there was not a significant difference in rice purchases between household heads who received peanut seed credit and those who did not. Other things being equal, the results indicated that household heads located in the Southwest Peanut Basin purchased 125 kg more rice than household heads located in the Southeast Peanut Basin. Furthermore, household heads who resided in the village where the main market was located purchased 106 kg more rice than household heads not residing in the village where the main market was located. The results further revealed that as millet production increased, so did rice purchases of the household head. Hence, increasing millet production was associated with an increase in rice purchases.

The implications of social closeness on farmers' behavior were also investigated. The results support the view that when a farmer sells millet to another farmer, he charges a lower price, compared to what he charges to another buyer. Conversely, when a farmer buys from another farmer, he pays a lower price, compared to what he pays to another seller. Social closeness was found to have a similar effect on price for the Woloff and for the Serer when millet purchases are carried out at the village. Social closeness was found to have a stronger effect on price for the Woloff than for the Serer when millet purchases take place at the market. For purchases at the village, social closeness was found to be more prevalent during the hungry season (July-September), which is the period where millet is badly needed for home consumption and yet it is the

period where cash is low to buy it. The analysis of social closeness suggested that a traditional "safety net" is already in place among farmers.

CHAPTER 6

MARKET COMPETITION IN THE PEANUT BASIN

"Traditional markets are unpredictable, unreliable, and carry limited coordinating information and incentives. This price uncertainty increases the risk of commercial production and thus reinforces the incentives of subsistence agriculture and reliance on the customary system."

(Shaffer, et al., 1987)

The study of market competition involves examining the role of markets in allocating resources. A fundamental question is how well markets in the Peanut Basin coordinate the transactions of market participants? More specifically, are markets integrated, i.e., are prices in the marketing system providing market participants with signals that stimulate transfers of millet from surplus to deficit zones, including semi-urban and urban zones? Are markets in the Peanut Basin segmented? Is it profitable to store millet to take advantage of seasonal price variation?

Many reasons may explain the lack of market competition in the food systems of developing countries:

a) Markets are thin in the sense that "small variation in supplies have large effects on prices" (Shaffer et al., 1987). Therefore price prediction becomes difficult, which negatively affects the profitability of storage.

b) Participants in the markets have bounded rationality, i.e., they are unable to

process all the information available to guide their decisions.

c) Lack of a grading system inhibits trading at a distance.

d) Transaction and search costs are high due to the need for visual inspection of the commodities being traded, the time involved in getting a good bargain, actual costs incurred in moving commodities from surplus to deficit regions, and the uncertainty of contracts and their enforcement.

The objective of this chapter is to analyze market competition in the Peanut Basin. The first section will investigate the relationships between millet price variation and the cost of storage. This will assess market competition through time. The second section investigates spatial market integration through computation of bivariate price correlation coefficients and through the use of a covariance analysis approach to test for the integration of the system of markets in the Peanut Basin. The third section investigates other aspects of market competition in the Peanut Basin by analyzing wholesalers' marketing costs and margins.

6.1. Market Competition Through Time in the Southern Peanut Basin

This section investigates the extent to which markets in the Peanut Basin can be considered competitive through time, by comparing the price variation to the cost of storage. Because the price of a storable commodity is expected to increase from harvest to the period just before the next harvest, it becomes an issue to investigate to what extent the price variation covers storage costs. These issues are discussed for millet in the Peanut Basin for the period October 1985-December 1989. Only the Southeast and the Southwest Peanut Basin are considered in the analysis. The Northern and the Central Peanut Basin are not included, due to the presence of missing values in the price series that do not allow consistency in the analysis. Because these regions produce less

millet than those in Southern Peanut Basin, it is likely that most of the missing values are associated with periods when farmers in those regions did not sell at all.

6.1.1 Millet Price Seasonality in the Southern Peanut Basin

Seasonal price analysis is an important technique that shows the variation of prices in a time series. The dissemination of the results of seasonal price analysis may enable market participants (farmers, traders, consumers) to take advantage of price behavior for their sales and purchases decisions (if they have sufficient liquidity). Knowing when prices are highest in the market may permit farmers who are able to sell to increase their income, while periods for which prices are lowest will be of major interest to low-income urban consumers and farmers who are net buyers. By informing decision makers of the periods of relative scarcity and abundance, seasonal price analysis allows them to have a better targeted approach for price stabilization. Furthermore, seasonal price analysis between regions for a particular commodity can shed light on the potential for trade between them.

The method used here to carry out the seasonal price analysis is the ratio-to-centered-moving-average approach. The objective is to isolate the seasonal variation of the monthly prices of millet received by farmers, based on the idea that each observed monthly price is composed of a trend, a seasonal, a cyclical and a random component. The multiplicative model was assumed, i.e., the observed monthly price being equal to the trend multiplied by the seasonal multiplied by the cyclical multiplied by the random component.

The first step is to calculate moving averages using the 12-month technique. As discussed by Goetz and Weber (1986), in the 12-month moving-average procedure each observation in the observed monthly price series is replaced by the average of the

monthly prices in the six preceding months and the monthly prices in the subsequent six months. Consequently "there is no moving average for the first and last 6 observations in the series" (Goetz and Weber, 1986). The second step calculates the seasonal ratios by dividing the observed price received by farmers for a given month with the corresponding moving average. The third step averages the seasonal ratios for the same month in the series to get the seasonal index for each month.

Table 6.1 Seasonal Price Indices for Millet in the Southern Peanut Basin.

Months	Prices Received by Farmers in Southeast P. Basin	Prices Received by Farmers in Southwest P. Basin	Wholesale Prices in Southeast P. Basin
October	84.4	83.4	87.3
November	81.7	83.8	83.4
December	91.7	92.7	93.7
January	112.9	106.7	108.3
February	117.2	112.8	115.5
March	112.8	109.5	109.5
April	105.7	100.3	100.1
May	98.9	99.6	97.2
June	93.3	93.8	93.6
July	106.4	106.9	103.7
August	103.4	112.9	118.8
September	91.5	97.5	88.9

Source: ISRA/BAME Price Collection, 1985-1989.

As table 6.1 indicates, the seasonal low price (for price received by farmers) occurs in November for the Southeast Peanut Basin and in October for the Southwest Peanut Basin. This implies that in both regions millet prices are lowest during the harvest season (October-December). For the seasonal high price, although the figure for February for the Southwest Peanut Basin is nearly identical to that in August, there is clearly a bimodal pattern in both regions. In both regions, prices received by farmers are on average almost identical during the harvest season (October-December) and during May-July but different during the other months. At the wholesale level in the Southeast

Peanut Basin, prices are lowest in November and highest in August. The table suggests that it may pay on average to store millet from harvest to February, for both farmers and wholesalers.

6.1.2 Millet Price Volatility and the Profitability of Storage

This section analyzes the volatility of millet prices in the Peanut Basin and the returns to storage, by assuming that both farmers and traders make their storage decisions on a month-by-month basis, following the analysis done by Mehta (1989) for Mali. Before starting this analysis, a review of how credit is arranged in the Peanut Basin is in order. This review is necessary in order to determine an appropriate rate of interest to use in the cost of storage calculations.

6.1.2.1 Credit Arrangements in the Peanut Basin

Survey results by Newman et al. (1987) indicated that 75 percent of assemblers relied on their own funds to purchase local cereals, 17 percent relied on credit provided by relatives, and 25 percent relied on other merchants to get access to credit. None of the assemblers interviewed obtained credit from banks and other financial institutions. Eighty-two percent of wholesalers relied on their own funds to purchase grains, 8 percent got credit from relatives, and 10 percent from other merchants. Only 6 percent of wholesalers got access to credit from banks and other financial institutions[8]. Twenty-one percent of assemblers and 26 percent of wholesalers provided pre-harvest loans to farmers. A more intensive survey of 58 wholesalers carried out during the 1984-85 marketing year indicated that 68 percent of wholesalers provided credit to farmers, and 47 percent provided credit to other merchants. Another survey carried out in the Peanut

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[8] The percentages do not add up to 100 because of multiple responses for some traders (assemblers, wholesalers). The analysis was based on 243 responses.

Basin during the 1986/87 marketing year from a sample of 114 traders (43 assemblers, 66 wholesalers and 5 semi-wholesalers) indicated that none of the assemblers and the semi-wholesalers, and 62 percent of the wholesalers had never asked for a bank credit (Williams, 1988). According to Newman et al. (1987), the interest rate in the informal credit market is 7.2 percent per month, compared to the official interest rate of 1.25 percent per month. Even though this interest rate is high, Newman et al. (1987) reported that on average wholesalers were able to recuperate only 62 percent of the loans they provided. They have no legal recourse if the loans are not paid back. This reflects what de Soto (1989) calls the "absence of good law" to facilitate trade in the Senegalese food system. Ouedraogo and Ndoye (1988b) have estimated an interest rate of 3.25 percent per month from a survey of traders in the Peanut Basin. Gaye (1988) estimated an interest rate of 40 percent a year in the Peanut Basin (3.33 per month), which is close to the interest rate estimated by Ouedraogo and Ndoye (1988b). According to Gaye (1988), access to credit is mainly based on relationships (familial or friendship). The reliance on relationships reduces the risk of default since it decreases the chance of opportunistic behavior.

The foregoing discussion demonstrates that both farmers and traders in the Peanut Basin rely more on the informal financial markets than the official market. For this reason, the interest rate in the informal financial markets will be used in this chapter to calculate the cost of storage.

6.1.2.2 The Volatility of Millet Prices in the Peanut Basin

The analysis of how millet prices fluctuate month by month can shed light on how the thinness of markets makes the decision to store very risky. It is assumed that both farmers and wholesalers store from month-to-month.

Table 6.2 Month-to-Month Price Change Facing Farmers in the Southeast Peanut Basin (CFA F/kg).

Year	1985/86	1986/87	1987/88	1988/89	1989/90
October		-9.4	-15.2	-1.5	-17.0
November	-4.8	-1.5	1.4	4.3	1.5
December	15.3	7.5	8.9	7.5	8.0
January	1.2	12.7	14.8	10.3	
February	-8.1	4.0	-2.4	-3.1	
March	3.3	-5.0	-1.2	-0.9	
April	-2.7	0	-4.8	3.9	
May	-3.3	-7.5	-9.7	-0.2	
June	-2.9	-8.1	-0.5	-0.8	
July	11.0	5.6	4.5	8.1	
August	13.3	-5.1	7.2	5.1	
September	-17.4	-7.3	-7.0	-13.8	

Source:ISRA/BAME Price Collection, 1985-1989.
The first number of the table (-4.8) indicates the price change from October to November.

Table 6.2 presents the results of the analysis for the Southeast Peanut Basin. It appears that prices received by farmers are highly volatile in the Southeast Peanut Basin in the sense that the month-to-month variation of prices is negative in 26 months out of 50[9]. This situation gives an indication of the riskiness of storage in that region. From table 6.2, it also appears that over the period 1985-1989, there is always a positive price change from November to December, from December to January and from June to July. The data also reveals that there is always a negative price change from August to September, from September to October, from April to May and from May to June. For the other months of the marketing years, the results are mixed, i.e., for some years there is a positive price change and for others, there is a negative price change.

[9] Due to the one month lag caused by the month-to-month decision to store, the number of months is reduced from 51 to 50.

Table 6.3 Month-to-Month Price Changes Facing Farmers in the Southwest Peanut Basin (CFA F/kg).

Year	1985/86	1986/87	1987/88	1988/89	1989/90
October		-17.3	-19.4	1.2	-6.7
November	-1.5	0.8	1.2	-2.5	9.2
December	11.2	6.9	10.0	21.2	
January	6.2	10.6	10.0	-7.5	
February	-10.2	3.8	1.2	-0.6	
March	1.5	-4.3	-3.8	2.9	
April	-1.2	0	-6.0	0.2	
May	-2.5	-6.5	-2.8	5.0	
June	0	-5.4	-7.1	5.0	
July	5.1	9.4	20.8	5.5	
August	22.4	-4.4	-1.2	-26.1	
September	-16.0	-13.1	-2.5	-1.9	

Source:ISRA/BAME Price Collection, 1985-1989.

Table 6.3 presents the results of the analysis for the Southwest Peanut Basin. Prices received by farmers in the Southwest Peanut Basin are also volatile; the month-to-month variation of prices is negative in 24 months out of 49. For the period covered in the analysis, there is always a positive price change from November to December, and from June to July. The month-to-month price change is always negative from August to September for all the marketing years covered. For the other months the results are mixed.

At the wholesale level, storage is also risky, as indicated by table 6.4. For a wholesaler who makes his storage decisions on a month-to-month basis in the Southeast Peanut Basin, the variation of prices is negative in 28 months out of 50. As the table indicates, there is always a positive price change from November to December and from June to July. The month-to-month price change is always negative from April to May and from August to September during the five years considered in the analysis.

Table 6.4. Month-to-Month Price Changes Facing Wholesalers in the Southeast Peanut Basin (CFA F/kg).

Year	1985/86	1986/87	1987/88	1988/89	1989/90
October		-10.8	-10.5	0	-16.0
November	-4.0	-2.6	-0.6	3.9	0.2
December	10.0	8.2	10.7	7.1	7.8
January	-0.2	9.9	14.4	9.7	
February	-4.5	5.5	-2.5	-3.2	
March	1.4	-6.6	-3.4	-0.4	
April	-0.3	-0.8	-7.8	3.7	
May	-3.6	-7.6	-6.9	-0.7	
June	-1.8	-6.0	-0.9	0.9	
July	10.0	4.9	9.1	8.5	
August	12.4	-3.9	20.5	2.8	
September	-11.0	-13.0	-21.8	-13.4	

Source: ISRA/BAME Price Collection, 1985-89.

6.1.2.3 The Profitability of Storing Millet in the Peanut Basin

As the analysis of millet price volatility indicates, the number of months for which there is a positive month-to-month price change are lower than the number of months for which the month-to-month price changes are negative. For the latter months, the return to storage is negative whatever is the cost of storage. Thus it is only when the month-to-month price variation is positive that it becomes an issue to investigate the returns to storage. The return to storage is obtained by subtracting the month-to-month cost of storage from the corresponding month-to-month price variation. It is assumed that both farmers and traders can take two actions with respect to millet storage:

a) they can store and sell from month-to-month.

b) they can store from month-to-month, and hold inventories whenever it is not profitable to sell.

At the farmer level, the following assumptions are made for the calculation of the storage costs:

a) The storage facilities cost 8,000 CFA Francs on average to household heads in the Southeast and the Southwest Peanut Basin.

b) Each storage facility can store up to 1,120 kg of millet (Hays, 1975).

c) Each storage facility can last up to 10 years.

d) Depreciation per kg per month = Investment/(Life Expectancy x Capacity x number of months stored) following Goetz and Weber (1986).

e) Storage losses at the farm are 5 percent per year following Hays (1975).

f) The monthly cost of storing one kg of millet = $\frac{(R + I) * P_h}{12} + D$,

following Goetz and Weber (1986) where

P_h is the average market price during the preceding month for the month-to-month decision to store.

R is the rate of storage losses, assumed to be 5 percent a year following Gilbert (1969) and Hays (1975).

I is the monthly interest rate in the informal sector, which is equal to 3.25 percent.

D is the rate of depreciation per kg of millet stored.

Table 6.5 analyzes the profitability of storage for farmers in the Southeast Peanut Basin during the period October 1985-December 1989. It appears that farmers who store on a month-to-month basis make money only in 19 months out of 50, i.e., with a probability of approximately 0.38, which is lower than the probability of 0.8 specified as our performance norm in chapter 2. The probability of making money from storing millet within a given marketing year is 0.36 for 1985/86, 0.33 for 1986/87, 1987/88 and

Table 6.5 Profitability of Millet Storage for Farmers in the Southeast Peanut Basin (CFA F/kg).

Year	1985/86	1986/87	1987/88	1988/89	1989/90
October		-12.7	-17.9	-4.1	-20.3
November	-7.9	-4.4	-0.8	1.8	-1.2
December	12.4	4.6	6.7	4.8	5.3
January	-2.3	9.6	12.2	7.3	
February	-11.6	0.4	-5.5	-6.5	
March	0.1	-8.8	-4.2	-4.1	
April	-6.0	-3.6	-7.8	0.7	
May	-6.5	-11.1	-12.5	-3.6	
June	-6.0	-11.4	-2.9	-4.0	
July	9.0	2.6	2.1	4.8	
August	9.9	-8.3	4.6	1.5	
September	-21.3	-10.3	-9.9	-17.6	

Source: ISRA/BAME Price Collection, 1985-89.

The numbers in the table are the month-to-month price changes minus the corresponding costs of storage. For example -7.9 represents the month-to-month price change from October to November minus the corresponding cost of storage.

1989/90, and 0.42 for 1988/89[10]. By comparing table 6.2 and table 6.5, it appears that the returns to storage is negative in four months for which the month-to-month price variation was positive or even. This implies that in these months the positive month-to-month price variation does not cover the cost of storage. During the five years covered in the analysis, storage of millet is always profitable for storage in November and sale in December and for storage in June and sale in July, but not for storage in April and sale in May, for storage in May and sale in June, for storage in August and sale in September and for storage in September and sale in October.

The variability of the returns to storage, i.e., how many years out of five farmers lose money, was also investigated in the Southeast Peanut Basin. The results from table 6.5 indicate that farmers who store and sell millet from month-to-month lose money in

[10] Note that there are only 3 months in 1989/90 for the Southeast Peanut Basin.

five years out of five. However, these farmers may make money if they increase the quantity of millet they sell during the months for which storage is profitable, and to minimize sales during the months for which storage is not profitable. For farmers who store from month-to-month and hold inventories whenever it is not profitable to sell, it pays to store in three years out of five. In this situation, farmers would probably be willing to incur the costs of storing millet. This reflects better the storage behavior of farmers. In fact, given the importance of millet for home consumption in the Peanut Basin, farmers will always have to carry out the storage function, whether profitable or not.

Table 6.6 Profitability of Millet Storage for Farmers in the Southwest Peanut Basin (CFA F/kg).

Year	1985/86	1986/87	1987/88	1988/89	1989/90
October		-20.9	-22.3	-1.6	-9.7
November	-3.6	-2.2	-0.9	-5.4	6.4
December	9.2	3.9	7.8	18.3	
January	2.8	7.4	7.4	-11.1	
February	-6.6	0.1	-1.6	-4.0	
March	-1.8	-8.1	-6.8	-0.4	
April	-4.5	-3.6	-8.9	-3.3	
May	-5.8	-10.1	-5.4	1.5	
June	-3.2	-8.8	-9.6	1.4	
July	1.9	6.2	18.6	1.7	
August	19.0	-7.9	-4.2	-30.1	
September	-20.2	-16.5	-5.5	-5.0	

Source: ISRA/BAME Price Collection, 1985-89.
The numbers in the table are the month-to-month price changes minus the corresponding costs of storage. For example, -3.6 represents the month-to-month price change from October to November minus the corresponding cost of storage.

Table 6.6 presents the results of the profitability of storing millet for farmers in the Southwest Peanut Basin. It appears that farmers who store on a month-to-month basis make money in 15 months out of 49, i.e., with a probability of 0.31, which is slightly lower than in the Southeast Peanut Basin. The probability of making money for storing

millet in a given marketing year is 0.36 for 1985/86, 0.25 for both 1986/87 and 1987/88, 0.33 for 1988/89 and 0.5 for 1989/90[11]. By comparing table 6.3 and table 6.6, it appears that the returns to storage are negative in nine months for which the month-to-month price variation was either positive or even. During the five years covered in the analysis, storage of millet is always profitable for storage in November and sale in December and for storage in June and sale in July, but not for storage in February and sale in March, for storage in March and sale in April, for storage in August and sale in September and for storage in September and sale in October.

The variability of the returns to storage was also investigated from table 6.6. The results indicate that farmers from the Southwest Peanut Basin who store and sell from month-to-month lose money in five years out of five. For farmers who store from month-to-month, and hold inventories whenever it is not profitable to sell, storage of millet is profitable in three years out of five.

At the wholesale level, the computation of the cost of storage is based on the following assumptions:

a) The wholesaler rents a storage facility of 20 tons capacity for 10,000 CFA F per month (Ouedraogo and Ndoye, 1988b).

b) The monthly cost of storing one kg of millet = $\frac{(R + I) * P_h}{12} + S$,

following Goetz and Weber (1986) where

P_h is the average wholesale price during the preceding month for the

[11] Note that there are only 2 months in 1989/90 for the Southwest Peanut Basin data series.

month-to-month decision to store.

R is the rate of storage losses per year, which is assumed to be 10 percent.

I is the monthly interest rate.

S is the rental cost of storing one kg of millet per month.

Table 6.7 Profitability of Millet Storage for Wholesalers in the Southeast Peanut Basin (CFA F/kg).

Year	1985/86	1986/87	1987/88	1988/89	1989/90
October		-14.5	-13.2	-2.7	-19.5
November	-7.3	-5.8	-2.9	1.2	-2.6
December	6.8	5.1	8.4	4.2	4.9
January	-3.8	6.5	11.7	6.5	
February	-8.1	1.7	-5.8	-6.8	
March	-2.0	-10.7	-6.6	-3.8	
April	-3.7	-4.6	-10.9	0.3	
May	-7.0	-11.4	-9.6	-4.3	
June	-5.1	-9.5	-3.4	-2.7	
July	6.8	1.7	6.7	4.9	
August	8.8	-7.3	17.7	-1.1	
September	-15.1	-16.3	-25.4	-17.4	

Source: ISRA/BAME Price Collection, 1985-89.
The numbers in the table are the month-to-month price changes minus the corresponding costs of storage. For example, -7.9 represents the month-to-month price change from October to November minus the corresponding cost of storage.

Table 6.7 investigates the profitability of storing millet by wholesalers in the Southeast Peanut Basin. It appears that wholesalers who store on a month-to-month basis make money in 17 months out of 50, i.e., with a probability of 0.34. The probability of making money from storing millet in a given marketing year is 0.27 for 1985/86, 0.33 for 1986/87, 1987/88 and 1989/90, and 0.42 for 1988/89[12]. By comparing table 6.4 and table 6.7, it appears that the returns to storage is negative in five months for which the

[12] Note that there are only 3 months in 1989/90.

month-to-month price variation was positive. For these months, the positive price variation does not cover storage cost. Storage of millet is always profitable for storage in November and sale in December and for storage in June and sale in July, but not for storage in February and sale in March, for storage in April and sale in May, for storage in May and sale in June, for storage in August and sale in September and for storage in September and sale in October. The examination of the variability of the returns to storage indicates that wholesalers who store and sell from month-to-month lose money in five years out of five. For wholesalers who store from month-to-month, and hold inventories whenever it is not profitable to sell, storage is profitable in one year out of five.

Table 6.8. Returns to Storage in the Southeast Peanut Basin for Wholesalers who Buy and Store Millet Month by Month and Stop Whenever Storage becomes Profitable (CFA F/kg).

Year	1985/86	1986/87	1987/88	1988/89	1989/90
October November December January	 -3.3 +6.8	 -3.2 +5.1	 -2.3 +8.4	 -2.7 +1.2	 -2.8 +4.9

Source: ISRA/BAME Surveys, 1985-89.

Another strategy that the wholesaler may adopt is to store millet from month-to-month, to hold inventories whenever it is not profitable to sell, and to get rid of all his stocks when storage becomes profitable and not to buy and store anymore during the remaining of the marketing year. It is assumed that the wholesaler starts building his stocks at the beginning of each marketing year (October). The results of the analysis are presented in table 6.8. It appears that a wholesaler having this behavior makes money in four years out of five and that he should not get involved in storage after December of each marketing year.

In what follows, we investigate the return to storage for wholesalers who buy millet at the beginning of harvest (October) and store it until December, i.e., before the beginning of the official peanut marketing season. We also look at how much the price of millet would have to rise to stimulate wholesalers to store for six months (October-March). In each of these scenarios, the wholesaler buys millet only at harvest and then

Table 6.9. Profitability of Millet Storage in the Southeast Peanut Basin for Wholesalers Storing from October to December (CFA F/kg).

	1985/86	1986/87	1987/88	1988/89	1989/90
Returns to Storage Using the Informal Rate of Interest	-0.6	-0.8	5.5	5.4	2.3
Returns to Storage Using the Official Rate of Interest	2.1	1.8	7.3	7.6	4.6

Source:ISRA/BAME Price Collection, 1985-89.
The informal rate of interest is 3.25 percent per month following Ouedraogo and Ndoye (1988b). The official interest rate is 1.25 percent per month.

holds inventories until the target date of sale[13]. Table 6.9 presents the results of the analysis of the return to storage for wholesalers who store millet from October to December. It appears that wholesalers who take this action make money in three years out of five if the informal rate of interest is used. However, if wholesalers get credit at the official interest rate, storage of millet from October to December becomes profitable for all the 5 years considered.

Table 6.10 illustrates how much the price of millet would have to rise to stimulate wholesalers to store millet for six months. The results show that for the four years

[13] The difference between this strategy and that analyzed in table 6.8 is that here the wholesaler buys millet only in October and store it until the target date for sale; in table 6.8, the wholesaler buys and store millet month by month from October and sells all his stocks whenever storage becomes profitable and then quits storing.

Table 6.10. Needed Price Increase to Cover Storage Cost for Wholesaler Storing from October to March (CFA F/kg).

	Needed Price Increase	Actual Price Increase
1985-1986	16.5	2.7
1986-1987	16.0	15.0
1987-1988	11.5	18.5
1988-1989	13.8	17.0

Source:ISRA/BAME Price Collection, 1985-89.
The needed price increase is based on the storage cost from October to March.

considered, the needed price increase covers actual price increase in two years out of four. If the wholesaler wishes to store millet from October to beyond March, the needed price increase will not cover actual price increase, which seems to confirm that long-term storage is not profitable at the wholesale level in the Peanut Basin (Ouedraogo and Ndoye, 1988b).

The analysis of temporal market integration in the Peanut Basin indicates that storage of millet on a month-to-month basis is highly risky for both farmers and traders in the sense that the probability of losing money is very high within each of the five years considered in the analysis. This situation is primarily due to the high volatility of millet prices. Although the informal interest rate used in the analysis (39 percent per year) is more than twice that of the official interest rate (15 percent per year), it had less impact than the volatility of prices when the decision to store is evaluated month by month. However, when the decision to store is evaluated from October to December at the wholesale level, getting access to the official interest rate increases the profitability of storage. For wholesalers who buy and store millet month by month, and stop whenever the returns to storage is positive, storage is profitable in four years out of five. For farmers who store from month-to-month and hold inventories whenever it is not

profitable to sell, storage is profitable in three years out of five, but it is profitable for wholesalers only in one year out of five.

The implication of the temporal market integration analysis is that there is a need to reduce the thinness of markets so that they become more predictable. Policies that may help reduce the thinness of markets include various stabilization policies, reduction of farmers' production risks, creation of improved varieties of millet that would increase yields significantly, encouragement of farmers' adoption of those improved technologies and provision of credit to both farmers and traders.

6.2. Spatial Market Integration in the Peanut Basin

6.2.1 Market Integration using Bivariate Price Correlations

The objective of this section is to test for spatial market integration in the Peanut Basin using bivariate price correlations. This method has been criticized for a number of reasons:

a) correlation coefficients may be high due to rising prices because of population growth and increased effective demand relative to supplies or to general inflation (Harris, 1979).

b) high price correlations may be due to stable margins or prices and can corroborate a situation of monopoly as well as perfectly competitive markets (Harris, 1979).

c) most of the correlation coefficients computed to assess market competition are based on non-detrended price data (Harris, 1979).

d) stable prices in rural markets can lead to high correlation coefficients even though little price movement is observed (Timmer et al., 1983).

Although all these shortcomings stemming from the bivariate price correlation

analysis are valid, this procedure can still be a useful guide in assessing the degree of connection of markets in a food system.

The procedure used in this section to test for market competition in the Peanut Basin is to remove the impact of the individual market effects by subtracting the mean price of millet for each market from the actual observed price. Two periods are considered in the analysis: the first is the one before the price reporting system undertaken by the Food Security Commissariat (CSA), i.e., from October 1984 to January 1987. The second covers the period since the price reporting system, i.e., from February 1987 to December 1989. The purpose of the analysis is to compare the degree of market connection during the two periods. Nine markets are considered in the analysis: Sagatta and Louga in the Louga region, Mbacke and Touba in the Diourbel region, Touba Toul in the Thies region, Mbar and Passy in the Fatick region, Ndiba and Ndoffane in the Kaolack region. The results of the analysis are shown in tables 6.11 and 6.12. The results can be summarized as follows:

a) among the 45 bivariate price correlation coefficients computed for the period before the price reporting system, 12 are not statistically significant. Among the 33 coefficients that are statistically significant, 26 are significant at 1 percent. Only 9 coefficients out of 33 (i.e, 27 percent) are greater or equal to 0.77 and no coefficient is equal to 0.9. This implies that the markets considered were not well-integrated before the price information system, as it is only in 27 percent of the market pairs that the price variation in one market was associated with the price variation in the other market by at least 60 percent.

b) among the 45 correlation coefficients computed for the period since the price reporting system, all are statistically significant. Forty-three coefficients are statistically

Table 6.11. Bivariate Price Correlations before the Period of Public Price Reporting in Selected Markets of the Peanut Basin (October 1984-January 1987).

Markets	Louga	Mbacke	Mbar	Ndiba	Ndoffane	Passy	Sagatta	Touba	TToul
Louga	1.0	.6	.76*	.50	.63	.61	.89	.75*	.81**
Mbacke		1.0	.70**	.73**	.44*	.32	.78	.89**	.70*
Mbar			1.0	.69**	.78**	.74**	.54	.85**	.75**
Ndiba				1.0	.77**	.62**	.78	.78**	.58**
Ndoffane					1.0	.70**	.93	.65**	.49*
Passy						1.0	.85	.59**	.62*
Sagatta							1.0	.81*	.75
Touba								1.0	.81**
TToul									1.0

Source:ISRA/BAME Surveys, 1984-89.
Notes:
* significant at 10 percent.
** significant at 1 percent.

significant at 1 percent. Thirty-two coefficients out of 45 (i.e., 71 percent) are greater than 0.77, meaning that for more than two-thirds of the market pairs, the price variation in one market was associated with the price variation in the other market by more than 60 percent. This implies that using the 0.77 correlation norm of chapter 2, the markets considered are better connected during the price reporting system period. However, if the 0.9 correlation norm is used, only 8 coefficients out of 45 (i.e., 18 percent) are greater or equal to 0.9. This would imply that it is for only 18 percent of the market

Table 6.12. Bivariate Price Correlations During the Period of Public Price Reporting in Selected Markets in the Peanut Basin (February 1987-December 1989).

Markets	Louga	Mbacke	Mbar	Ndiba	Ndoffane	Passy	Sagatta	Touba	TToul
Louga	1.0	.88**	.59*	.83**	.85**	.68*	.72**	.87**	.84**
Mbacke		1.0	.97**	.89**	.89**	.86**	.91**	.99**	.94**
Mbar			1.0	.87**	.87**	.87**	.86**	.95**	.89**
Ndiba				1.0	.95**	.87**	.84**	.88**	.87**
Ndoffane					1.0	.81**	.75**	.89**	.91**
Passy						1.0	.81**	.78**	.61**
Sagatta							1.0	.79**	.83**
Touba								1.0	.92**
TToul									1.0

Source:ISRA/BAME Surveys, 1984/89.
Notes:
* significant at 10 percent.
** significant at 1 percent.

pairs that the price variation in one market is associated with the price variation in the other market by at least 80 percent.

In summary, the analysis of spatial market integration using the bivariate price correlations showed that markets were weakly connected before the existence of the public price reporting system, as the degree of market connection is confirmed only for 27 percent of the coefficients showing 60 percent of the price variation in one market pair associated with the price variation in the other market. The markets appear to have

become connected since the creation of the public price reporting system.

A number of possible reasons could explain why market integration appears to have increased. Average millet production was 685,000 tons for the period before the price reporting system and 720,000 tons during the price reporting system, which suggests that average production was slightly higher during the price reporting system. Given the thinness of the markets, this small increase in production could translate into a large increase in marketed surplus. More active markets tend to be better integrated. An alternative explanation may be that the price data are better since the price reporting system was put in place. However, the price data used in the analysis were collected by ISRA, through the cereals marketing program in the Peanut Basin, using the same method and the same enumerators in both periods.

6.2.2. A Fixed-Effect Panel Data Model (or Covariance Analysis) to Test Market Integration in the Peanut Basin

6.2.2.1 A Critical Evaluation of the Variance Component Model Developed by Delgado:

In an article published in the American Journal of Agricultural Economics, Delgado (1986) developed a variance component (or error component) model to test for market integration in Northern Nigeria. The model was developed as follows:

$$P_{it}=M+V_i+U_t+Z_{it} \qquad (18)$$

where P_{it} is the price of the grain in market i in week t;

M is the mean price of the grain each season in the sample;

V_i is a constant location effect;

U_t is a constant time effect;

Z_{it} is a stochastic interaction term.

Delgado (1986) made two assumptions:

a) the variance of prices for a given crop in a given village is constant over the season.

b) transport and transaction costs for marketing a given crop between any two markets within the system are constant for the two markets concerned, subject to a random disturbance over the season.

The critique of the approach will be based on the following:

a) there was no need for including M, the mean price of food grain each season in the decomposition of the price, if the ultimate goal is to remove the individual location effects (as done by Delgado). In fact, subtracting the mean price from the observed price series sweeps out the individual location effects (Hsiao, 1987). Thus the inclusion of the mean M in the equation was redundant.

b) assuming constant individual and time effects means that the model used was a fixed effects model and not a variance component model, which would require that both the individual and time effects be random. The computation of the variance of price would have been more difficult in that situation.

c) the assumption of constant transaction costs for marketing a given crop between any two markets within the system may be a little strong.

d) the merits of the model developed by Delgado are to show the integration of the whole system of markets and the fact that market integration can be different depending on which periods or seasons the analysis refers to.

6.2.2.2 An Alternative Approach to Test Market Integration in the Peanut Basin

Based on the above discussion, the model developed by Delgado was reformulated to test for market integration in the millet subsector before and during the price reporting system undertaken by the CSA. The model is written as follows,

$$P_{it} = V_i + U_t + Z_{it} \qquad (19)$$

following Delgado's notation:

$i = 1,...,N$= number of rural markets considered; $t = 1,...,T$= number of fortnights per period. Two periods are considered: the first period, before the price reporting system, starts in October 1984 and ends in January 1987 (i.e., it covers 56 fortnights); the second period, since the price reporting system was put in place, starts in February 1987 and ends in December 1989 (i.e., it covers 70 fortnights).

P_{it} is the observed price received by farmers in market i in fortnight t; V_i is the individual effect of market i; U_t is a constant time effect (fortnight); Z_{it} is a stochastic interaction term. Following Delgado (1986), the Z_{it} are assumed to have a constant variance within periods for each market but not necessarily across markets.

Conceptually, it is possible to estimate equation (2) with or without the individual market effects (V_i). This can be done regardless of whether they are random or fixed (Hsiao, 1987). Their inclusion would require specifying a dummy variable for each market, which would lower the degrees of freedom in the test statistics. The elimination of the individual market effects is an alternative approach that does not reduce the degrees of freedom. This is done for each period and for each market by subtracting the mean producer price from the observed fortnight producer price data. Thus

$$P_{it}^{*} = U_t + Z_{it} \quad (20)$$

Since we assume a constant time effect U_t, the test for market integration will involve showing that the estimate of U_{it} for each individual market and for each period (i.e., before and during the price reporting system) is equal to the estimate of U_t from the pooled regression of all markets considered in the analysis. If we fail to reject the null hypothesis of equality of trends across markets then we can conclude that the system of markets is integrated, meaning there is a degree of connection among them. Put another way, market integration is defined as the existence of similar price trends across markets despite positive transaction costs. The similarity of the price trends across markets would imply that if market prices increase in one market in the system, prices in the other markets in the system will increase as well and vice-versa. In short, this approach simply generalizes the bivariate price correlation findings to the case of n markets[14].

Given the assumptions of the model, the market trends of equation (3), the U_{it} and U_t, were estimated for each market in the system and for the pooled market-level producer sale prices by a separate Ordinary Least Squares (OLS) polynomial regression of P_{it}^{*} on powers of t. Both periods were modeled with a third-order polynomial. Whenever a fourth-order polynomial was attempted, the cubic term which was statistically significant in the third-order polynomial became statistically insignificant.

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[14] However, this test is equivalent conceptually to testing for a statistically significant bivariate correlation coefficient, not for testing that it is greater than some critical level, such as 0.77 or 0.9. Therefore, if this test shows a common price trend across markets, all it proves is that markets are integrated, but it does not say how well they are integrated.

The form of the third-order polynomial of p_{it}^* on powers t is as follows:

$$P_{it}^* = \sum_{i=1}^{N} \sum_{k=0}^{3} \beta_{it} t^k \tag{21}$$

for each individual market where i and t are defined as in (2) and

$$P_{it}^* = \sum_{k=0}^{3} \beta_k t^k \tag{22}$$

for the market pooled data.

Because the test of market integration will require pooling prices across markets, it is necessary to test for cross-sectional heteroscedasticity. This can be done by using a derivative of Bartlett's test (see Delgado, 1986), the Lagrange Multiplier test, the White test, the Goldfeld-Quandt test, or the Breusch-Pagan/Godfrey test. We use the Lagrange Multiplier (LM) test, which as the derivative of Bartlett's test used by Delgado, does not require additional estimation besides the different OLS runs. The Lagrange Multiplier test is defined as:

$$LM = \frac{T}{2} \sum_{i=1}^{N} \left| \frac{S_i^2}{S^2} - 1 \right|^2 \tag{23}$$

where i = 1,...,N = number of markets in the system; S_i^2 is the mean squared error of the individual OLS runs for each market in the system; S^2 is the mean squared error from the OLS run by pooling the observations in all markets in the system. The LM statistic is distributed chi-squared with N degrees of freedom. For all the tests performed for each period (i.e., before and during the price reporting system) the hypothesis of

homoscedasticity was rejected at the 5 percent level. Thus imposing linear restrictions by simple pooling of prices across markets overestimates the variance of the pooled regression. $\hat{\beta}_{ik}$ is consistent and unbiased, but S^2 is inconsistent and biased, leading to wrong hypotheses tests. In order to get around the heteroscedasticity, a Generalized Least Squares (GLS) estimation is required for the pooled polynomial regression for both the periods before and during the price reporting system. But we need to find weights which give observations with smaller variances larger influence in the estimates of the pooled regression. Like Delgado (1986), we used the reciprocals of the standard errors of the OLS residuals from separate regressions for each market as weights and apply GLS to the pooled market price data. The covariance of (Z_{it}) = Ω =

$$\begin{bmatrix} \sigma_1^2 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \sigma_N^2 \end{bmatrix}$$

We need to find a matrix V such that $V'V = \Omega^{-1}$. Since we do not know the true estimates of the variances of prices for each market we use the reciprocals of the standard error of the OLS as weights. Thus the matrix V is equal to

$$\begin{bmatrix} \frac{1}{S_1} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \frac{1}{S_N} \end{bmatrix}$$

The estimate of $\beta_{ik}, \hat{\beta}_{ik}$ for individual markets in matrix form is $(\alpha'\alpha)^{-1}\alpha' p_{it}^*$ where α' is k by T (recall k is the power of the polynomial regressions of powers t; T is

the total number of fortnights); α is T by k; p_{it}^* is T by 1. The matrix α[15] is as follows:

$$\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 2 & 4 & 8 \\ \vdots & \vdots & \vdots & \vdots \\ 1 & T & T^2 & T^3 \end{bmatrix}$$

The estimate of β_k for the pooled regression $\hat{\beta}_k$ in matrix notation is $[\delta'\delta]^{-1}\delta' P_{it}^*$, where δ' is k by NT; δ is NT by k; P_{it}^* is NT by 1. The p_{it}^* are weighted by the reciprocals of the standard error of the OLS residuals from the separate regression for each market.

The test of the hypothesis of market integration, i.e., that millet price trends are the same across markets for each period separately, is done by the following statistic:

$$\frac{\dfrac{(RRSS - URSS)}{r}}{\dfrac{URSS}{\sum_{i=0}^{N}(n_i - k)}} \qquad (24)$$

which is distributed F $(r, \sum_{i=0}^{N}(n_i - k))$ under the null hypothesis of equality of trend (H_0) (see Delgado, 1986), where RRSS is the restricted residual sum of squares obtained by applying Generalized Least Squares (GLS); URSS is the total unrestricted residual sum of squares obtained by applying Ordinary Least Squares (OLS) to each market separately and adding them; r is the number of parameter restrictions including the

[15] α is used as the matrix rather than T in order to avoid confusion in the notation between this matrix and the number of fortnights in each period which are also numbered from 1 to T.

intercept applied to the pooled regression (N - 1)xk; N is the number of markets; k is the number of parameters in the polynomial regression of powers t; n_i is the number of fortnights in each market for each period (i.e., 56 before the price reporting system and 70 during the price reporting system).

Discussion of the Results

The results of the test of market integration before and during the price reporting system are shown in table 6-13. The different estimations were carried out despite the existence of missing values in the millet price data. However, the degrees of freedom considered in the denominator of the F-test were specified regardless of whether there were missing values or not. Three tests were carried out. The first one is the test of market integration before the price reporting system for seven markets considered in the Southern Peanut Basin, which is the major part of Senegal that generates a significant portion of the millet marketed throughout the country. The other two tests assess market integration during the price reporting system for a sample of 16 markets in the whole Peanut Basin and for the seven markets in the Southern Peanut Basin referred to above.

The null hypothesis of the existence of a common price trends across markets in the Southern Peanut Basin cannot be rejected at the 5 percent level for both the periods before and during the price reporting system. In contrast, the existence of a common price trends across the 16 markets in the Peanut Basin was rejected at the 5 percent level. The latter implies that the behavior of millet prices in the Peanut Basin considered as a whole is so different that the system of markets cannot be considered as a unified market. However, this does not exclude the existence of a common millet price trend between pairs of markets, as would be indicated by the bivariate price correlation.

Table 6-13. Test of Homogeneity of Millet Price Trends across Markets in the Peanut Basin Before and During the Price Reporting System.

Periods	Peanut Basin	F calculated	Degrees of Freedom	Null Hypothesis[1]
Before the Price Reporting System	Southern Peanut Basin[2]	0.52	(24,364)	Fail to Reject at 5 percent
During the Price Reporting System	Whole Peanut Basin[3]	1.71	(60,1056)	Reject at 5 percent
	Southern Peanut Basin	0.28	(24,462)	Fail to Reject at 5 percent

1. The null hypothesis H_0 states that there is a common price trends across all markets.
2. Southern Peanut Basin refers to both Kaolack and Fatick regions and is composed of the following 7 markets:Dioly, Keur Madiabel, Ndiba, Ndoffane, Ndrame, Mbar and Passy.
3. 16 markets are considered in the analysis.

Given the distribution of millet production throughout the Peanut Basin, the reservation prices farmers put on millet differ significantly. When transaction costs are added, the non-homogeneity among markets increases, thereby reducing the impact of a unified market for the whole Peanut Basin. Markets in the Southern Peanut Basin are more integrated, probably because of higher volume of trade, which makes markets less thin compared to the other parts of the Peanut Basin. Private traders in the Southern Peanut Basin rotate from one market to another during the week in order to buy millet and to supply deficit regions and urban centers. Thus if millet prices increase in one market, more private traders will move to other markets, which will increase demand relative supply, thereby increasing millet prices in those markets and vice-versa.

In summary, the system of markets in the Peanut Basin is not integrated, but markets in the Southern Peanut Basin are integrated for both the period before and

during the price reporting system. Consequently, the systems of markets in the Peanut Basin can be considered segmented into markets in the Southern Peanut Basin and the other markets in the rest of the Peanut Basin.

6.3. Wholesalers' Marketing Costs and Margins

In any marketing system, traders incur marketing costs due to "the commodity transformations in time, space and form that are associated with storage, transportation and processing" (Timmer et al., 1983). Yet in Senegal, as in many countries of the Sahel, private traders are often accused of exploiting farmers by paying them low prices for their commodities and selling those commodities back to the farmers at a much higher prices. Many studies have shown the usefulness of private traders and the role they must play during the transition to a more market-oriented economy (Weber and Riley, 1983; Shaffer et al., 1987; Staatz et al., 1989).

This section analyzes private traders' marketing costs and margins during the 1987/88 marketing year and compares them to those in 1986/87. Table 6.14 shows the average costs and margins for wholesalers selling millet at the place of purchase with or without storage during the 1986/87 and 1987/88 marketing seasons. Net margins in 1987/88 are slightly higher than in 1986/87, but they are for both marketing years below 5 percent of the sales prices. The average quantity of millet sold by wholesalers increases slightly in 1987/88, while the average capital invested is lower compared to 1986/87. This would imply that prices at which wholesalers purchased millet were lower in 1987/88 compared to 1986/87. In order to investigate if the net margin received by wholesalers constitutes normal profit, the return to capital (i.e., net margin plus the opportunity cost of capital minus the opportunity cost of unpaid labor over capital invested expressed in percentage terms) is compared to the interest rate in the informal

Table 6.14. Average Marketing Costs and Margins for Wholesalers Selling Millet at the Place of Purchase during the 1986/87 and 1987/88 Marketing Years.

	Without Storage		With Storage	
	1986/87	1987/88	1986/87	1987/88
Gross Margin (CFA F/kg)	2.72	3.74	3.86	5.87
Handling Costs (CFA F/kg)	0.98	0.98	1.02	1.02
Storage Costs (CFA F/kg)	0.0	0.0	0.19	0.53
Opportunity Costs of Capital (CFA F/kg)	0.03	0.06	0.15	1.02
Net Margin (CFA F/kg)	1.71	2.70	2.50	3.32
Net Margin as % of Sale Price	2.94	4.49	3.84	4.83
Average Quantity Sold (kg)	2948	3003	7064	7393
Average Capital Invested (000 CFA)	182	175	509	488
Average days of Storage	0	0	5	15
Number of Sales Analyzed	16	46	33	63

Source: ISRA/BAME Surveys, 1986-88.

Notes:

1. The 1986/87 data are taken from Ouedraogo and Ndoye (1988b).
2 Handling costs for 1987/88 are assumed to be identical to those in 1986/87.
3. The opportunity cost of capital for both marketing years is 3.25 % per month.
4. Average capital invested for 1987/88 is rounded to the nearest 1000.

credit market. The opportunity cost of unpaid labor is assumed to be 90 percent of the minimum wage, which according to Berg (1990) was 184 CFA F per hour in 1986-88. It is further assumed that the wholesaler works on average 11 hours a day (i.e, from 8 in the morning to 7 in the afternoon). In order to calculate the annual returns to capital for wholesalers during the 1986-88 marketing years, there is a need to know how often the merchant rotated his capital during the year. The rate at which private traders rotate their capital during the year is variable, as it can be once a month for many times during the year, twice a month, or once every two months. For this reason, a sensitivity analysis is done to capture the variability of the returns to storage based on the following scenarios:

a) The wholesaler rotates his capital once a month.

b) The wholesaler rotates his capital twice a month.

c) The wholesaler rotates his capital once every two months.

d) The wholesaler rotates his capital once a month during one-half of the marketing year, and twice a month during the other half of the marketing year[16].

e) The wholesaler rotates his capital once a month during half of the year and once every two months during the other half of the year.

f) The wholesaler rotates his capital twice a month during half of the year and once a month every two months during the other half of the year.

The sensitivity analysis is based on the assumption that for each time the wholesaler rotates his capital, he gets the net margin reported in table 6.14 and he also sells the average quantity of millet and invests the average capital indicated by table 6.14.

The results of the analysis are presented in table 6.15. It appears that for wholesalers in the Peanut Basin, the annual rate of returns to capital is in general lower than the annual interest rate of 39 percent used in the analysis. This implies that for wholesalers, the rate of returns to capital is normal in many situations. The rates of returns to capital could even have been lower if the amount of capital invested reported in table 6.14 had incorporated the estimate of the value of the equipment owned by the wholesaler.

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[16] The rate of capital rotation is likely to be lower in years of abundant harvests (when the market moves slowly, but when margins per kg are higher) than in short years. Therefore, unit margins and rate of rotation of capital may offset each other, stabilizing trader returns from year to year.

Table 6.15. Sensitivity Analysis of the Annual Rate of Returns to Capital for Wholesalers in the Peanut Basin.

Scenarios	Without Storage		With Storage	
	1986/87	1987/88	1986/87	1987/88
a) Rotate capital once a month	21.6	44.4	22.6	11.5
b) Rotate capital twice a month	43.2	88.8	45.2	23.0
c) Rotate capital once every 2 months	10.8	22.2	11.3	5.8
d) Rotate capital once a month for half of the year and twice a month during the other half of the year	32.4	66.6	33.9	17.2
e) Rotate capital once a month half of the year and once every 2 months during the other half	16.2	33.3	17.0	8.7
f) Rotate capital twice a month during half of the year and once every 2 months during the other half	27.0	55.5	28.2	14.4

Source:ISRA/BAME Surveys 1986-88.

The calculations in the table are based on the assumption that each time the wholesaler rotates his capital, he gets on average the net margin indicated by table 6.14 and that he also sells on average the same quantity of millet and invests on average the same amount of capital as those indicated in table 6.14.

6.4. Chapter Summary and Policy Implications

This chapter has attempted to test the competitiveness of the millet markets in the Peanut Basin by applying different approaches. The results and their policy implications are briefly summarized in this section.

Millet storage is very risky in the Southern Peanut Basin for both farmers and traders due primarily to the volatility of prices, which makes the probability of earning money through storage within a given year low. For both farmers and traders it always pays to store millet in November and sell in December and to store in June and sell in July. Farmers and traders who store and sell millet on a month-to-month basis lose money during the five marketing years (1985-86 to 1989/90) considered in the analysis. However, in reality farmers and traders having such behavior may not lose money in a given marketing year since they can maximize their sales during the months for which

storage is profitable, and minimize sales during the months for which it does not pay to store. For farmers who store from month-to-month and hold inventories whenever the price variation does not cover storage cost, storage is profitable in three years out of five. For wholesalers using this strategy, storage pays only in one year out of five. For wholesalers who buy millet at harvest and store it up to December, storage is profitable in three years out of five. These wholesalers would have made money in five years out of five if they were able to get access to the interest rate that prevails in the official credit market. For wholesalers who buy and store millet month by month and sell it whenever it is profitable and not to buy again for the rest of the marketing year, storage is profitable in four years out of five. Wholesalers having this behavior have to stop trading millet at the end of December.

Spatial market integration using bivariate price correlations showed that for the period before the public price reporting, 27 percent of the correlation coefficients were greater or equal to 0.77. For the period since the public price reporting system, 71 percent of the correlation coefficients were greater than 0.77. This implied that markets were better connected since the creation of the public price reporting system. The integration of the system of markets was also investigated. Market integration (of the system of markets) is defined as the existence of a common price trends across markets despite positive transaction costs due to imperfections in the markets. The results indicate that the system of markets in the Southern Peanut Basin is integrated for both the periods before and during the price reporting system undertaken by the CSA, while the whole system of markets in the Peanut Basin cannot be considered as a unified market.

The net margins of wholesalers selling millet at the place of purchase show that their net margins are less than 5 percent of the sales prices during both the 1986/87 and the 1987/88 marketing years. Net margins are higher during the 1987/88 marketing year compared to 1986/87. The analysis of the returns to capital for wholesalers selling at the place of purchase reveals that the rates of profit of wholesalers are normal.

The following policy implications arise from this chapter:

1. There is a need to reduce the volatility of millet prices in the Peanut Basin. This can be achieved by reducing the thinness of the markets, by using buffer stocks, or by reducing transaction costs[17]. Reducing the volatility of prices will likely increase the probability of making money from storage and will stimulate both farmers and traders to undertake that function. The reduction of the thinness of markets can be achieved by enabling farmers to reduce their production risk and by facilitating their access to supporting institutions, which are necessary to increase millet production beyond the level of subsistence. This will adjust millet production to market needs.

2. There is a need to improve the degree of integration of the markets in the Peanut Basin by continuing and improving the market information system undertaken by the CSA, by facilitating the access to credit for private traders and by improving the legal foundations of markets. The latter can specify rules under which traders can pool their capital to increase the scale of their business. Bigger scale operations will likely enable traders to reduce the pressure of rotating capital many times in a given month in order to survive. Facilitating private traders' access to official credit can help them increase the length at which they store millet because of the lower interest rate unless they have other more profitable opportunities, in which case the credit is likely to be diverted to

[17] Not all of these policies may be feasible in the Senegalese context.

those uses.

CHAPTER 7

SUMMARY, POLICY IMPLICATIONS AND NEED FOR FURTHER RESEARCH

In the New Agricultural Policy and the Cereals Plan, the government of Senegal aims to encourage local cereals production for consumption. Millet being the most important local cereal produced in Senegal, the feasibility of and the challenges to the government's objective can be better understood by analyzing the interaction between millet production, marketing and price policy. Thus the main objective of this study was to evaluate the performance of the millet subsector and to determine the prerequisites to achieving the government's objective. This concluding chapter summarizes the major findings of the dissertation and their policy implications, examines the changes in public policy needed to stimulate millet production and transactions, and suggests some topics that could be explored in the future.

7.1. **Summary of the Major Findings and their Policy Implications**

7.1.1. The Ability of Household Heads to Produce Sufficient Millet to Satisfy the Needs of Their Dependents

Increasing millet production and consumption in Senegal requires providing incentives to rural households so that they become able to produce beyond what is required for their own consumption. Under this condition, farmers will generate marketable surpluses that could be distributed to urban areas. The GOS, by liberalizing local cereals markets, implicitly assumed that farmers would shift resources to millet and increase production significantly. But in the Peanut Basin, the household head has the responsibility of feeding all the members in the household. The dependents are not

required to cultivate millet in their fields unless they want to do so. For this reason, the feasibility and the implications of the government's objective can be understood by determining the number of household heads in the sample who are able to generate marketable surpluses of millet. The results of the analysis showed that in the Northern and in the Central Peanut Basin, only 16 percent of household heads were capable of producing enough millet to cover 6 months of consumption in 1986/87. In the Southern Peanut Basin, 82 percent of household heads were able to produce enough millet to feed their dependents for the entire year. This implies that under current conditions, for most household heads, millet production does not cover the consumption needs of individual members.

Apparently, farmers in the Peanut Basin face major production constraints, of which the most important are the lack of rain (especially for the Northern and the Central Peanut Basin); lack of inputs; insect attacks; the high prices of inputs, especially fertilizer; and the lack of credit. In the past, the agricultural credit program failed because of the way the credit was distributed. It will be difficult to have a similar credit program because Senegal is currently under structural adjustment with the World Bank and IMF, which requires that the government minimize the costs of its support to the agricultural sector. A new credit program designed to minimize the risk of default is discussed in section 7.2.2.

Contract farming, similar to that carried out through the confectionery peanut program, was shown to be useful in helping farmers increase their millet production, provided the contracts are channelled through farmer groups, according to the scheme discussed in section 7.2.2. Contract farming, by integrating input and output markets, enables farmers to internalize the externalities associated with the credit received, by

improving their well-being while increasing the probability of reimbursement. Contract farming such as that carried out through the confectionery peanut program strengthens the complementarity between food crops and cash crops in the Peanut Basin.

7.1.2. The Degree of Market Involvement

The analysis has shown that household heads in the Peanut Basin are highly integrated into the millet markets compared to Southeastern Senegal, where 40 percent of household heads do not trade (Goetz, 1990). However, the percentage of household heads who are net sellers of millet is low; the majority of household heads are net buyers. This implies that in the short run, the government should help stabilize millet prices for net buyers, particularly if the government objective of encouraging millet consumption is to be achieved. However, beyond this equity issue, improving the efficiency of the marketing system and helping farmers increase millet production will be necessary in the long run. The yield gap analysis implies that millet supply response in Senegal can be increased with some technical help.

7.1.3. Thinness of Markets and the Hypothesis of "Forced" Sales

The percentage of millet production marketed in the Southern Peanut Basin by households where all members are included in the survey is 15 percent on average. This low percentage implies a major challenge for achieving the government objective of encouraging millet consumption in Senegal without a major technological breakthrough. In households where all members are surveyed, it was found that the percentage of millet production marketed by the dependents was higher than the percentage of millet production marketed by the household heads. This implies that targeting the dependents to specialize in millet production will likely increase the total quantity of millet marketed in the Peanut Basin. However, it is unlikely that the dependents will specialize in millet

production if the price uncertainty is not reduced, or without a major technological breakthrough.

The extent to which household heads sell at harvest at low prices and buy back later in the season was investigated in the study. The results indicate that this behavior is not confirmed in the Southeast Peanut Basin (i.e., for the Woloff) during the 1986/87 marketing year, but is confirmed in the Southwest Peanut Basin (i.e., for the Serer). The results indicate that household heads for whom this behavior applies sell at harvest and buy back throughout the year, but the percentage of household heads who bought during the wet season (July-September) was the highest (84 percent of household heads who sell at harvest and buy back). Furthermore, the results indicate that household heads who sold at harvest and purchased back during the dry season (January-March) or during the hot season (April-June) incurred financial losses if the transactions took place at the market. Household heads who sold at harvest and bought back during the wet season obtained a windfall gain if the transactions were held at the market. However, household heads whose transactions took place at the village incurred financial losses during the wet season. In order to investigate if the pattern observed in 1986/87 was typical, a multiple year price data were used to put the discussion of seasonal pattern of millet sales in perspective. In the absence of a panel of households, the prices observed in the main market in the market triad for the Southwest Peanut Basin were used to analyze the gains and losses resulting from selling millet at harvest and buying back during the 1985/86, 1987/88 and 1988/89 marketing years. The results indicated that household heads who sold millet at harvest and bought back during the 1987/88 and the 1988/89 incurred financial losses in those years; for the 1985/86 marketing year, household heads who sold at harvest and bought back during the dry season (January-

March) and during the wet season (July-September) incurred financial losses, whereas household heads who bought back during the hot season (April-June) obtained a windfall gains. The results of the analysis imply that when markets are uncertain and volatile, the behavior of prices may provide losses as well as occasional windfall gains for household heads who sell at harvest and buy back. In general, however, the lack of liquidity that results in farmers selling at harvest and buying grain back later in the season imposes costs on these farmers.

7.1.4. Social Closeness and the Transactions among Farmers

By liberalizing the local cereals markets, one goal of the GOS was to enable farmers to take advantage of diversified market outlets as a result of the increased "legal" competition among market participants. Furthermore, when risk is important in a subsistence economy like Senegal, minimizing transaction costs through the choice of contractual relationships becomes an important issue.

For millet sales, the results of the analysis show that when a Woloff farmer in the Peanut Basin sells millet to another farmer, he provides on average a subsidy for each kg sold. For millet purchases, when a farmer buys millet from another farmer, he gets a subsidy for each kg purchased. The average amount of the subsidy was found to be lower when the transactions take place at the market than at the village. Furthermore, for purchases at the village, there was not a significant difference in the average amount of subsidy provided by the Serer and by the Woloff. For purchases at the market, the average amount of subsidy was higher for the Woloff than for the Serer. The results also indicate that the impact of social closeness is greatest during the wet season (July-September), which corresponds to the period where cash is low in rural areas, while millet is badly needed for consumption. One implication of the analysis is that one has

to be careful in analyzing elasticities of marketed surpluses when farmers have different market outlets if social contracts guide transactions among farmers. The analysis of social closeness seems to indicate that a traditional "safety net" is already in place in the Peanut Basin. Under current conditions, this solidarity is strengthened by the fact that the farmer who is making a price concession to another farmer expects a reciprocal obligation if he is short in grain in the future. Given the level of uncertainty in subsistence farming, social closeness may be viewed as a risk-sharing mechanism to reduce transaction costs. For this reason, the introduction of village-cereal banks may be a more formalized way of using the solidarity among farmers if the primary objective of the cereal banks is to sell to village members at prices slightly lower than those that prevail at the market. This means that the cereal banks' primary objective will not be driven by profit, but by reducing price uncertainty for members who will be short in grain.

Continuous food aid may, however, reduce the moral obligation of providing a price subsidy to another farmer in the sense that when food aid is allocated to a village, the probability of receiving it is in theory the same for all farmers living in the village. This may reduce the interdependence among farmers and lead them to a situation where they lose the reciprocal obligation of trading among themselves. With the introduction of food aid, the seller may not see the obligation of providing a price subsidy, assuming he can receive food aid if he is short in grain next year.

7.1.5. Market Coordination Issues

Market coordination refers to the ability of the markets to match supply with demand effectively. However, when prices are volatile, resulting from the thinness of markets, this coordination becomes difficult.

At the farmer level, in both the Southeast and the Southwest Peanut Basin, the probability of making money from the month-to-month storage is lower than our specified performance norm of 0.8. For farmers who store from month-to-month and hold inventories whenever it is not profitable to sell, it pays to store in three years out of five.

At the wholesale level in the Southeast Peanut Basin, the probability of making money from the month-to-month storage is 0.34. For wholesalers who store from month-to-month and hold inventories whenever it is not profitable to sell, storage is profitable only in one year out of five. For wholesalers who buy millet at harvest (October) and store it until December, storage is profitable in three years out of five. These wholesalers would have made money in five years out of five if they had access to the official credit market. For wholesalers who buy and store millet on a month-to-month basis and sell whenever it is profitable and not to buy again for the rest of the marketing year, storage is profitable in four out of five years. Wholesalers for whom this behavior applies will have to stop trading millet at the end of December of each marketing year.

The analysis of temporal market integration in the Peanut Basin implies that when markets are uncertain and prices volatile, storage may be a very risky business. As a result, it may not be in the private traders' interest to get involved in long-term storage. Given the importance of millet for home consumption in rural areas, farmers will continue to store it despite the price volatility because the shadow price of millet may be higher than the observed market or farm-gate price. The government could, for example, work on trying to improve the functioning of the capital markets and the information system, both of which would encourage private storage.

The analysis of spatial market integration using the bivariate price correlation coefficients reveals that markets were not well-integrated for the period before the public price reporting system came into being (i.e., before February 1987). Only 9 coefficients out of 33 (27 percent) were greater or equal to 0.77. For the period since the price reporting system began, the markets appear better integrated, as 32 coefficients out of 45 (i.e., 71 percent) were greater than the 0.77 correlation norm used by Barry (1989). The markets appear less integrated if the 0.9 correlation norm applied by Lele (1971) is used.

The bivariate price correlation approach was generalized to the case of n markets to assess the integration of the system of markets. Market integration is understood as the existence of a common price trend across markets. The results indicate that the system of all markets in the Peanut Basin is not integrated, i.e., the system cannot be considered as a unified market. However, the system of markets in the Southern Peanut Basin is integrated for both the period before and during the price reporting system. The implication of the analysis is that private traders (wholesalers, assemblers) transmit price signals to farmers in the Southern Peanut Basin, but do so less effectively for farmers in the other parts of the Peanut Basin. This is probably due to the thinner market in those regions, which makes prices more volatile and supply more unpredictable and more difficult to collect.

The analysis of the marketing costs and margins for wholesalers selling at the place of purchase with or without storage reveals that the net margins for both the 1986/87 and the 1987/88 marketing years are below 5 percent of the sales prices. The analysis of the returns to capital indicates no evidence of monopoly profits.

7.2. Changes in Public Policy to Improve the Performance of the Millet Subsector

7.2.1. Avoid General Policies

The results of the analysis demonstrate clearly that it is no longer appropriate to have a general policy approach in Senegal, but rather to have targeted policies that take into account the heterogeneity among households and among farmers, and the resource potential among the different regions and their comparative advantages. For example, it was shown that farmers are not homogeneous throughout the Peanut Basin, especially comparing farmers in the Southern Peanut Basin to farmers in the other parts of the Peanut Basin. Furthermore, the behavior of markets in the Southern Peanut Basin is different from the behavior of markets in the other parts of the Peanut Basin. In addition, the degree of market involvement is different between the Southern Peanut Basin and Southeastern Senegal, where 40 percent of households do not enter the market (Goetz, 1990). Likewise, the hypothesis of "forced" sales is confirmed in the Southwest Peanut Basin, whereas it was not confirmed for Southeastern Senegal (Goetz, 1990). A closer collaboration with the Farming System Research (FSR) teams is needed to learn more about farmers' circumstances they take into consideration in their recommendation domains that can serve as a basis for facilitating the targeted policies.

To start concretely in the Peanut Basin, the following options may be considered:

i) the government may first concentrate its effort on increasing the production potential of farmers in the Southern Peanut Basin. This will make households already generating surpluses to increase them further and enable those not generating enough surpluses to be able to do so. It could then improve the marketing system to facilitate the flows of millet from the Southern to the Central and the

Northern Peanut Basin. This will imply devoting more resources to the higher agricultural potential areas of the Peanut Basin, and to provide the necessary institutions and infrastructure to enable the product markets to function efficiently, such that millet flows more rapidly to the lower potential areas of the Peanut Basin. But an important question in this situation is where would the households in the lower potential areas find the financial resources to buy the surpluses of millet from the Southern Peanut Basin? Based on table 4.4 from chapter 4, it would be necessary that remittances be increased, as certainly many rural households from the Northern and the Central Peanut Basin will migrate to urban areas. Alternatively, the government may help households in the Northern and the Central Peanut Basin by enabling them to increase their investments in livestock (especially sheep fattening) and petty trading, which after remittances, are the most important sources of income in the Central and the Northern Peanut Basin.

ii) another option may be to develop shorter and more drought-tolerant varieties of millet to cope with the short length and more uneven distribution of rainfall in the Central and the Northern Peanut Basin.

7.2.2 Institutional Innovation to Improve Millet Production in the Peanut Basin

This section draws on the lessons learned from the confectionery peanut contracting to suggest an institutional innovation to improve millet production in the Peanut Basin. The experience from the confectionery peanut contracting described in chapter 4 can serve as a basis for a new credit program to improve the welfare of farmers in Senegal. In Senegal, agricultural credit was provided from independence to the early 1980's, but the results of the program were not in general what the government expected, as farmers were not paying back the credit they obtained, which led to massive

debt forgiveness. Even though the frequent drought that affected the Sahel might partially explain farmers' behavior, it remains true that the overall credit program was poorly designed. A few of the reasons are summarized below:

a) The credit program was channelled through the cooperatives, which were the creation of the government and not based on the desire of farmers to organize themselves. As a result, it was difficult to avoid opportunistic behavior, and to foster trust among the cooperative members.

b) A good system of incentives did not exist to stimulate competition among the members of the same cooperative and between cooperatives and to sanction opportunistic behavior.

c) The credit was provided based on the expression of farmers' individual needs. The drawback to this procedure was that there was no basis for knowing whether the needs expressed by farmers conformed to what they could reimburse in reality.

d) The credit was provided based on the total amount of withholding ("retenue") from farmers' peanut sales to the cooperative. This was not a good system because of bad record keeping.

e) The cooperatives were the target of different interest groups. For the government, the primary objectives of the cooperatives were to regulate the peanut subsector, to facilitate the extraction of surpluses in the early stage of development, and to promote the modernization of the agricultural sector. For politicians, the primary function of the cooperatives was to serve as a basis for getting more political support in exchange to providing easy access to credit and other services. For rural notables and religious leaders, the cooperatives were to

be used to strengthen their authority and enhance their prestige (Waterbury, 1987).

All the developed countries of today have evolved from a sound agricultural credit program that enabled farmers to increase productivity. Senegal cannot escape from this reality. However, any credit program must be designed appropriately, to increase its chance of success. The remainder of this section attempts to develop some thinking in that direction.

A new credit program can be built in Senegal, based on a set of new rules, different from those that prevailed in the past, the current forms of organizations in rural areas, and the lessons learned from the confectionery peanut contracting. In the new program:

a) The credit should be channelled through farmer groups and not through current cooperatives and village sections. In the Peanut Basin, farmer or village groups are becoming the dominant form of organizations for the rural population. Farmer or village groups are smaller than the cooperatives and village sections created by the government. Farmers who belong to the same farmer group share common values and beliefs, which establish trust among them and reduce transaction costs. The analysis of social closeness in chapter five showed that farmer solidarity was prevalent in the village. This suggests that future cooperatives will have a better chance of success if they are based on farmer groups.

b) The credit should not be based on what farmers think their needs are, but on what is the minimum amount an average farmer can receive and still be able to improve his food security, while allowing a high probability of reimbursement in

light of the procedure used in the confectionery peanut program. The credit can be based on one hectare during the preliminary phase, and farmers, who after three years of involvement pay back their debt at 100 percent, can have an additional hectare.

c) Every farmer group which will does not reimburse 100 percent of its debt will not obtain credit the following year. And if after one more year the credit is still not reimbursed, the farmer group will be dissolved and the members will not receive any credit from the government in the future. This type of reinforcer will minimize debt forgiveness, which hurt the functioning of the former "Programme Agricole". Furthermore, farmer groups that pay back their debt early should be rewarded in order to stimulate more competition among them.

d) The farmer group will be responsible for the amount of credit received, and its distribution will be solely decided by the group. Farmers in the group will most likely have similar credit history, which will allow them to evict others not having this characteristic.

e) The farmer group may get involved in other activities such as sheep fattening, retailing to members of nonagricultural commodities (consumer goods), and skilled manual work. These activities enable the farmer group to diversify its functions and to multiply its income opportunities.

f) The farmer group should be legally instituted, i.e., be legal in the view of the government. Furthermore, each member must be required to sign a binding agreement to the rules of the organization. For example, such rules may specify under what conditions a non-reimbursement of a member's debt may give the organization the right to confiscate the member's property. In case of a dispute

among members, the body responsible for resolving it should be made clear in the legal documents. The government must play an important role in this process and all its actions must build on the informal procedures used by farmers.

7.2.3. Increase Investments in Agriculture

More resources need to be devoted to research on improving the productivity of local cereals at the farm by creating drought resistant varieties of local cereals that would cope with the shorter length of rainfall. To facilitate this process, there is a need to take into account farmers' needs and constraints in the design of the research. Furthermore, it is important that farmers get access to supporting institutions. Raising the level of productivity for local cereals by generating decreasing-cost technology is a necessary condition to enable the agricultural sector to provide the basic staple foods that would facilitate the substitution of local cereals for imported rice for the growing population. Agriculture is the primary source of employment and income for the majority of the population in Senegal. For this reason, there is a positive correlation between agricultural performance and the income and well-being of farmers (Mellor, 1986). If rural incomes increase, the demand for labor-intensive goods produced outside the agricultural sector increases, which will increase employment in that sector, and the need to pull people out of agriculture (Mellor, 1986).

7.2.4. Changing the Legal Foundation of Markets

Market participants will not be willing to invest in the agricultural sector or expand their domain of exchange beyond the circle of families and friends, if the legal foundation of the economy is not changed. This requires a clear definition of the rules of the game, contracts and their enforcement, protection of property rights, and an adequate market information system.

In Senegal, the rules of the game governing market transactions change regularly, which make them unpredictable for market participants. Ideally, the rules of the game should be stable to facilitate participants' willingness to invest and expand their business.

Contracts guiding local cereals transactions in Senegal are not written and are primarily based on the network of families and friends. As described above, farmers develop social contracts to cope with production uncertainty. In order to expand the domain of exchange of farmers, there is a need for both implicit and explicit contracts so that the trust and commitments that exist among people who know each other are expanded throughout the country.

According to Ouedraogo et al. (1989), the price reporting system undertaken by the CSA enables market participants to plan their purchases or sales better, and to know in advance which markets offer the most favorable price. Although the price reporting system of the CSA is an important step toward increasing the transparency of markets in Senegal, the public agency should develop a sound method for providing information about the level of stocks, and include production and area forecasts. The public agency should also consider broadcasting prices on television as in Mali (Dembélé, Staatz and Egg, 1990). Furthermore, the government needs to specify grades for local cereals, which will increase the potential for long distance trade.

7.3. Need for Further Research

Although this study builds upon a much longer program of marketing research at ISRA, most of the results reported are based on data collected during 12 months. For example, it was found that the majority of household heads in the sample are net buyers of millet. The extent to which this had to do with weather-related factors was not sorted out in the study. Multi-year panel data would have allowed us to assess the extent to

which the market position of household heads remains the same or changes from year to year. Probably the ISRA/IFPRI consumption study carried out after the crop year 1986/87 will provide a comparative analysis for both the Peanut Basin and Southeastern Senegal.

The study was not able to assess to what extent farmers in the sample used improved varieties of millet and the factors affecting their adoption rate. For example, there is a need to know which institutional factors (credit, extension, availability of inputs, reliable output markets) are impeding the process of adoption.

The study was not able to shed light on what happens to the quantity of millet production not marketed by the dependents. This issue is important because it provides a better understanding of whether the dependents contribute to household millet consumption or not. For example, according to Cattin and Faye (1982), the dependents may give additional millet to their wives if it is their turn to cook for the entire household.

The study found that millet prices are highly volatile, which makes storage highly risky. It would be important to study the price behavior of other commodities such as sorghum, maize and cowpeas and the profitability of storing them.

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