The Groundnut Market in Senegal: Examination of Price and Policy Changes

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(ABSTRACT)

The Government of Senegal is attempting to liberalize the groundnut market. In the past, this market was highly regulated with government-set producer prices, groundnut oil processing mills owned by parastatals, and requirements that all groundnuts be sold to these quasi-governmental organizations. In recent years, these rules are being relaxed, and farmers are allowed to sell groundnuts on the open market. However, farmers continue to sell most of their groundnuts, as before, to the mills.

This study attempts to shed light on the effects of this market liberalization. First, an attempt is made to provide estimates of the farmers' short-run output supply and input demand responses to price changes. A quadratic profit function model is estimated using data collected for the current study and a similar dataset collected by Akobundu [1997]. Second, a quadratic programming model is used to examine the effects of eliminating pan-territorial prices. Results indicate that the elimination of the pan-territorial price system will have an overall benefit to Senegalese society. However, as expected, groundnut producers in areas remote from the groundnut oil processing mills would face lower prices. The effects on producers and consumers in the major producing regions, however, were found to be minimal.

Finally, the dissertation provides an extensive description of the economic activities of small-scale farm households in Senegal's Groundnut Basin. Differences between males and females and between household heads and other males in the household are also examined. Although females are not as involved in groundnut production, they do not seem to face discrimination in either the official or the open market.

The description of the situation facing small-scale farmers provided in this dissertation is not encouraging. The quantity and timing of the rains in the Groundnut Basin add an unwelcome uncertainty to farming. Increases in population are adding pressure to the environment and are placing heavy demands on wood and grazing lands. Only eight percent of the farmers had groundnut seed multiplication ratios less than one, and sixty-seven percent had ratios less than five.

The dissertation also indicates that farmers are not producing enough to feed their families. Fewer than twelve percent of the households produce a caloric surplus. Sixty percent produced less than fifty percent of their caloric needs. The study indicates that farmers are not earning enough from agricultural production to take care of normal expenses throughout the year. Thus, when combined with uncertain rains and a worsening environment, the farmers have little margin of safety. Therefore, any government policies affecting groundnut production in particular or agricultural production in general should take into account the situation already facing the farmers.

DEDICATION

This dissertation is dedicated to my wife, Lyn, our son, Rafael, and to my parents, Ruth Simpson Hart Gray and the late Reverend Corbelle Katon Gray.

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Acronyms and Abbreviations

AB	*arachide de bouche*
AH	*arachide huilerie*
AS	*arachide semence*
CE	*chef d'exploitation*
CFA	*Communaté Financiere Africaine*
CM	*chefs du ménage*
CMD	*chefs du ménage dependent*
CS	*coque sèche* or groundnuts in the shell
CSA	*Commissariat de Sécurité Alimentaire*
D&T	*décortiquée et triée* or shelled and treated groundnuts
EEC	European Economic Community
EU	European Union
F	female
fCFA	Currency (Franc) used in CFA countries
GOS	Government of Senegal
HD	*homme dépendent*
IFI	international financial institutions
IMF	International Monetary Fund
ISRA	*Institut Sénégalais de Recherches Agricoles*
M	male
Mb	*mbindane*
N	*navetane*
NPA	*Nouvelle Politique Agricole* or New Agricultural Policy
OCA	*Office de Commercialisation Agricole*
ODA	official development assistance
ONCAD	*Office National de Coopération et d'Assistance pour le Développement*
OPS	*Organismes Privés Stockeurs*
S	*sourga*
SAP	structural adjustment program
SIP	*Sociétés Indigènes de Prévoyance*
SONAGRAINES	*Société National d'Approvissionnement en Graines*
SONAR	*Société Nationale d'Approvissionement du Monde Rural*
SONOCOS	*Société Nationale de Commercialisation des Oléagineux du Sénégal*
SST	*sax-sax titurés* or groundnut pâte
USAID	United States Agency for International Development
VERTE	green groundnuts

Chapter 1: Introduction

1.0 Introduction

A principal role of governments everywhere should be to improve the lot of their citizens. In Senegal, more than seventy percent of the people depend on agriculture[1] as their primary economic activity. Therefore concentrating on policies to improve conditions in the agricultural sector is one important way the Government of Senegal (GOS) can improve the lot of its citizens.

Beside its importance in the lives of the people, agriculture is also important for the operation of the state. Traditionally, most of Senegal's export earnings have come from agriculture and mainly from a single crop—groundnuts. Recently, however, a combination of events has reduced the amount of money that can be made from the production of groundnuts. Drought, changes in the world price, and political events in Europe are changing the role groundnuts play in the Senegalese economy. The Senegalese farmer is faced with the problem of whether to grow groundnuts as a cash crop or to grow food to feed the family. Also the state is faced with uncertainty about whether or not to increase groundnut exports as a way to improve its balance of trade.

More than forty percent of Senegal's agricultural land is planted to groundnuts. At the end of the 1970s, peanuts accounted for over forty percent of the value of the country's total exports. For many farmers, groundnut production is the only way to earn money to buy other commodities.

The Senegalese government has been heavily involved in the production and marketing of groundnuts, both during the colonial period and after Senegal achieved its independence from France on April 4, 1960. The government set prices, assigned

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[1] Figure cited in the *Declaration de Politique de Developpement Agricole* (Declaration of Agricultural

groundnut oil processing quotas, and improved communication and transportation facilities, particularly to benefit the groundnut trade. The French protected Senegalese groundnut imports into France throughout the colonial period and after independence until 1976 when France's entry into the European Economic Community (EEC) forced it to drop this protection.

Most of the GOS's intervention in groundnut production and marketing was not, however, for the purpose of assisting the small-scale farmer. During the colonial period, the interventionist policies were intended to support French firms processing the groundnuts, to reward political allies among the Senegalese, or to obtain revenue to support the administration of the colony. After independence, these motivations continued to influence groundnut policy.

From 1968-1972, Senegal suffered from a major drought, which caused dramatic reductions in the quantity of groundnuts produced. After the drought, world prices doubled. The government responded by allowing producer prices to double also. The world price rise was brief, but the GOS, anticipating that the price rise would be longer-lived, committed itself to large increases in public spending. In 1976, when the French removed its protection for Senegalese groundnut exports to France, the fall in export earnings combined with the increase in public spending created a major debt crisis.

Senegal's balance of trade problems were exacerbated by food imports. Historically, Senegal had financed food imports by exporting groundnuts. The French elimination of protection for Senegalese groundnut exports and declining world groundnut prices created falling and unstable terms of trade for groundnuts relative to mostly imported rice (the major grain consumed in urban areas.) Therefore, in 1984, the government proclaimed *la Nouvelle Politique Agricole* (NPA), or the New Agricultural Policy. A major goal of this policy was to achieve eighty-percent food self-sufficiency by the year

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Development Policy) issued by the Government of Senegal in June 1994. [Kelly *et al.*, 1996, p. 10]

2000. To reach this goal, farmers were to be induced to reduce their production of groundnuts and increase their production of cereals such as millet, sorghum, and maize. Specifically, to encourage the substitution of the food crop for the cash crop, the government set a producer floor price for locally grown grains. Further, the government expanded credit to allow farmers to purchase fertilizer and fertilizer-responsive cereal varieties and reduced credit allocated for the purchase of groundnut seed. [Goetz, 1991]. Unfortunately, many of these policies were introduced without a clear understanding of their effects. There were no studies that predicted the farmers' responses to changes either in producer prices of grains and groundnuts or in the prices of inputs such as fertilizer.

Besides not having the information to completely understand the responses of the Senegalese farmers to official policies, politico-economic and environmental events outside the control of the GOS made the policies seem ineffective. Although world events and the weather will continue to confuse any analysis of the Senegalese groundnut sector, it is important to understand how small-scale farmers will respond to government policies with respect both to producer and input prices.

1.1 Typical Setting for Groundnut Production

Most of Senegal's groundnuts are produced on small-scale farms. Thus, government attempts to assist farmers cannot ignore policies related to groundnuts. Furthermore, policies related to other crops and agricultural inputs in general will affect the production of groundnuts and, potentially, the welfare of the farmer. Before any policy is implemented, policy makers should understand the impacts that the policy might have on the farmer and the farm household.

A small farm in Senegal is not owned and operated by a nuclear family employing, as needed, strangers to supplement family labor. Instead the Senegalese farm household is more complex. Agricultural production is organized around the compound or *carré.* (In

Wolf, the most prominent local language in Senegal, the word is *keur*). The *carré* usually supports from two to five nuclear families, unmarried males (*sourgas*), and hired laborers (*mbindanes*) or sharecroppers (*navetanes*[2]). Those living within the *carré* comprise an *exploitation*. The *exploitation* is usually headed by a male (*chef d'exploitation* or CE) whose own household (or *ménage*) includes his wife or wives and his young children. The secondary households within the *exploitation* are headed by other male relatives—brothers, cousins, or older sons—of the CE. The heads of secondary households are referred to as the *chefs du ménage dépendent* or CMD. [Golan, 1990: p. 4].

The *exploitation* usually grows a subsistence crop such as millet, groundnuts as a cash crop, and crops such as vegetables, manioc, and condiments. The various members of the extended household share the responsibilities for these various crops. The CE allocates the land belonging to the *exploitation* either communally or individually to different members of the *exploitation*. The head must initially ensure that enough land is planted in millet before the other land is distributed so that the food needs of the *exploitation* are met. All members of the *exploitation* have responsibilities to work in the communal millet fields.

According to Waterbury [1987], fields are organized in concentric circles with the staple food crop closest to the house and the cash crop (usually groundnuts) further out. After the communal millet fields are allocated, other lands are divided among the adult members of the *exploitation*. The secondary households within the *exploitation* can be classified as independent or dependent households according to whether they are responsible for their own meals. The head of an independent household must also ensure that he plants enough millet to feed his household.

[2] *Navetanes* are present in the household during the rainy season (or *nawet*) [Goetz, 1990, p. 66]

Wives, older children, and other adult members of the *exploitation* are given land to plant and manage their fields according to their own needs. The head of the *exploitation* may also plant a personal field. It is common for individuals to plant their personal fields in groundnuts to satisfy their need for cash.

Typically, women are given the more distant fields for groundnut or millet production, although women may also exploit small plots near the house for vegetable production. Women in the household cannot be simply producers. They have many conflicting demands on their time including caring for children, hauling water, and pounding millet, while also having to share in the communal labor duties of the *exploitation*. Unfortunately, they have limited and often last access to agricultural inputs and equipment.

Labor is readily shared within the *exploitation*. If, however, there are seasonal needs, labor may be hired from outside the *exploitation*. If times are hard, members of the household, mainly the men, may be forced to leave the household to seek work elsewhere, thus reducing available household labor.

The complexity of the Senegalese farm complicates any investigation into the impact of any government policy. As Waterbury notes:

> Much of the micro-economic literature of rural households will miss the mark in Senegal because the locus of decision-making varies according to crop and to contact with public authorities. [Waterbury, 1987, p. 48]

For example, a policy may have a positive effect on the household heads having more access to public institutions than others in the household, but have a lesser effect on the women. A labor policy may influence adult members to leave the *exploitation* to seek work on the outside. This in turn may have a negative effect on agricultural production.

On the other hand, married women rarely migrate for work off-farm. Finally all policies may have an impact on the ability of the households to feed themselves.

The most straightforward policy instruments available to the GOS concerning groundnuts are ones that influence the producer price of the crop itself. A second set of policy instruments can affect the prices of agricultural inputs such as seeds, fertilizer, pesticides, and agricultural equipment. Usage of these inputs can affect the level of production both of groundnuts and of millet. Third, the government can affect the availability of credit. Without credit farmers will be limited in the amount of inputs they can purchase, because whatever cash they receive from their groundnuts comes at the end of the harvest. A fourth policy is the accessibility of insurance. Droughts are frequent in Senegal. If a drought causes serious crop failure, farmers without some form of crop insurance may fall into debt, affecting their ability to purchase seeds and other inputs for the next season's planting. Agricultural extension and research is a fifth policy intervention that can affect the farmers. Better seeds and farming practices can positively affect crop production. There are also policies affecting both the agricultural *exploitation* and the world outside the *exploitation*. For example, increasing wage rates for hired labor may not only affect agricultural production, but if wage rates are high enough off-farm, family members may be able to help the *exploitation* more by migrating off the farm and remitting part of the earnings back home. This study will focus on the farmers' responses to changes in the producer prices and in the prices of inputs.

1.2 Historical Price Setting

Historically, the GOS has maintained a monopoly on the purchase of groundnuts and on processing them into oil. At the beginning of the season, the GOS set one producer price for groundnuts throughout the country. Accepting this *pan territorial* price, farmers were required to sell their groundnuts to official agencies. Since the cost of transporting the groundnuts from the collection points near the villages to the mill was borne by the GOS or its parastatal groundnut agency, every farmer received the same price, regardless of how far the farm was from the groundnut mill.

Through pressure from international agencies, the GOS is liberalizing the groundnut market. As a first step, farmers were allowed to sell groundnuts on the open market. However, since the open market is still not well organized, the majority of the groundnuts are still sold to the mills at the government-determined pan territorial price. In recent years, there have been attempts to privatize the mills and to encourage a further expansion of the open market. However, the fulfillment of these objectives is still in the future.

1.3 Objectives and Testable Hypotheses

Households in the Kaolack and Fatick regions of Senegal consists of one or more family groups each including a household head, one or more wives, children, and other adult males. A better understanding of these groundnut-producing households will improve understanding of how policies will affect them.

The objectives and hypotheses are as follows:

1) To examine the effects on Senegalese small-scale groundnut farmers of changes in the producer price of groundnuts and in prices of inputs.

   Hypotheses:

   a) The supply of groundnuts and the supply of cereals are inelastic with respect to producer prices.
   b) The quantity of agricultural inputs is price elastic.

2) To determine differences within the household in the Kaolack and Fatick regions of Senegal as to the production and commercialization of groundnuts and the availability and access to agricultural inputs.

Hypotheses:

a) There are no differences between men and women and between the household head and other adult males in the price received for groundnuts.

b) Access to agricultural equipment and other inputs affects the production and sale of groundnuts among the various groups who comprise the household.

3) To examine what would happen if the pan territorial price on the producer price of groundnuts were removed.

Hypothesis:

a) If the groundnut market is liberalized and farmers are allowed to sell their product on the open market, farmers in places distant from the oil mills or major population centers will receive less for their groundnuts.

b) Eliminating pan-territorial pricing will have a net benefit to society as a whole.

1.4 Methods

A random survey of approximately 200 households in the Kaolack and Fatick regions of Senegal's Groundnut Basin will be conducted. This survey will be similar to a survey of 147 households in 25 villages conducted by Akobundu in 1997.[3] In parts of the analysis for this study, data from both surveys may be combined.

The data collected for the current study and the data collected by Akobundu [1997] will allow a better understanding of the households. In particular:

1) The demographics of a typical household and whether different members of the household are treated differently or respond differently to policies,
2) The environmental conditions facing farmers in these regions and how the farmers perceive them as affecting their production,
3) The variety and quantity of crops produced by the households and whether there are differences among men and women, especially concerning the use of agricultural equipment and fertilizer,

4) The type of labor used by the household,
5) The production and commercialization of groundnuts and differences between men and women,
6) The patterns of spending in the household,
7) The ceremonial demands placed upon the households, and
8) The other sources of income available to the household.

Data in the current survey will be collected on the quantities of groundnuts and other crops grown by the household, quantities of inputs used including labor, prices received for the crops, and price paid for the inputs. A profit function model of these households will be created, and from this model, output supply and input demand equations can be derived. After these equations have been estimated, output supply elasticities and input demand elasticities will be calculated to enable estimates of the household's response to price changes to be obtained.

Much of the data collected in the survey will be obtained not only for the household as a whole, but also for individual members—male and female, household head and other adult males—to enable inter-household comparisons to be made. The survey data will also allow a description of a typical household in the survey regions to be made. From this description, one will be able to discover, among other things, how the household spends its money and what other crops besides groundnuts are being tried as cash crops.

The survey data collected as a part of this dissertation will not be used to examine effects that may result from eliminating the pan-territorial price. This topic will be examined at a more macro-economic level. To examine the effects of relaxing the government set pan territorial price, a quadratic programming model will be used maximizing the sum of producer and consumer surplus. Groundnut production data from the twenty-nine administrative departments of Senegal (1996/1997) will be used in the analysis. Various

[3] The results of the Akobundu survey are published in Akobundu [1997].

scenarios to be examined include how the cost of transportation affects the movement of groundnuts and the welfare of consumers and producers.

Chapter 2: Historical Background

2.0 Introduction

This chapter briefly reviews the history of Senegal and then discusses in somewhat more detail the history of Senegal's experiences with groundnuts from their earliest introduction by the Portuguese to the time of this dissertation. This chapter provides the political and historical context in which the current research takes place.

2.1 General Historical Background[1]

Since Senegal as a political entity dates only from 1920, its history must include the history of the peoples and kingdoms that have inhabited and controlled the area. Little is known of Senegal's past before its initial encounters with Arab traders in the ninth and tenth centuries. Writings from these Arabs and later writings by Portuguese traders indicate that the original people lived further north than their present location. The spread of Islam out of North Africa pressured the population to move south to their present location. Islam itself reached Senegal in the eleventh century, although it did not become firmly established throughout the country until the nineteenth century. From the time of these initial contacts with the Arabs and Portuguese, the peoples of Senegal have maintained contact with their northern neighbors both through trade and military conflict.

Senegal was a physical part of the great African empires that existed in the Sahelien region from the fourth to the sixteenth centuries. The great empires of Ghana (ca. 1000 BCE), Mali (ca. 1350 BCE), and Songhai (ca. 1520 BCE) controlled parts of modern-day Senegal. As these major empires broke up, lesser kingdoms rose and fell in their attempts to control the land.

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[1] Information from this section and the following one draws on the *Area Handbook for Senegal*, pp. 9-38, the *World Bibliographic Series Volume 166: Senegal*, pp. xvii-xxii, and Geller [1982], pp. 1-43].

During the fifteenth century, Portuguese navigators explored the coast of Senegal and began trading both in gold and slaves. The Portuguese maintained their papal-granted monopoly until the mid-sixteenth century when English, Dutch, and French traders began competing with them. The French established trading agreements with local leaders in the early part of the sixteenth century and in 1638, established their first settlement on an island in the mouth of the Senegal River. By 1677, they had driven out the Dutch and established a naval base on Gorée Island, a former Dutch settlement.

Throughout the seventeenth and eighteenth centuries, France continued to exert its commercial influence in Senegal. The French based their commercial activities around the Senegal River. At the same time the British were establishing influence around the Gambia River further south. Competition between these two European powers caused many settlements to change hands several times. Finally at the Congress of Vienna in 1815, the French were granted firm commercial control over the area. Since this treaty also abolished the slave trade, the French made an effort to base their settlements on crops rather than on trade, attempting to plant cotton and other tropical crops. At this time, however, the French were unable either to convince the local people to give the necessary land or to finance the military force necessary to seize the land.

After France lost its colonies in the Americas to the British, it focused its attention on Africa. In 1840, it passed an ordinance making Senegal a permanent French possession. This ordinance also stated that French control would extend not only over the areas in Senegal already under French control, but also over those territories likely to be annexed by them.

The French efforts to expand their sphere of influence collided with the expansion of Islam. In the late eighteenth century, the Tukulors, a militant Islamic group, established an empire in Senegal. In the 1850s, al-Hajj Umar Tal, a member of the ruling class, made a pilgrimage to Mecca where he joined the Islamic Tijaniyya brotherhood, one of the three Islamic brotherhoods that still wield enormous influence in Senegal. In an attempt to spread the faith, he not only attacked the non-Moslems among the Senegalese, but also attempted to expel the French. Although defeated by the French in 1860, the Tijaniyya brotherhood continued to spread the faith to the east. However, the confusion caused by these wars made it easier for the French to establish their control.

As Islam spread, conflicts were also created between religious leaders and traditional tribal chiefs. The French attempted to take advantage of this situation by a practice of divide and conquer. However, their support of the tribal chiefs backfired, for rather than elevating the chiefs, it transferred the loyalty of the people to the religious leaders. Therefore, the Islamic brotherhoods, Tijaniyya, Qadiriya, and Muridiya, acquired not only more political, but also more economic power.

In the late nineteenth century, during the "scramble for Africa", the French attempted to forcibly pacify the colony. In the early 1880s, they began a military push east across the Sahel and south into the forested areas of Guinea. Their self-proclaimed "Grand Design" was to establish French control all the way across Africa. By 1899, their Grand Design resulted in the French controlling most of West Africa.

By 1895, through treaties with other European colonial powers, France had established the boundaries of Senegal, which at that time included most of Mali and Mauritania. In 1904, the colony's boundaries were pared back to include only the land south of the Senegal River and west of the Falémé River—essentially current-day Senegal excluding the Gambia.

From 1904 until independence, Senegal was one of the nine districts in the federation *l'Afrique Occidentale Français (*AOF*)* or French West Africa.[2] Dakar served as the

[2] The nine present day countries that made up French West Africa are Mauritania, Senegal, Guinea, la Côte d'Ivoire, Mali, Burkina Faso, Benin, Togo, and Niger.

capital of this federation and the residence of the French governor-general. Senegal was the jewel of this federation, and the cultural and intellectual elite, or the *évolués*, could actually become French citizens. As such, they had a voice in their government. However, most Senegalese were treated as colonial subjects. These distinctions among the inhabitants of Senegal created by the French resulted in divisions that still exist today.

After France solidified its hold on its vast colony, it had to concentrate on how to make the colony pay for itself. Each colony was to become self-sufficient, paying for its own administration and its own defense. As a coastal colony with well-established trade linkages, Senegal had no problem with the goal. However, as part of French West Africa, it had to help support the poorer inland areas.

Since trade was a primary motivation in France's conquest of Africa, the French began construction of railroads to link the navigable stretches of the Senegalese rivers. When the rivers proved unsuitable for year-round transport, a more extensive network of rail was constructed centered in Dakar. Thus Dakar became Senegal's most important city and the center of its exports. The railroads and the industries and cash crops production that grew up around them were the hallmarks of Senegal's development before World War II.

World War II was a turning point in Senegal's history. When France capitulated to Germany, the Vichy government ruled Senegal until 1943 when the tide of the war began to turn. Many Senegalese soldiers served the cause of the Allies. In 1944, the French enacted a law allowing labor in the colonies to organize. In 1946, representatives from the colonies were called upon to assist in the writing of a new French constitution. With these experiences, it was obvious that "a wind of change was blowing across Africa."

The wind was not strong enough by itself to push Senegal to complete independence. It needed a shove from nationalist movements within Senegal, led most prominently by

Senegal's first president Leopold Senghor. The nationalist movement was aided by events in Algeria and in Southeast Asia where France was suffering the loss of other colonies. The unrest in France triggered by these events brought Charles De Gaulle to power.

One of De Gaulle's first acts was an offer of independence to France's African colonies. After much debate, the form of independence accepted by all of the colonies in French West Africa except Guinea was to become self-governing republics within the framework of a French Community. Senegal was at first to join with Mali as a unit of the Mali Federation. As a part of this federation, Senegal became independent from France on April 4, 1960. Although the federation did not last the year, Senegal still celebrates the April date as its independence day.

At independence, Senegal was relatively well endowed. Since Dakar had been the capital of French West Africa, Senegal inherited a good communications network and an extensive transportation network. Light industries had been developed, and good links had been established for trade in groundnuts, its primary export. It retained its good relationship with France thus availing itself of French assistance in personnel, money, and goods. The continued connection with France, however, meant that Senegal remained solidly within the French sphere of influence. The French dominated its economy; French advisors staffed its public administration; and the French military maintained a presence in the country.

The Senegalese tried to make their own imprint on the newly independent state. Senghor's philosophic concepts of African socialism and *négritude* were intended to adapt European political and social traditions to the values and realities of Senegalese society. The objective of the new government's efforts was to incorporate the large rural population that had become polarized from the urban minority that dominated the economy. Thus in the first few years, in the name of African socialism, the state embarked on a major effort of rural institution building intent on the optimal development of the country and the equitable distribution of the wealth. Senghor articulated his government's policy by stating: "The policy of Senegal is based on development, development, and always development." [Nelson, p. 206]

2.2 Groundnut-Specific Background: Pre-Independence

Any attempts at truly national development have to take into account the enormous dependence of the Senegalese economy on the production and export of groundnuts. This section will discuss Senegal's experience with groundnuts in the period leading up to Senegal's independence from France in 1960.

Portuguese slave traders probably brought groundnuts to Senegal from South America as early as the sixteenth century for use as a food crop. However, they were not exploited commercially until the French began to experiment with groundnuts as a potential export crop. Given the expense attendant with running their colonies, France was always looking for a way to have the colonies support themselves, and groundnuts proved to be one avenue to reach this goal. In 1847, when it was recognized that Senegal's sandy soils and limited rainfall precluded the exploitation of other agricultural commodities, French Governor Protêt proclaimed, "peanuts will save the country". His pronouncement proved true. Groundnut production expanded rapidly (see Table 2.1), and for nearly a century, groundnuts made up almost ninety percent of Senegal's export earnings.

Initially, groundnuts were grown around the port cities of Saint-Louis and Rufisque. However, as the French moved into the interior, groundnut cultivation followed this extension of French authority into the Sine-Saloum area later known as the Groundnut Basin.

Table 2.1: Early Growth of Groundnut Exports

Year	Quantity of Exports (1,000 metric tons)
1875	13.9
1885	45.1
1895	51.6
1905	96.2
1915	303.1
1925	453.7
1936	487.3
1948	451.0
1958	808.0

Source: Cruise O'Brien [1975], p. 7

The various Islamic brotherhoods[3] and the marabouts[4] were also instrumental in the spread of groundnut production. Because of the economic return the marabouts foresaw for groundnut production, they urged their disciples to cultivate groundnuts on their lands. This action pleased French colonial administrators because it coincided with their economic plans for the colony. Thus, because of their interest in extending groundnut production, the colonial authorities granted many Tijaniyya and Mouride marabouts extensive tracts of land on which to grow groundnuts. They also supported the marabouts in their disputes with mainly Fulani herders over the conversion of traditional grazing lands into groundnut fields.

Groundnut production was also significantly aided by the construction of the railroads. By 1923, rail had been laid inland from Dakar to Louga, northeast of Dakar, and to Diourbel and Kaolack, towards the southeast [*Handbook*, p. 55]. As the railroad extended towards Bamako, groundnut production continued its expansion. Today the Groundnut

3 There are several Islamic brotherhoods in Senegal. The two most prominent are the *Mouride* and the *Tijaniyya*. The largest brotherhood is the *Tijaniyya*. The most powerful politically and commercially is the *Mouride.*

4 Marabouts are Moslem holy men who, in Senegal, serve not only as religious leaders, but also civic leaders. They remain today very influential commercial actors as they continue to control large areas in the Groundnut Basin.

Basin essentially surrounds the railroad. In fact, ninety-three percent of Senegal's groundnuts are produced in areas serviced by the Dakar-Saint Louis and Dakar-Niger railroads [Geller, pp. 13-14].

At first, groundnut production was a gain for the Senegalese farmers since there was sufficient land both for groundnuts and food. Later, however, population increases and the increased demand for consumer goods forced the farmer to decide how much food and how much cash crop to plant.

Despite the spread of groundnut cultivation, the groundnut sector was dominated by a small group of actors. A few large French trading companies who controlled the processing of groundnut oil also controlled groundnut marketing. The middlemen who purchased the crop from the small farmers were mainly Lebanese and Syrians. A large percentage of groundnut production was on land controlled by the marabouts. The ologopolistic nature of the groundnut market led many people to believe that the individual farmer was not adequately protected.

To assist the farmer and to protect him from exploitation by middlemen, the French formed cooperative groups called *Sociétés Indigènes de Prévoyance (SIP)*. It was envisioned that these groups would protect the farmers against a lack of foresight, help needy families during years of bad harvest, and distribute food during the *soudure* (end of the dry season/beginning of the rainy season often know as "hungry time"). Membership in the SIPs was mandatory, which in effect forced all farmers to grow some cash crop in order to pay their dues. In time, the SIPs became just another part of the French administration, subject to abuses of power and outright corruption that plagued other institutions.

Robert Tignor argues [1987, p. 100] that the French trading companies and the middlemen were not the source of the problems blamed on them by the French colonial government and later by the Senegalese government. Instead, there were a sufficient number of them to allow competition to keep producer prices fair and interest rates low.

The problems for the groundnut cultivators came in the late 1920s and 1930s when the world price of groundnuts fell, and revenues decreased dramatically (see Table 2.2.) In response, the big trading companies fixed producer prices at a low level. Since the farmers' debt payments, often to these same companies, remained high, their situation became serious.

Table 2.2: Senegalese Groundnut Exports 1926-1936

Date	Quantity (tons)	Revenue (francs)	Revenue (US$)
1926	494,416	752,643,000	28,305,490
1927	405,608	616,623,000	
1928	413,356	593,310,000	
1929	406,760	554,310,000	
1930	508,195	501,841,000	
1931	453,811	306,731,000	11,962,988
1932	191,469	162,340,000	
1933	388,010	188,276,000	
1934	494,264	234,090,000	
1935	392,308	347,334,000	
1936	487,340	351,675,000	

Note: Prices are current prices
Source: Tignor 1987, p. 102

To make up for their falling revenues, farmers reacted by increasing the amount of land planted in groundnuts. This, however, did not solve the problem. Although groundnut exports in 1931 were near the level in 1926, returns were less than half. Almost every actor in the groundnut sector was affected—the export-import firms, the oil mills, the small merchants, the farmers, and the state administration who were faced with falling revenues.

The farmers, in response, shifted from groundnut to millet production. Between 1929 and 1931, farmers increased the area planted in millet by 150,000 hectares. This, however, did not solve the problem due to a drought in 1932. Both the drought and the switch from groundnuts to food crops caused groundnut exports to decline dramatically.

In 1933, to revive the groundnut trade, France imposed a duty of approximately ten-percent on imports of vegetable oil, while allowing Senegalese groundnuts to be imported duty-free. In Senegal, they also lowered railroad rates, increased funding for groundnut research, and temporarily removed the export tax.

The French recognized that the farmers' concern about food would inhibit expansion of groundnut cultivation. Therefore they reinforced the capacity of the SIPs to ensure food security through the import of rice from Indochina and the storage of food for distribution during the *soudure.*

It was during this period also that the French expanded the capacity at the agricultural research station at Bambey. Their goal was to increase the distribution of high-yielding groundnut seeds through the SIPs to the farmers.

The SIPs were not the only groups involved with groundnuts. Since before World War I, private traders had been buying groundnuts directly from the farmers. In 1933, the SIPs were allowed to enter the marketing arena in competition with the private traders. However, the entry of the SIPs into marketing was not totally successful for several reasons. First, the SIPs paid farmers only seventy-five percent of the purchase price when they took possession of the groundnuts, and the rest was promised after the crops had been sold to the mills and administrative and transport costs covered. Farmers were a bit suspicious of these arrangements, preferring to have one hundred percent up front.

Thus the SIPs were never able to successfully compete with the private traders. Besides their unwillingness to pay all the money up front, the SIPs never formed the personal bonds with the individual farmers. Furthermore, the private traders had already formed bonds with the local transporters (mostly people with donkey carts) to deny farmers the ability to ship their groundnuts to the SIPs. Private traders also rewarded transporters for delivering groundnuts directly to them.[5]

In the 1930s, the colonial government made other interventions in the groundnut sector. Notable was the creation of the *Crédit Agricole Mutuel*. Loans from this organization were made both to the SIPs and to individuals. Loans to M*ouride* religious leaders supported the expansion of groundnut cultivation into new areas. Another credit agency, the *Fonds Commun des Sociétés de Prévoyance*, financed the purchase of equipment and other agricultural material.

However, despite providing the farmers access to better seeds and credit, the SIPs also became more bureaucratic, inefficient, and corrupt. These traits eventually worked more and more against the interests of the farmers.

When World War II began, the strains on the SIPs were exacerbated. When France fell to the Germans, Senegal was cut off from the rest of the world. Since Senegal had come to rely on rice imports from Indochina, now unavailable, farmers became concerned more with food self-sufficiency that groundnut production and trade. Towards the end of the war, the colonial administration tried again, with some success, to encourage the cultivation and export of groundnuts.

The pressures on the SIPs, made worse by the war, proved too much of a financial burden. Thus after the war, the French relieved the SIPs of the responsibilities of

[5] The past success of the private sector in the marketing of groundnuts may be a good omen for Senegal as it currently attempts to liberalize the groundnut market.

collecting, storing, and transporting groundnuts. These functions reverted to the commercial sector. However, the colonial government now exerted greater control over these commercial establishments, setting purchase prices and establishing the amount each establishment could purchase. Thus the state could determine the level of profit reaped by the private purchasing firms and then extract a healthy share of this profit.

After World War II, the French government of Senegal continued to intervene in the groundnut sector with the dual aims of helping the farmers and of providing sufficient revenue to operate the colony. Other cooperatives were created, but these new organizations fell prey to the same problems as the SIPs. Corruption and mismanagement were characteristic of these new institutions also. The individual farmers felt that all these institutions, both private and state-run, were remote and thus received low priority for their support. By 1953, only a few private cooperatives remained, controlling only a small percentage of the groundnut crop.

2.3 Groundnut-Specific Background: After Independence (1960-1967)

After independence, the newly independent Government of Senegal felt it had to get more control over this sector of its economy. Among its first acts, in 1960, was an attempt to increase production by transforming the SIPs into real, village-based cooperatives. These cooperatives were to become the cornerstone in Senghor's African socialism. They were an attempt by the government not only to free the farmers from the exploitative middlemen, but also to eliminate the system of rural patronage in the hands of local politicians and marabouts. At the same time, the government created the *Office de Commercialisation Agricole (OCA)* to market the major crops, including groundnuts, and to sell essential items to farmers.

Although private traders continued to operate, the cooperatives took over an increasing share of the market. In 1960/61, the 695 newly created cooperatives collected twenty-two percent of the groundnut crop. By 1966/67, this share had risen to sixty-three percent, and by 1967/68, ninety-eight percent of all groundnuts passed through the cooperatives. By 1969, except for a few large producers, even farmers who did not belong to a cooperative had to deliver their groundnuts to a cooperative. [IMF (1970), p. 504]

In 1966, a new public agency, the *Office National de Coopération et d'Assistance pour le Développement (ONCAD)*, was created and given a legal monopoly over the marketing of groundnuts. ONCAD was given the following responsibilities:

1. Maintaining a stock of groundnut seeds in warehouses (*seccos)* around the country. In May, seeds were advanced to cooperatives to be reimbursed in kind (plus a twenty-five percent service fee) in December.
2. Having available inputs and equipment necessary for the cultivation of groundnuts.
3. Buying groundnuts (plus millet and rice) from the cooperatives and transporting them to receiving stations for sale.
4. Ensuring the smooth operation of the cooperative system. [IMF (1970), p. 506]

Thus besides having a state monopoly on the purchase of groundnuts, OCA and then ONCAD also had a mandate to sell seeds, tools, and fertilizers, all on credit. There were also plans to have these state institutions supply low-priced consumer goods to the peasants to help them avoid the 'debt trap.' All these actions were intended to increase groundnut production and thus to raise the standards of living of the groundnut producers.

The creation of OCA and then ONCAD combined with the formation of the cooperatives practically eliminated the role of the private sector in the marketing of groundnuts. While ostensibly freeing groundnut producers from the exploitation of private traders, moneylenders, and colonial commercial oligopolies, the government also gained a major source of revenue. Essentially the government simply replaced the French firms who had controlled the groundnut trade before independence.

Efforts to increase groundnut production were a success. By 1965, production had reached one million tons, a growth of almost one hundred percent since the last years of the colonial period. In 1966, the groundnut sector accounted for eighty percent of the jobs. Unfortunately, the parastatal organizations formed to assist the farmer had themselves become exploitative, like the organizations they replaced. The lofty aims for the cooperatives also failed to be realized. The goal of self-managing cooperatives did not happen. Government middlemen soon gained a reputation for being corrupt and dependent on the local power structure. The cooperatives became simply transmission centers between the farmers and the large parastatals. Many of these cooperatives had been appropriated for the personal service of large producers, mainly marabouts [Delgado and Jammeh, p. 120].

2.4 Groundnut-Specific Background: End of the Senghor Years (1967-1980)

In 1968, the French eliminated the export price supports for Senegalese groundnuts. The elimination of export price supports caused a 25 percent decrease in the Senegalese terms of trade. In response, the GOS reduced the price it paid farmers for groundnuts by over sixteen percent. To ease the burden on the farmers, ONCAD subsidized input prices, made interest-free loans, and forgave past debts. These actions placed a heavy financial burden on ONCAD. [Youm, p. 24]

Also in 1968, Senegal and the rest of the Sahel were struck by a severe drought that lasted nearly four years. The drought compounded problems in the groundnut marketing chain: declines in the supply of agricultural inputs, low producer prices, the failure of the cooperatives and ONCAD to pay their debts, and an understandable increase in the use of parallel markets [Claassen and Salin, pp. 116-117].

In the six years 1968-1973, the export share of groundnuts fell from eighty percent to forty percent. GDP growth rate fell from 2.8 percent in the years 1960-1967 to one percent during these six years. The GOS tried to counter this decline by public investments. Unfortunately these investments were not productive and thus made the problem worse. [Youm, pp. 24-25]

Things were looking better in the period 1974-1977. After the drought, the world price of groundnuts doubled, and the world price for phosphates, another of Senegal's leading exports, quadrupled. These events made Senegal's reform of its agricultural sector less urgent. Prices paid to groundnut producers were allowed to double, and in response, farmers expanded production. Groundnut production achieved records both in 1974/75 and in 1975/76.

During this same period, petroleum-producing nations, united as OPEC, restricted petroleum supplies and caused a rise in world prices. Despite this rise, Senegal's terms of trade improved dramatically. This rise in the world prices of groundnuts and phosphates, however, was short-lived. For phosphates it lasted only two years; for groundnuts the return to normal was even quicker.

The government, however, had responded to these events by greatly increasing public spending. It invested in factories primarily for value-added exports including the expansion of its groundnut oil-processing mills operated by the *Société Nationale de Commercialisation des Oléagineux du Sénégal* (SONOCOS). This expansion would prove unnecessary later on, as groundnut production was insufficient to fulfill SONOCOS's capacity. Since the terms of trade did not turn around immediately, the government continued to spend until late in the 1970s, when exports finally declined and imports increased.

The problems listed above led directly to a debt crisis. Claassen and Salin assert that this crisis had its origin even in the 1960s during the cooperative movement.

> In the early 1960s, each cooperative was built around several villages. While in former times, the collateral for credit consisted of liens on crops and agricultural equipment, the individual responsibility for debt was replaced by collective responsibility in terms of "village solidarity." However, the collective solidarity for debt was not limited to a particular village, but was extended to other villages forming part of the same cooperative. Because a good payer in one village felt rationally reluctant to cover the debts of bad payers in other villages, several collective debt defaults occurred. Another factor was the particular relationship of the peasant to the state, which was more antagonistic than cooperative. Lower producer prices for groundnuts since the late 1960s and the paternalistic behavior of ONCAD created a game-theoretic reaction: widespread debt defaults and resort to parallel markets. [p. 119]

As mentioned above, the government's response to the mounting debt of the farmers was one of forgiveness. In 1970/71 and 1972/73, at the height of the drought, the GOS had assumed all farmer debt left after the harvest, approximately 2,600 million fCFA[6]. This was the first of such actions that included some intentional debt forgiveness and some actual debt default.

Lewis [1987] summarized the period from 1960 to 1978 as having the following characteristics:

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[6] Senegal, along with most of the former French colonies in West Africa is a member of the *Communaté Financiere Africaine* (CFA). These countries use the franc CFA, abbreviated in this paper as the fCFA. The fCFA is pegged directly to the French franc (FF). Before 1994, 1 FF = 50 fCFA. After 1994, 1 FF = 100 fCFA. See section 2.6.

- *A top-heavy bureaucracy, centered in Dakar, left over from the days of French West Africa:* The service sector, including the government, accounted for about 56 percent of Senegal's gross domestic product.
- *An economy heavily dependent on groundnut exports:* Groundnuts were, however, an unstable form of foreign exchange. First, competition from other vegetable oils was taking part of its market even in France. Second, groundnut production was greatly affected by droughts that occurred in the 1970s.
- *French support for Senegal's economy:* France was not only the chief supplier of official development assistance (ODA), but also French private firms were invested in Senegal, French expatriates worked in Senegal, and France allowed Senegalese workers to work in France and send money back home. One unfortunate drawback was that France did not necessarily fund investment; instead it supported consumption.
- *The government of Senegal support for its own interest:* Lewis charges that the government was interested neither in growth nor in equity. Instead the government leaders concentrated on supporting their own high living standards and their political allies throughout the country.
- *Good fortune:* The rise in the prices of groundnuts and phosphates at almost the same time as the 1972 oil shock allowed Senegal to miss the economic shocks that hit the rest of the world.

From 1968 until 1980, Senegal experienced six years of drought. The price increases that had cushioned the shock of the 1972-petroleum crisis did not continue. By the time of the second petroleum shock in 1978, Senegal's gross domestic product had fallen 26 percent. As groundnut revenues fell, the government's debt increased. Payments on the debt had risen from four percent of the value of exports in 1972 to fifteen percent in 1978-1979.

Traditionally the government had viewed the conditions that led to these problems as cyclical in nature. They had also been able to count on the French to help them get through the crisis. Their usual response was to ease the pain of the citizens and wait for the up swing in the cycle. Therefore, their response to the problems in the late 1970s and early 1980s was again to forgive farmers' debt. [Tuck, p. 165]. The budget deficits that resulted became enormous, reaching twenty-nine billion fCFA in 1979/80.

In 1980, after twenty years as head of state, Leopold Senghor left the Presidency on December 31, 1980. He designated as his successor his Prime Minister, Abdou Diouf. Diouf was left the unenviable task of resolving the economic crisis facing Senegal, building on the first efforts already begun in the last year of Senghor's presidency.

2.5 Groundnut-Specific Background: Structural Adjustment

Increasingly, it became obvious that Senegal's problems were more structural than cyclical. As France reduced its level of support for its former colony, international financial institutions (IFI) such as the European Union (EU), The World Bank, and the International Monetary Fund (IMF) began to play a more important role in support of the Senegalese economy. Beginning in December 1979, the IMF and The World Bank began lending Senegal substantial amounts of money under the conditions that Senegal adopt a Structural Adjustment Program (SAP). From 1981-1983, loans were negotiated, but then cancelled when the IFIs felt that progress towards meeting the conditions of the loans were not being achieved. Chowdry and Beeman [p. 154] describe this as "a policy of blatant carrot and stick tactics by the IFIs." Since almost all countries, especially the French, were linking their funding to that of the IFIs, the IFIs had more influence over the Senegalese economy than the actual amount of their financial assistance would warrant.

Before the intervention of the IFIs, Senegal's agricultural policy was based on the following goals:

- A concentration on increasing groundnut production for export and then using the profits to purchase cereal inputs for urban consumption, and

- A utilization of state agencies to supply agricultural inputs and to market the products. [Chowdhry and Beeman, p. 161]

After the imposition of the SAP, policies changed. The IMF recommended:

- Increasing the prices of basic goods including rice, cooking oil, and petroleum products;
- Increasing the rates of indirect taxes and duties, raising the price of fertilizer and reducing the producer price of groundnuts;
- Making the operations of the agricultural marketing agencies more efficient and reducing their costs;
- Reducing overall administrative costs by freezing wages and lowering operating and equipment costs;
- Limiting the growth of the civil service; and
- Reducing state debt and limiting the growth of the money supply and the supply of credit.

[Duruflé, pp. 101-102]

To these conditions the World Bank added a growth strategy that "included the placement of more economic function in the private sector such as those formerly handled by state or parastatal agricultural agencies, the reduction of price distortions and the development of savings." [Chowdry and Beeman, p. 155] These conditions were ambitious, but Senegal made significant progress in many areas.

By mid-1980, irregularities at ONCAD had so alarmed international donors that the GOS was forced to abolish the agency despite the fact that it still owed 94,000 million fCFA to the banking sector. ONCAD's functions were divided among other organizations. Its groundnut marketing functions were transferred to SONACOS, a firm owned jointly by the government and the private oil processing firms. Responsibility for the distribution of agricultural inputs was given to a newly created organization, *Société Nationale d'Approvissionement du Monde Rural (SONAR)*, which lasted only until 1985.

In response to pressure from the IFIs, the Diouf government proposed a set of reforms. Two basic principals were (1) to reduce government intervention in agriculture and encourage the participation of the private sector, and (2) if possible, to remove all government taxes and subsidies [Kelly *et al* 1996, p. 18].

However, less than three years after the beginning of structural adjustment, it was deemed a failure. Two factors seemed to have been critical. First, as in the past, insufficient rain resulted in a poor harvest in 1980/81. Both food production and groundnut exports were below expected levels. Second, the level of government debt was much greater than anyone expected. This was exacerbated by overly optimistic forecasts about the results of Senegalese government policies.

As an incentive to groundnut producers and against recommendations of the IFIs, in 1981, the GOS raised prices forty-three percent expecting a corresponding rise in world prices. When this failed to materialize, there was an enormous increase in the debt caused by the government having to cover the difference between its buying and selling price for groundnuts. [Lewis, pp. 307-308]

2.6 Groundnut-Specific Background: Senegal's New Agricultural Policy

By 1984/85, the government's official marketing system was in serious trouble. Government revenue had dropped, as had export earnings. The groundnut oil mills were operating at less than twenty percent of capacity. Much of the groundnut crop was kept within the household for consumption, sold illegally to private traders, or smuggled across the border to The Gambia. In response to the situation, the GOS changed course.

In 1984, the government articulated a new agricultural policy or *Nouvelle Politique Agricole (NPA)*. Besides addressing agricultural problems, the policy was also a response to the financial and institutional crises of the late 1970s and early 1980s. The objectives of the NPA were (1) to increase cereal self-sufficiency from fifty to eighty percent by the year 2000 and (2) to transfer certain economic activities (input and product marketing) from the state to the private sector. [Martin and Crawford, p. 85] The NPA intended to provide more incentives to the producers rather than wasting scarce resources on unproductive administration. [The Economist Intelligence Unit 1986-1987, p. 19]

To encourage increased cereal production the government took several steps. First, in an attempt to liberalize the cereals market, the government abandoned fixed producer prices in favor of floor and ceiling prices. This was an attempt to increase production and still protect the farmers. Second, extension and research services were expanded in attempts to reduce costs. As a further security measure, a government body, the *Commissariat de Sécurité Alimentaire (CSA)*, was created to maintain emergency cereal stocks and to intervene in markets when prices fell outside the floor and ceiling limits. Due to limited resources, however, these interventions were not very effective, and the government stopped intervening in the millet and sorghum markets in 1989.

The new agricultural policy made significant changes in the groundnut market. Many of these changes were organizational. Since it took over groundnut marketing from ONCAD, SONACOS had being buying directly from cooperatives. In 1985, to further the involvement of the private sector, the GOS licensed a small number of private traders *(Organismes Privés Stockeurs* or OPS) to buy groundnuts directly from the farmers or from the cooperatives. The government continued, however, to set producer prices.

The OPS were not given complete freedom to operate in an open market. For example, the government controlled the areas they had access to. The OPS were not necessarily given access to the same area year after year. This made it difficult for the OPS to give credit to farmers at a time when the farmers had few other avenues to receive credit. [Kelly *et al*, 1996, p. 19]

In the early 1980s, the government had made major changes in the way it had handled agricultural inputs. During the short life of SONAR, formed after the dissolution of ONCAD, all credit for the purchase of fertilizers, equipment, and seed was stopped. These changes occurred with little warning to the farmers.

> Rules changed with little warning, as the government and donors jumped from one stopgap measure to another. This continues to the present day as the government tries to fine-tune those policies that have failed to elicit the desired response from various participants in the agricultural sector. [Kelly *et al.* 1996, pp. 20-21]

The elimination of credit severely restricted the ability of farmers to purchase new equipment such as seeders and plows. Kelly *et al* predicted that failure to address this issue "could profoundly alter agricultural production in the Peanut Basin." [p. 22]

The government also restricted the distribution of fertilizer to farmers in the Groundnut Basin and reduced fertilizer subsidies. This caused fertilizer use to drop almost sixty-four percent[7] from 1980/81 to 1984/85. To help alleviate the problem the United States Agency for International Development (USAID) gave subsidies in declining amounts to farmers to purchase fertilizer from 1986 to 1989. These subsidies, however, were much smaller than those previously given by the GOS. These efforts were less than a total success for several reasons. First, world prices for fertilizer were rising. Second, the farmers were accustomed to purchasing fertilizer on credit and thus were unable to raise

[7] Fertilizer usage dropped from 74,000 metric tons in 1980/81 to 27,000 metric tons in 1984/85 caused both by government enforced restrictions in its distribution and the removal of subsidies, which caused a doubling of fertilizer farm-gate prices. [Kelly *et al.* 1996, pp. 22]

sufficient money before the planting season to purchase the product. By the mid-1990s, fertilizer use throughout Senegal was only about half of what it had been during the 1970s. [Kelly *et al.* 1996, pp. 22-23]

The government's involvement with groundnut seed was terminated when SONAR was finally dissolved in 1985. After that farmers were left with four choices: (1) save their own seed from year-to-year, (2) purchase seed commercially, (3) join a seed bank operated by the government-run *Société National d'Approvissionnement en Graines* (SONAGRAINES), (4) buy seed on credit. Many farmers chose to save their own seed stock. However, storage problems combined with the pressures to consume the seed during hard times reduced the success of this option. The government's policies with respect to groundnut seed cause other problems.

> Changes in peanut seed credit and distribution policies in the 1980s reduced the area planted in peanuts and triggered a chain of secondary effects that influenced intra-household income distribution, land use patterns (particularly fertility-enhancing millet/peanut rotations), and labor contracting practices. [Kelly *et al.* 1996, pp. 26]

The government's change in seed policy changed the household's crop mix as those household members who were unable to procure groundnut seed planted millet instead. Soil fertility may have been affected as the normal groundnut/millet rotation was interrupted. Finally, as fewer groundnut seeds were purchased and planted, the number of *navétanes* or contract laborers hired was reduced since these laborers traditionally received part of their payment in seed. As a consequence, there were fewer people to work in the common fields, thus affecting cereal production as well.

One final consequence of the new seed policy was the difficulty of maintaining national seed stock quality. Since farmers were unable to purchase improved seed, instead using their own stock, by 1989, the amount of improved seed used nationally declined to less than one-sixth of the total seed planted. [Kelly *et al.* 1996, pp. 27]

To compensate the farmers for losses caused by the removal of input subsidies and credit, the government continued to raise prices despite what was happening on the world market. In 1986, after the government raised groundnut prices fifty percent, from 60 to 90 f/CFA per kilogram, export prices fell. The government continued to prop up producer prices until 1989 when they lowered prices to 70 f/CFA per kilogram to be in line with world prices. [Kelly *et al*., 1996, p. 19] (See Table 2.3[8].)

The government did not ignore consumer markets, particularly the rice market. Rice is very popular in Senegalese urban markets and is increasing in popularity everywhere. Because of its importance in urban areas, the government controls the consumer price of rice. Despite efforts to grow rice on irrigated perimeters, most rice in Senegal is imported. Until just after independence, rice imports were subsidized. Today, however, they are taxed and serve as an important source of government revenue. Nonetheless, rice stays competitive with millet and sorghum, especially in the urban markets. Given preferences for rice in the diet, rice is often chosen over the other grains when the prices are close. The price of rice fairly much determines the maximum price that the producer can demand for millet and sorghum [Kelly *et al*, 1996, p. 20].

8 For comparison, Table 2.3 also includes nominal producer prices for cotton and the major grains.

Table 2.3: Nominal Producer Prices (fCFA/kg) and the Consumer Price Index (CPI)

Year	Groundnuts	Cotton	Millet	Rice (paddy)	Maize	Sorghum	CPI*
1980/81	50	60	40	41.5	37	40	56.6
…	…	…	…	…	…	…	…
1986/87	90	100	70	85	70	70	105.4
1987/88	90	100	70	85	70	70	101.1
1988/89	70	100	70	85	70	70	99.2
1989/90	70	100	70	85	70	70	99.7
1990/91	70	100	70	85	70	70	100.0
1991/92	70	100	70	85	70	70	98.2
1992/93	70	100	70	85	70	70	98.1
1993/94	100	115	70	90	70	70	97.6
1994/95	120	150	70	…	70	70	129.1
1995/96	125	170	70	…	70	70	139.2
1996/97	131					130	143.1
1997/98	150					125	145.7

* *CPI (African Index) 1990 = 100*
Source: The Economist Intelligence Unit (various issues)

In January 1994, Senegal, together with the rest of the *Communaté Financiere Africaine (CFA)*, devalued its currency for the first time since 1948. Before 1994, the CFA franc had been pegged to the French franc at the value of fifty CFA francs for one French franc. After January 1994, one French franc became equivalent to one hundred fCFA. Thus with the devaluation, the CFA franc lost half its value. Although the devaluation made Senegalese exports, especially groundnuts and groundnut byproducts, more attractive, it increased the cost of imported goods.

Senegal's structural adjustment efforts in 1984 did not change its negative trade balance (see Table 2.4). In fact, the trade deficit has shown clear pattern—rising to a high in 1990, then falling significantly in the next two years.

Table 2.4: Senegal's Balance of Trade

Date	Value of Merchandise Exports	Value of Merchandise Imports	Balance of Trade
1980	477	1,038	561
....	…	…	…
1984	634	981	347
1985	562	826	264
1986	625	961	336
1987	605	1,023	418
1988	617	1,230	613
1989	751	1,534	783
1990	783	1,620	837
1991	652	1,097	445
1992	672	970	298

N.B.: All values in U.S. dollars
Source: The World Bank [1995], pp. 88-89

Much of Senegal's import expenditures are on rice primarily to feed the urban population, although rice is becoming more popular in the diets of Senegalese throughout the country. The fall in the value of groundnut exports has only exacerbated the problem since it has reduced the money available to purchase imports.

In response to the balance of trade deficit, Senegal tried both to expand groundnut production and to reduce the amount of rice imports. One tactic to reduce the demand for rice was to make staples like millet more price-attractive to the consumer. Thus the farmer was faced with a conflict between increasing groundnut production and growing more food crops.

In order for the Government of Senegal to evaluate its policies to substitute local food production for imported rice and to make groundnuts more productive, it must understand the response of the small farmer to these policies.

By 1998, the privatization in the groundnut-marketing sector had not progressed very far. Today, the groundnut oil processing mills are still owned by the government parastatal, SONACOS. Groundnut seeds are still being distributed by SONAGRAINES. The government still sets the price paid to producers for groundnuts. Although farmers are now allowed to sell their groundnuts in the open market, after the groundnut harvest, agents of SONACOS still fan out around the Groundnut Basin offering farmers the official price. This price is the same throughout Senegal, regardless of how far the farmer lives from the mills.

There have been some changes as a result of structural adjustment. A higher percentage of the groundnut seeds used by the farmers now come from their own stock, and farmers no longer receive government subsidized fertilizers.

The mills themselves are also feeling the results not only of the structural adjustment, but also of events outside Senegal. Because of rules involving its entry into the EU, France no longer protects Senegalese groundnut products from competition. Thus the mills are operating at less than one hundred percent capacity, and the GOS continues to seek, so far unsuccessfully, a private buyer.

What will result from a complete privatization of the groundnut market is still unclear. Those affected will be the GOS itself, the oil mills, the private groundnut purchasers, and the farmers who have been producing groundnuts for sale since the early part of the twentieth century.

Chapter 3: Data Description and Survey Results

3.0 Introduction

This chapter describes the small-scale farmers who live in the Fatick and Kaolack regions of Senegal and were the subjects of a survey conducted to provide data for this study. There are several facets to the description. First, the farm household is described demographically including ethnicity, size, composition, age, and gender makeup. Next, the activities of the households are discussed. The major activity in this part of Senegal is agriculture. Thus, a description will be provided of crops produced, agricultural inputs and equipment, size of the harvest in comparison to what was planted, and commercialization of the crops. Finally, a description of how the households spend their income is presented.

Throughout the chapter, comparisons are made among different household members to determine whether differences exist in their production and access to resources. Especially important among these comparisons are those between men and women. Other comparisons are made between the overall household head and dependent heads of household and between family and non-family members of the household.

To collect the needed data, a survey was conducted in March and April 1998 of 228 farmers from thirty villages in the Kaolack and Fatick regions of Senegal.

Table 3.1: Survey Villages and Meteorological Posts

Meteorological Posts	Survey Villages	
Region of Fatick	**Region of Fatick**	**Closest Meteorological Post**
Fatick	Baboucar Toumbou	Fimela
Niakhar	Bagdad	Colobane
Diakhao	Bambadalla Thiakho	Toubakouta
Tattaguine	Diofior	Fimela
Fimela	Gowethie	Gossas
Foundiougne	Kamatane Mbar	Djilor
Djilor	Keur Serigne Khodia	Toubakouta
Sokone	Loul Sessène	Fatick, Fimela
Toubakouta	Ndioudiouf	Fatick
Niodior	Sagne Folo	Niakhar, Diakhao
Gossas	Sob Nomade	Ouadiour
Ouadiour	Sorom	Sokone
Colobane	Thiamene Birane	Sokone
Guinguineo		
Kahone	**Region of Kaolack**	
Sadio	Diama Gadio	Nganda
	Diam-Diam	Koungheul
Region of Kaolack	Diout Nguel II	Boullel
Department of Kaolack	Katakel	Nganda, Kaffrine
Kaolack	Keur Katim Diakhou	Median Sabbah
Gandiaye	Keur Magaye	Guinguineo
Ndoffane	Keur Mamou Coumba	Wack Ngouna
Ndiedieng	Keur Ngaye	Koungheul
	Keur Omar	Ndoffane
Department of Kaffrine	Keur Setti Diakhou	Nioro Secteur
Kaffrine	Kongoli	Kaolack
Birkelane	Koungheul Socé	Koungheul
Koungheul	Louba	Nganda
Malem Hoddar	Séane	Koungheul
Nganda	Thiakho Djigane	Ndoffane
Boullel	Thiombi	Gandiaye
	Wandé	Kaffrine
Department of Nioro du Rip		
Nioro Secteur	**Additional Villages from Akobundo Survey**	
Median Sabbah	Batara Ouolof	
Paos Koto	Thioubène	
Wack Ngouna	Mabo	
Nioro Metro	Keur Manièbè	
	Diaby Koundel	

3.1 Survey Design

The thirty villages surveyed (see Table 3.1[1]) were chosen randomly from a list kept at the *Institut Sénégalais de Recherches Agricoles/Kaolack*[2] (ISRA). Six *exploitations* in each village were surveyed. Protocol demanded that the selection of those to be interviewed be done in consultation with the head of the village (*chef du village*). Although the surveyors explained to the village head the necessity of selecting households randomly, in reality, there was no way to verify that the list he provided was indeed random. Certainly those selected for an interview had to be present at the time of the survey. Thus farmers who were working elsewhere, either because they were industrious or because their poor harvest forced them to leave the village to seek money, were not included in the survey. Also, the surveyors had no way to know whether the village head selected farmers who would impress the surveyors as to the bounty (or scarcity) of the harvest.

The *chef d'exploitation* (CE) for each of the one hundred and eighty exploitations in the survey was interviewed, and data on his household collected. In addition, if the exploitation consisted of more than one household or ménage, the CE was asked to select one of the *chefs du ménage dépendent* (CMDs) to also respond to the survey.

Questions in the survey addressed agricultural production, income from other sources, agricultural input utilization, crop commercialization and consumption, household composition, ownership of assets, and the latest monthly expenditures. Questions were also directed at farmers' opinions about level and distribution of rainfall in the past rainy season and the reasons, besides rainfall, for any fall in their groundnut production.

The survey form was written (in French) in cooperation with the professional staff at ISRA, including the three surveyors who would administer the survey (see **Appendix 1).**

[1] Table 3.1 not only contains a list of the villages visited in the current survey and those surveyed by Akobundu [1997]. It also lists all meteorological posts in the two regions and indicates which post is closest to each village.

It was then tested in a village near Kaolack. After this pilot testing, revisions were made, and attempts were made to ensure that the intent of the survey was clear to all involved.

Since most of the villagers in the two regions are not fluent in French, the surveyors translated the questionnaire into the local language of the villagers, in most cases into Wolof, the predominant language in the regions. Answers were similarly retranslated into French. Therefore, although the author, who speaks French but not Wolof, was able to observe the interviews and at times make suggestions or ask questions, he was unable to monitor the questions or the responses.

3.2 Location of the Survey

The current survey was restricted to the Kaolack and Fatick regions at the center of Senegal's Groundnut Basin. These regions are just north of The Gambia and are cut by the Sine-Saloum Rivers. The administrative centers are the similarly named cities of Fatick and Kaolack. Kaolack, a deep-water port on the Sine River, is one of Senegal's major cities.

The land in this portion of Senegal is flat, dry and sparsely covered with acacia trees. The rain falls only four to five months a year, usually amounting to between 500 and 700 mm (20-30 inches). Soil quality is poor and becoming worse as tree cover is removed and farming becomes more intensive. Population in the rural area is just over fifty per square kilometer. (See Table 3.2.)

Most of the villages in the survey were off the paved road that passed through the cities of Fatick and Kaolack. In the rainy season, many would be difficult to reach except by four-wheel drive vehicles. However, in the dry season during which the survey was conducted, they were quite accessible.

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[2] Senegalese Institute for Agricultural Research located just outside Kaolack

Table 3.2: Characteristics of the Central Groundnut Basin, Senegal 1989/90

Rural population	958,819
Population density (per square kilometer)	
Rural only	52
Rural and urban	67
Percent of rural population in market villages	17
Long-term range of rainfall (mm per year)	500-700
Length of rainy season (months)	4-5
Soil quality	Sandy, ferric, and leached
Vegetation	Sparsely wooded savanna

Source: Delgado, Hopkins and Kelly (1998), p. 80

The survey followed a similar survey conducted by Akobundu in 1997. To begin the creation of a long-term picture of the area, the current survey included twenty of the villages surveyed by Akobundu. The current survey also included ten additional randomly selected villages.[3] A complete list of the villages in the two surveys (Akobundu in 1997 and Gray in 1998) can be found in Table 3.1. It includes a listing of all the meteorological stations in the regions and an association between each village and the meteorological station closest to it.

3.3 Household Demographics

Exploitations in Senegal comprise one or more households (*ménages*) under the leadership of a *chef d'exploitation*. In the current survey, 228 households in 180 *exploitations* were surveyed. Fifty-seven percent (or 103) of the 180 *exploitations* surveyed have only a single household. (See Table 3.3.) Although the intent of the survey was to question one CMD in each *exploitation* having more than one household, only forty-eight CMDs were actually surveyed. Thus in twenty-nine of the seventy-seven *exploitations* where more than one household was said to exist, no CMD was available for questioning, and thus no survey form was completed. In all, 2,825 people are included

[3] Akobundu [1997] surveyed five more villages than originally planned. These "extra" five villages are not included in the current survey.

in the 228 households surveyed, including unmarried males (*sourgas)*, sharecroppers (*navetanes)*, and hired laborers (*mbindanes*).

Table 3.3: Household per Exploitation

Number of Households/Exploitation	Number Surveyed	Total Number of Households	Percent	Cumulative Percent
1	103	103	45.2	45.2
2	74	148	32.5	77.6
3	37	111	16.2	93.9
4	11	44	4.8	98.7
5	1	5	0.4	99.1
6	2	12	0.9	100.0
Total	**228**	**423**	**100**	

In Table 3.4, we can see that just over forty-eight percent (or 1,360) of the people in the households surveyed are female, and half (or 1,412) are children less than fifteen years of age. Just over forty-five percent (or 1,282) of the members of the household are active agriculturally, and approximately the same percentage of these are female. Few adults in the survey (less than five percent) do not participate in agriculture. This may suggest that in this region, people keep working when their age or physical condition may cause them to retire in other countries.

Sixty percent of the labor in the household is provided by the household heads (CM, which include CEs and CMDs) and their wives or non-married daughters. If the unmarried males who generally live in the household throughout the year are included, the percentage rises to nearly ninety-four percent. Hired laborers (*mbindanes*) and sharecroppers (*navetanes*) each make up approximately three two percent of the labor force.

Table 3.4: Make-up of the Households

	Agriculturally Active						Non-active			Children			HH Total
	CM	F	N	S	Mb	Total	M	F	Total	M	F	Total	
# of People	236	558	43	406	39	1,282	32	93	125	703	709	1,412	2,819
Avg./household	1.0	2.4	0.2	1.8	0.2	5.6	0.1	0.4	0.5	3.1	3.1	6.2	12.4
St. Dev	0.25	7.4	7.8	7.8	8.1	4.0	8.7	8.8	0.8	9.2	10.0	4.7	8.1
Maximum	4	9	4	30	3	38	1	5	6	20	20	34	65

Legend: CM = *chef du ménage* S = *sourga*
F = female Mb = *mbindane*
N = *navetane* M = male

The mean household size in the survey is slightly larger than twelve people. The median size of the household is eleven. The mean agriculturally active population is 5.6[4], and the mean non-active population is 6.7, most of whom (6.2) are children. The mean number of *navetanes, sourgas*, and *mbindanes* in the survey per household is 0.2, 1.8[5], and 0.2 respectively. Only twenty-nine households utilized *navetanes*; 150 employed a *sourga*; and only twenty-nine employed a *mbindane*. These adult males work primarily for the CE; only one household under the control of a CMD utilized either a *sourga, navetane,* or a *mbindane*.

Ethnically, over sixty percent of the households in the survey are Wolof (145), and approximately a quarter of the households are Sérére (52). Six other ethnic groups make up just under fifteen percent of households in the survey. (See Table 3.5.)

[4] In the study that Goetz (1990) conducted for his dissertation, the mean labor force for this region was 5.36.

[5] The mean number of *sourgas* was high compared to the others because of the occurrence of two households, one of which employed twenty-two *sourgas* and a second that employed thirty.

Table 3.5: Ethnic Groups in the Survey

Ethnic Group	Number	Percent
Wolof	145	63.6
Sérére	52	22.8
Bambara	11	4.8
Socé	8	3.5
Poular	6	2.6
Mandingue	3	1.3
Sarakholé	2	0.9
Toucoukour	1	0.4
Total	**228**	**100**

3.4 Rainfall

3.4.0 Introduction

Rainfall is critical to the success of agriculture in Senegal. Every year around the beginning of June, farmers anxiously await the first rainfall. Fields have been prepared; seeds have been purchased and treated; tools have been repaired; and farm laborers have been hired. Everything awaits the actions of Mother Nature.

In Senegal, as elsewhere in the Sahel, neither the amount of rain nor its duration and spacing over time is certain. Rainfall can vary significantly from year-to-year in quantity, spacing, and duration. In central Senegal's Groundnut Basin including Kaolack and Fatick, rainfall is never abundant, averaging 500-700 mm per year. In recent years, Senegal has experienced declines in the amount of rainfall. According to Pison [1995], this decline has been fairly regular since the turn of the century.

Although the quantity of rain is crucially important, it is just as important that the rain fall regularly. Farmers usually wait until the first significant rainfall before planting their groundnuts. After the crop has been planted, if the second rainfall is too late, the crop may not survive, and the farmer may have to re-seed. It is also important that the rains are regular after the crop begins to grow, or the new shoots will wither.

3.4.1 Actual Rainfall in Survey Area

In 1997, the rainy season preceding the harvest reported on in this survey, and in 1996 the rains in the region of Kaolack were below the 1988-1997 ten-year average. In 1997, the quantity was eight percent below the ten-year average, and the duration was six percent shorter. In 1996, these declines were thirteen percent and seven percent respectively. (See Table 3.6.)

In the region of Fatick, rainfall data were available only for 1995-1997. Therefore only a three-year average was calculated. In 1997, the quantity was five percent below average, and the duration was four percent shorter. In 1996, these declines were almost eleven percent and 2.5 percent respectively. (See Table 3.7.)

These averages hide an even worse situation in particular areas. For example, at the meteorological station of Ndoffane in the region of Kaolack, the quantity of rain was nearly twenty percent below the ten-year average, and the duration was seventeen percent below average. At the meteorological station in the town of Fatick, the corresponding figures were nearly twenty-five percent and fifteen percent below the three-year average.

It is very difficult to know how much rain fell in a particular village or on a particular field. Meteorological stations are not in every village, and although a significant rainfall may be recorded at a station, no rain at all may fall on a nearby village.

Table 3.6: Rainfall Data: Region of Kaolack 1988 - 1997

Location	1988 -1997		1997				1996				1995	
	Average Rainfall	Average # of Days	Amt.	% Deviation From Mean	Days	% Deviation From Mean	Amt.	% Deviation From Mean	Days	% Deviation From Mean	Amt.	Days
Kaolack												
Kaolack	568.2	40	592	4.1	34	-15	435	-23.4	32	-20	431	34
Gandiaye	520.2	38.3	455	-12.5	35	-8.6	418	-19.6	30	-21.7	571	32
Ndoffane	595.7	38.6	474	-20.4	32	-17.1	465	-22	34	-11.9	569	32
Ndiedieng	561.3	40.9	643	14.6	42	2.7	331	-41.1	40	-2.2	597	40
Kaffrine												
Kaffrine	556.4	42.6	456	-18	39	-8.5	537	-3.4	42	-1.4	485	46
Birkelane	590.2	39.8	543	-8	30	-24.6	373	-36.7	33	-17.1	513	35
Koungheul	608.6	42.5	490	-19.5	29	-31.8	593	-2.6	39	-8.2	615	40
Malem Hoddar	599.9	36.2	501	-16.4	29	-19.9	564	-5.9	31	-14.4	591	36
Nganda	666.6	44.2	576	-13.6	38	-14	635	-4.8	36	-18.6	545	36
Boullel	437.6	27	379	-13.4	27	0	507	15.9	36	33.3	478	30
Nioro du Rip												
Nioro Secteur	664	48.9	553	-16.8	55	12.5	550	-17.2	46	-5.9	666	54
Median Sabbah	698.4	45.4	623	-10.8	49	7.9	640	-8.3	43	-5.3	677	45
Paos Koto	672.4	43.4	564	-16.1	41	-5.5	627	-6.7	39	-10.1	577	41
Wack Ngouna	634.3	47.3	756	19.2	45	-4.9	562	-11.5	39	-17.5	686	49
Nioro Metro	572.6	38.4	613	7.1	51	32.8	524	-8.5	45	17.2	710	53

Table 3.6: (Continued) Rainfall Data: Region of Kaolack 1988 - 1997

	1994		1993		1992		1991		1990		1989		1988	
Location	**Amt.**	**Days**	**Amt.**	**Days**	**Amt.**	**Days**	**Amt.**	**Days**	**Amt.**	**Days**	**Amt.**	**Days**	**Amt.**	**Days**
Kaolack														
Kaolack	641.5	43	643.1	33	523.3	36	506.5	37	556.3	45	806.5	52	546.4	54
Gandiaye	458.1	41	486.0	35	493.2	30	452.5	33	421.5	40	665.7	58	781.2	49
Ndoffane	703.2	47	671.8	33	780.8	39	365.2	31	429.8	40	569.2	51	929.3	47
Ndiedieng	754.2	43	614.3	39	535.1	36	351.8	32	543.9	37	586.5	49	656.9	51
Kaffrine														
Kaffrine	693.0	49	638.9	43	533.2	43	423.4	35	494.1	35	597.7	44	704.7	50
Birkelane	800.1	44	756.2	39	607.2	40	580.5	40	392.4	38	676.9	53	659.2	46
Koungheul	731.4	51	728.8	48	696.1	50	412.6	33	506.2	40	695.5	53	618.0	42
Malem Hoddar	854.7	46	872.5	39	597.1	38	341.2	32	490.4	27	548.3	41	637.2	43
Nganda	777.4	56	769.7	41	704.1	45	433.2	30	549.9	43	867.6	63	809.7	54
Boullel	520.4	40	635.2	40	483.9	37	503.5	32	430.9	28				
Nioro du Rip														
Nioro Secteur	706.7	58	698.3	44	705.7	46	602.0	41	484.4	37	759.2	54	916.0	54
Median Sabbah	787.0	51	681.8	38	551.7	44	442.1	40	513.2	36	1,035.4	57	1033.5	51
Paos Koto	869.0	48	635.9	44	720.1	41	504.0	31	448.2	35	808.3	58	969.9	56
Wack Ngouna	341.5	58	648.0	41	726.3	47	562.6	40	472.7	38	686.8	58	901.8	58
Nioro Metro	737.8	59	762.1	46	751.5	47	511.9	39	542.9	44				

Table 3.7: Rainfall Data: Region of Fatick 1995 - 1997

Location	1995-1997		1997				1996				1995	
	Average Rainfall	Average # of Days	Amt.	% Deviation From Mean	Days	% Deviation From Mean	Amt.	% Deviation From Mean	Days	% Deviation From Mean	Amt.	Days
Fatick	513.1	39	386.5	-24.7	33	-15.4	438.2	-14.6	39	0	714.7	45
Niakhar	464.6	37	353.5	-23.9	33	-10	455.4	-2	39	6.4	584.8	38
Diakhao	445.7	34	530.7	19.1	34	1	300.1	-32.7	33	-2	506.3	34
Tattaguine	515	29	404.3	-21.5	29	-1.1	430	-16.5	25	-14.8	710.7	34
Fimela	585.4	33	439.1	-25	32	-2	585.5	0	32	-2	731.5	34
Foundiougne	686	38	571.9	-16.6	37	-1.8	666.6	-2.8	35	-7.1	819.4	41
Djilor	619.6	35	637.4	2.9	31	-12.3	521.7	-15.8	34	-3.8	699.8	41
Sokone	643.7	40	652	1.3	46	16	590.7	-8.2	32	-19.3	688.3	41
Toubakouta	742.8	41	698.3	-6	40	-2.4	597	-19.6	37	-9.8	933.2	46
Niodior	677.1	40	757.4	11.9	40	0	653.8	-3.4	35	-12.5	620.2	45
Gossas	427	35	465.6	9	32	-7.7	379.7	-11.1	37	6.7	435.8	35
Ouadiour	387.5	29	395.7	2.1	29	1.2	286.2	-26.1	28	-2.3	480.6	29
Colobane	425.9	31	457	7.3	30	-4.3	300.4	-29.5	33	5.3	520.3	31
Guinguineo	407.6	29	391.3	-4	28	-4.5	454.9	11.6	31	5.7	376.7	29
Kahone	449.5	36	470.1	4.6	36	0.9	445	-1	38	6.5	433.3	33
Sadio	449.8	29	383.9	-14.6	22	-25	445.5	-0.9	30	2.3	519.9	36

3.4.2 Farmers' Perceptions of Season's Rainfall

To address the lack of field-specific rainfall information, farmers were asked their perceptions of the 1997 rainy season in terms of quantity and duration. (See Table 3.8.) Farmers said whether they considered the rains good, average, or bad. After coding the responses, a weighted average[6] was calculated to create a village-based perception of both the rainfall quantity and its distribution over time. This allowed the villagers' perceptions of the rains to be compared with the actual rainfall in nearby meteorological posts.

The farmers were not given a definition of "good", "average", or "bad". Therefore they used their own standards. It is not clear whether they compared the 1997 rains with the previous season or with some long-term average. It is likely that the standards for "good" and "bad" were not the same for all farmers within the same village, and certainly not for farmers in different villages. Farmers in villages that usually get less rainfall than other villages may have different strategies for cultivating their groundnuts. Thus, even when the rainfall is less in their village than in a village in another part of the Groundnut Basin, they may say the rains were better than farmers in the other villages.

On the whole, the perceptions of the farmers are confirmed by the results obtained by examining the data collected at the meteorological stations. Forty-one percent of the farmers felt that the quantity of rain that fell on their farms was bad; thirty-nine percent said it was average; and only twenty percent thought the quantity was good. This seems to validate using the rainfall data collected at the nearest meteorological stations.

[6] On the survey form, the responses were coded: 1=good, 2-bad, and 3=average. For the analysis, the data were re-coded to be in a more logical order.

Table 3.8: Farmers' Perceptions of Rainfall Quantity and Distribution

Village	Farmers per Village	# of Farmers Whose Perceptions of Quantity Are:			# of Farmers Whose Perceptions of Distribution Are:			Weighted Perception of	
	#	Good	Avg.	Bad	Good	Avg.	Bad	Qty.	Dist.
Baboucar Toumbo	7	0	4	3	0	2	5	2.7	2.4
Bagdad	7	0	4	3	0	0	7	3.0	2.4
Bambadalla Thiakho	9	2	6	1	0	6	3	2.3	1.9
Diam-Diam	9	0	1	8	0	2	7	2.8	2.9
Diama Gadio	6	1	4	1	0	2	4	2.7	2.0
Diofior	7	1	3	3	2	2	3	2.1	2.3
Diout Nguel II	6	0	1	5	0	1	4	2.8	2.8
Gowethie	6	1	5	0	1	2	3	2.3	1.8
Kamatane Mbar	7	4	3	0	0	2	5	2.7	1.4
Katakel	7	0	4	3	0	0	7	3.0	2.4
Keur Katim	12	3	6	3	0	7	5	2.4	2.0
Keur Magaye	6	0	2	4	0	0	6	3.0	2.7
Keur Mamou Coumba	8	4	2	2	3	1	4	2.1	1.8
Keur Ngaye	10	4	2	4	0	1	9	2.9	2.0
Keur Omar	8	0	2	6	0	1	7	2.9	2.8
Keur Serigne Khodia	10	5	5	0	1	7	2	2.1	1.5
Keur Setti	6	2	3	1	0	1	5	2.8	1.8
Kongoli	4	0	2	2	0	1	3	2.8	2.5
Koungheul Soce	8	2	3	3	1	4	3	2.3	2.1
Louba	9	0	4	5	0	0	9	3.0	2.6
Loul Sessene	6	0	2	4	0	2	4	2.7	2.7
Ndioufdiuof	9	2	2	5	1	1	7	2.7	2.3
Sange Folo	6	0	3	3	1	1	4	2.5	2.5
Seane	7	5	2	0	0	2	5	2.7	1.3
Sob Nomade	9	3	2	4	1	2	6	2.6	2.1
Sorom	9	2	1	6	0	1	8	2.9	2.4
Thiakho Djigane	8	1	4	3	0	2	6	2.8	2.3
Thiamene Birane	9	2	4	3	0	2	7	2.8	2.1
Thiomby	6	1	2	3	0	0	6	3.0	2.3
Wande	7	0	2	5	0	0	7	3.0	2.7
Totals	**228**	**45**	**90**	**93**	**11**	**55**	**161**	**2.7**	**2.2**
Percent	**100**	**20**	**39**	**41**	**5**	**24**	**71**		

Note: In calculating the weighted perceptions, Good = 1, Average = 2, and Bad = 3.

Table 3.9: Villages Ranked by Perceived Perceptions of the Rains

Rank	Village	Combined Perception	Rank	Village	Combined Perception
1	Keur Serigne Khodia	3.60	16	Sange Folo	5.00
2	Keur Mamou Coumba	3.88	17	Thiakho Djigane	5.00
3	Seane	4.00	18	Baboucar Toumbo	5.14
4	Kamatane Mbar	4.14	19	Kongoli	5.25
5	Gowethie	4.17	20	Loul Sessene	5.33
6	Bambadalla Thiakho	4.22	21	Sorom	5.33
7	Koungheul Soce	4.38	22	Thiomby	5.33
8	Keur Katim	4.42	23	Bagdad	5.43
9	Diofior	4.43	24	Katakel	5.43
10	Diama Gadio	4.67	25	Louba	5.56
11	Sob Nomade	4.67	26	Keur Omar	5.63
12	Keur Setti	4.67	27	Diout Nguel II	5.63
13	Thiamene Birane	4.89	28	Diam-Diam	5.67
14	Keur Ngaye	4.90	29	Keur Magaye	5.67
15	Ndioufdiuof	5.00	30	Wande	5.71

The farmers judged the distribution of the rains over time to be worse than the quantity of rain. Only five percent thought the distribution of the rains over time was good; seventy-one percent thought it was bad; and twenty-four percent thought it was average. In twenty-two of the thirty villages, no one thought the duration of the rains was good. In six of the villages, everyone agreed that the duration of the rains was bad.

Table 3.9 lists the villages ranked by the sum of the farmers' two perceptions of the past season's rainfall.

3.5 Agricultural Activity: Fields Planted

3.5.0 Introduction

The 228 farmers in the survey are small-scale farmers. Although most grew at least one crop for sale, they relied mainly on their own production for food, although they did purchase food in the market.[7] Groundnuts are overwhelmingly the most common cash crop. Millet is the most common food crop, although other cereal food crops are not uncommon. Farmers also planted a variety of other crops.

The land available to the *exploitation* is divided among a variety of uses. First, land is allocated for the common cereal fields. The produce of these fields will be used to feed everyone belonging to the *exploitation*. These fields are under the control of the CE. After the common fields have been determined, the remaining land is allocated among the adult members including the CE. In general, lands allocated to individual members of the *exploitation* are managed by that member, and proceeds from the land revert to that individual.

Table 3.10: Number of Agricultural Fields

		# HH's	# People	# Fields	Avg./Person
Groundnut	**CM**	209	216	372	1.7
	F	160	420	387	0.9
	N	26	39	39	1.0
	S	109	285	238	0.8
	Total	—	960	1 036	1.1
Cereal	**CM**	224	232	620	2.7
	F	58	172	123	0.7
	N	14	19	18	0.9
	S	45	127	81	0.6
	Total	—	550	843	1.5
Other	**CM**	85	88	104	1.2
	F	46	122	104	0.9
	N	2	3	2	0.7
	S	7	10	10	1.0
	Total	—	123	220	1.8

Legend: CM = *chef du ménage*
F = female
N = n*avetane*
S = *sourga*

[7] See Table 3.12 for a breakdown of the crops produced by farmers in the survey.

In the survey, farmers were asked about the number of fields planted in groundnuts, cereals and "other" crops. (See Table 3.10.) They were also asked who in the household controlled each field. The survey did not elicit information about the relative sizes of the various fields.

3.5.1 Groundnut Fields

Women play an important role in the agriculture of the region. For example, women are responsible for thirty-seven percent of all the household groundnut fields in the survey. However, women's role in the production of groundnuts is not the same in all households. In thirty percent of the households surveyed, no woman has responsibility for a groundnut field. In the seventy percent of the households in which women control at least one groundnut field, 420 women control 385 fields. Therefore, not every agriculturally active woman has personal control of a groundnut field. In contrast, in ninety-two percent (or 209) of the households, the head (CE or CMD) controls a groundnut field, and these individuals control thirty-six percent of all the groundnut fields.

Other members of the household also control groundnut fields. Less than thirteen percent (or 29) of the households in the survey employ a *navetane*, and these households employ a total of forty-three *navetanes*. In twenty-six of these twenty-nine households, thirty-nine *navetanes* control thirty-nine groundnut fields. *Sourgas* live in two-thirds (152) of all households surveyed. In all, 412 *sourgas* were enumerated. However, only 109 households employing a *sourga* allow him to control a groundnut field. In these households, 289 *sourgas* control almost a quarter (or 238) of the household groundnut fields.

Table 3.11: Control of Groundnut Fields by Household Member

Statistic	CM	Female	*Navetane*	*Sourga*
Average Number of Fields	1.71	0.92	1.00	0.83
Stdev	0.90	0.23	0.00	0.31
	Z-Score			
H_0: F = CM	-16.59			
H_0: F = N	-1.79			
H_0: F = S	1.72			

Statistic	Men	Women
Average Number of Fields	1.20	0.92
Stdev	0.75	0.23
	Z-Score	
H_0: Women = Men	8.83	

NOTE: The Z-Score is often called the standardized value for the test.

One question may be how the role of women in groundnut production compares with that of the men. In the households in which a woman controlled a groundnut field, they control on average 0.92 fields (σ=0.23). Household heads control on average 1.71 fields (σ=0.90), *navetanes* control one field (σ=0), and *sourgas* control 0.83 fields (σ=0.31). Table 3.11 details the analysis comparing women both with the various categories of males within the household and with men as a group. As can be seen from the averages and the associated Z-scores, women control fewer groundnut fields on average (at the 95% confidence level) than the household head. However, the hypotheses that the average number of fields controlled by women equals the average number of fields controlled by *navetanes* and by *sourgas* could not be refuted. Essentially, every adult woman, *navetane*, and *sourga* controls a single groundnut field. When a comparison is made strictly between men and women, women control, on average, fewer groundnut fields than men (with a 95% level of confidence).

3.5.2 Cereal Fields

A woman controls a cereal field in only a quarter (or 59) of the households, and these fields amount to fifteen percent of the total number of cereal fields in the survey. The women who do control cereal fields control on average 0.72 fields. The fact that relatively few women control comparatively few cereal fields is not surprising. Cereal, mainly millet, is the main food crop and is used to feed everyone in the household. Therefore it is usually planted in common fields under the control of the CM. In the survey, CMs control nearly three-quarters of all cereal fields, controlling, on average 1.9 fields apiece.

Like the women in the household, *navetanes* and *sourgas* control very few cereal fields—ten and two percent respectively. Fewer than half the households employing a *navetane* have a cereal field controlled by a *navetane*. Of the *navetanes* who do control a field, they control 0.95 fields. Fewer than twenty percent of the households with a *sourga* allow him to control a cereal field, and *sourgas* control, on average, 0.64 cereal fields.

3.5.3 "Other Crop" Fields

"Other crop" fields most often contain vegetables, a crop traditionally managed by women. Women control almost forty-eight percent of the total number of "other crop" fields, the same number as controlled by the household heads. *Navetanes* and *sourgas* combined control less than five percent of the "other crop" fields identified in the survey.

Table 3.12: Crop Production and Crop Sales

Crops	Units	# Farmers Who Produced	Total Quantity Produced	Average Quantity Produced	# Farmers Who Sold	Total Quantity Sold	Average Quantity Sold	Total Value (fCFA)	Average Value (fCFA)
Groundnuts (total)	kg	213	609,389	2,861	194	481,841	2,484	73,477,063	378,748
Arachide de bouche	kg	49	66,366	1,354	43	59,493	1,384	9,180,643	213,503
Arachide huilerie	kg	210	526,623	2,508	198	408,176	2,061	61,844,400	309,222
Arachide semence	kg	8	16,400	2,050	8	14,172	1,772	2,452,020	306,503
Fanes d'arachide	carts	199	2,540	13	55	217	4	2,653,550	48,246
Millet	kg	220	348,821	1,586	54	28,762	533	3,747,240	69,393
Sorghum	kg	79	23,895	302	7	1,750	250	225,250	32,179
Maize	kg	31	8,295	268	4	1,152	288	166,520	41,630
Rice	kg	16	4,348	272	0	0	—	0	0
Niebé	kg	18	1,887	105	7	602	86	164,550	23,507
Watermelon	—	33	—	—	33	—	—	2,579,500	78,167
Bissap	basins	12	238	20	12	142	12	303,500	30,350
Sesame Seed	kg	6	820	137	3	530	177	104,500	34,833
Other vegetables	kg	5	225	45	5	191	38	76,100	15,220
Okra	kg	5	457	91	4	377	94	109,000	27,250
Tomatoes	kg	3	432	144	3	382	127	79,500	39,750
Manioc	kg	1	300	300	1	300	300	17,500	17,500
Cotton	kg	20	12,459	623	19	11,897	626	2,142,625	112,770
Total Value Received by Farmers in the Survey for Sales of Agricultural Products =85,846,398 fCFA									

3.6 Crop Production

3.6.0 Introduction

As would be expected in a survey conducted in Senegal's Groundnut Basin, almost all the farmers (93%) produced one of three types of groundnuts, *arachide de bouche* (confectionery groundnuts), *arachide huilerie* (groundnuts grown primarily for oil), or *arachide semence* (seed groundnuts). Most of these farmers (210 out of 213) produce *arachide huilerie*. Less than twenty percent of the farmers (49) grew *arachide de bouche*, and fewer than four percent grew *arachide semence*.[8] (See Table 3.12.)

Nearly all households (220) report that they produced millet, the main subsistence crop in Senegal. Although the household eats most of the millet it produces, millet is also sold when a surplus exists or money is needed. Almost a quarter of the farmers (54) in the survey sold millet, although the total amount sold was only eight percent of total production. Farmers in the survey also grew other grains, specifically sorghum (79), maize (31), and rice (16), although these grains amounted to only ten percent of millet production. As with millet, farmers also sold these grains, and the amount sold was only eight percent of production.

Besides grains, the farmers also grew a variety of other food and cash crops. Only five farmers in the survey (2%) limited themselves to only one crop. Seventy-six percent of the farmers grew at least three crops, and forty-one percent grew at least four.

Cotton is also grown as a cash crop in the study area, although it is a more important crop further south in Senegal. Twenty-one farmers in the survey reported planting cotton, and all but two sold their crop. [9]

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[8] Seed groundnuts are often grown on contract to an official or commercial seed agency. When a farmer is given a license to produce seed, he is given a first-generation hybrid seed. From this seed, the farmer produces a second-generation seed to be delivered to the seed agency for re-sale to other farmers.

[9] One farmer reported planting 0.5 kilograms of cottonseed, but did not report any production. A second farmer, who produced only sixty kilograms of cotton, used his crop to reimburse a previous loan.

In recent years, watermelon is increasingly being cultivated as a cash crop. Of the thirty-eight farmers in the survey who said they planted watermelon seeds, thirty-three sold their output on the open market for an average of over 78,000 fCFA. Because of the size and weight of the watermelons, the farmers in the survey are not equipped to carry their crop to market. Instead, the watermelons are sold by the field to a merchant who comes to the village and harvests them directly. Therefore, the farmers found it impossible to determine the exact number of watermelons in their fields or their size and quality—characteristics that significantly affected the price paid.

Another important source of revenue for the household is the groundnut grass (*fanes d'arachide*) left after the groundnuts are harvested. Fifty-five farmers in the survey reported selling some or all of their groundnut grass, yielding, on average, over 48,000 fCFA. Despite the importance of groundnut grass as a source of revenue, its continued sale may have a negative effect on the fertility of the soil since, if left on the ground, it is an important source of green manure.

Many of the minor crops, especially *bissap* (leaves from a bush used to prepare a refreshing red drink) are easily marketable in nearby towns. Twelve farmers in the survey produced and sold *bissap,* realizing, on average, over 30,000 fCFA. Vegetables are another minor crop that is easily sold. However, the quantities of all these minor crops are relatively small. They are more perishable than groundnuts, cotton, or cereals and, thus, difficult to preserve in anticipation of more favorable market conditions.

3.6.1 Groundnut Production

Almost seventy-three percent of the farmers surveyed produced less than three metric tons of groundnuts each. The average production was only 2,856 kilograms. Only nine farmers (less than five percent of the survey) produced more than ten tons, a figure frequently used to describe a large-scale farmer. The farmer in the survey who produced the most groundnuts grew more than 32 tons, over nine tons more than the next largest producer. Six percent of the farmers surveyed grew less than 200 kilograms, and the least amount of groundnuts harvested by any farmer was 33 kilograms.

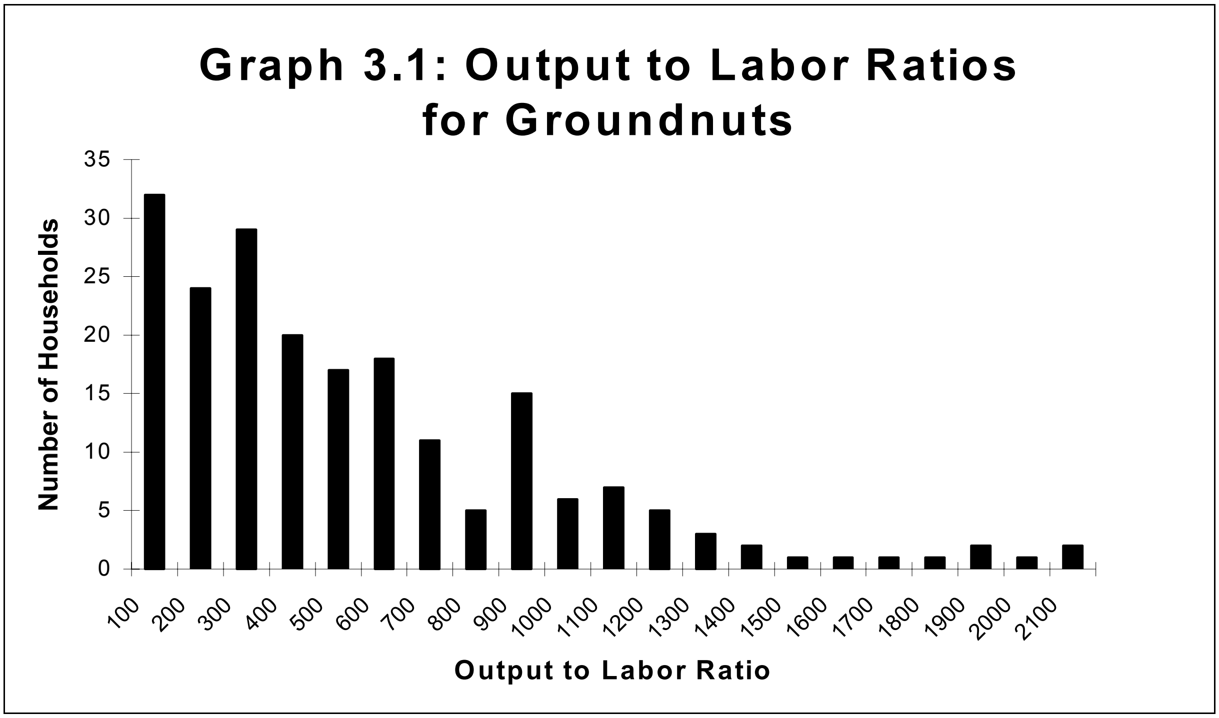
3.6.2 Cereal Production

Millet production also reflects the size of the farms. The average production of millet and sorghum was less than two tons. Slightly over sixty-nine percent of the farmers grew less than two tons of millet; eighty-nine percent grew less than three tons. (The largest-scale millet producer who grew over thirteen tons more than the next largest producer influences this mean figure.) The median amount of millet produced is between 950 and 1,000 kilograms. The average amount of millet grown is insufficient to feed the average household for the year. (See Section 3.21.) For this reason 182 households purchased cereals. During the month preceding the survey, rice was the major cereal purchased.

3.6.3 Output to Labor Ratios

To get some indication of the productivity of labor in the households, output to labor ratios for groundnuts were calculated for each household. Groundnut output indicates the total production (kg) for the household. Labor indicates the number of adult-equivalent members of the household. Output to labor ratios were then calculated for each household and summarized in Graph 3.1.

The data varied wildly (μ=491; σ=43; minimum=5.5; maximum=2109). The most common ratios were less than one hundred. Sixty percent were less than 500 kg per worker, and eighty-seven percent were less than 1,000 kg per worker.



There is a marked geographical divide in the levels of output to labor ratios. All six of the surveyed villages in the rectangular area south of Ndofane and bounded by the ocean on the west and on the east by the 16.5° line of longitude (approximately where The Gambia bulges north) had average output to labor ratios greater than seven hundred. All eight villages in the Fatick Region north of the Sine-Saloum Rivers had average output to labor ratios equal to or less than four hundred. All of the villages north of Kaffrine and those between Kaffrine and Nioro also had average output to labor ratios less than four hundred. Only Kongoli (970) just outside Kaolack, Kamatane Mbar (700) and Sorom (640) near the Saloum River, and Séane (680) and Koinghuel Socé (500) in the east were exceptions to the clear productivity advantages of those villages close to The Gambia (see Table 3.13).

Table 3.13: Output to Labor Ratios for Groundnuts by Region and Village and Farmers' Perceptions of Rainfall Quantity and Duration

Survey Villages: Fatick	**Average Output To Labor Ratio**	**Perceptions of Average Rainfall Quantity**	**Perceptions of Average Rainfall Duration**
Baboucar Toumbo	360	2.43	2.71
Bagdad	140	2.43	3.00
Bambadalla Thiakho	770	1.89	2.33
Diofior	320	2.29	2.14
Gowethie	320	1.83	2.33
Kamatane Mbar	700	1.43	2.71
Keur Serigne Khodia	1380	1.50	2.10
Loul Sessene	280	2.67	2.67
Ndioufdiuof	183	2.33	2.67
Sange Folo	400	2.50	2.50
Sob Nomade	300	2.11	2.56
Sorom	640	2.44	2.89
Thiamene Birane	300	2.11	2.78
Survey Villages: Kaolack			
Diam-Diam	320	2.89	2.78
Diama Gadio	1130	2.00	2.67
Diout Nguel II	300	2.83	2.80
Katakel	350	2.43	3.00
Keur Katim	930	2.00	2.42
Keur Magaye	430	2.67	3.00
Keur Mamou Coumba	840	1.75	2.13
Keur Ngaye	160	2.00	2.90
Keur Omar	270	2.75	2.88
Keur Setti	840	1.83	2.83
Kongoli	970	2.50	2.75
Koungheul Soce	500	2.13	2.25
Louba	320	2.56	3.00
Seane	680	1.29	2.71
Thiakho Djigane	380	2.25	2.75
Thiomby	430	2.33	3.00
Wande	180	2.71	3.00
Two Region Average	**520**	**2.23**	**2.68**

Only the average output to labor ratio of the households in Kongoli approaches those ratios of the villages near The Gambia.

It would be ideal if high output to labor ratios were correlated to the farmers' perceptions of the rainfall quantity and distribution over time. In Table 3.13, one can see a reasonably strong correlation between the average output to labor ratios in a village and the farmers' perceptions about the quantity of the rain.[10] The correlation with the duration of the rainfall was not as strong. As might be expected, the farmers usually felt that when rainfall quantity was good (or bad), its duration was also good (or bad).

3.7 Crop Disposition

As mentioned above, groundnuts are usually a cash crop for the farmers in the survey, and millet and other cereals are usually used for food. The farmers reported several ways they disposed of their crop. Besides eating or selling it, the farmers could reserve a part of the harvest as seed for the next year, could save it for future sale, or could reimburse someone for a past loan.

In the survey, over eighty percent of the total groundnut production was sold (or was being saved for future sale. See Table 3.14) Eleven percent was reserved for the next season's seed, and slightly less than four percent was consumed. Just over three percent was paid to reimburse a past loan.

As would be expected, most of the groundnuts eaten within the household were *arachide* huilerie. A much smaller percent of the *arachide de bouche* and the *arachide semence* were eaten since these types of groundnut usually bring a higher price in the market.

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[10] The correlation is negative because the farmers' perceptions were recoded as (1=good, 2=average, 3=bad). Therefore, one would expect high output to labor ratios to be correlated with perceptions of "good" rainfall.

Table 3.14 Final Disposition of Groundnut Production

	Total Groundnuts	**Arachide huilerie**	**Arachide de bouche**	**Arachide semence**
Total Production (kg)	609 389	526 623	66 366	16 400
% of Total Production	100	86.4	10.9	2.7
Autoconsumption (kg)	23 720	22 805	815	100
% of Groundnut Type	3.9	4.3	1.2	0.6
Reserved for Seed (kg)	69 940	66 720	1 620	1 600
% of Groundnut Type	11.5	12.7	2.4	9.8
Reimbursed (kg)	20 033	15 467	4 038	528
% of Groundnut Type	3.3	2.9	6.1	3.2
Sold (kg)	481 841	408 176	59 493	14 172
% of Groundnut Type	79.1	77.5	89.6	86.4
To Be Sold (kg)	9 750	9 750	0	0
% of Groundnut Type	1.6	1.9	0.0	0.0
Other (kg)	4 105	3 705	400	0
% of Groundnut Type	0.7	0.7	0.6	0.0

By contrast and as expected, over eighty percent of the cereal grown by the surveyed households was consumed. (See Table 3.15.) Only eleven percent of cereal production was destined for sale. For cereals, the “other” category usually refers to the *deem*, an amount (typically ten percent) required by the Koran to be given to the poor. These gifts accounted for over seven percent of total cereal production.

Other crops produced by the household were, for the most part, grown for sale. (See Table 3.16.) Except for sesame seed, thirty percent of which was eaten by the household, more than eighty percent of all the “other” crops were grown for sale. Since vegetables, including okra and tomatoes, are perishable, it is not surprising that the households consume less than fifteen percent of the vegetables.

Table 3.15 Final Disposition of Cereal Production

	Total Cereal	Millet	Sorghum	Maize	Rice
Total Production (kg)	385 359	348 821	23 895	8 295	4 348
% of Total Production	100	90.5	6.2	2.2	1.1
Autoconsumption (kg)	313 120	282 199	20 135	6 574	4 212
% of Cereal Type	81.3	80.9	84.3	79.3	96.9
Reserved for Seed (kg)	464	410	0	4	50
% of Cereal Type	0.1	0.1	0.0	0.0	1.2
Reimbursed (kg)	1 995	1 635	360	0	0
% of Cereal Type	0.5	0.5	1.5	0.0	0.0
Sold (kg)	31 664	28 762	1 750	1 152	0
% of Cereal Type	8.2	8.2	7.3	13.9	0.0
To Be Sold (kg)	10 635	10 315	320	0	0
% of Cereal Type	2.8	3.0	1.3	0.0	0.0
Other (kg)	27 481	25 500	1 330	565	86
% of Cereal Type	7.1	7.3	5.6	6.8	2.0

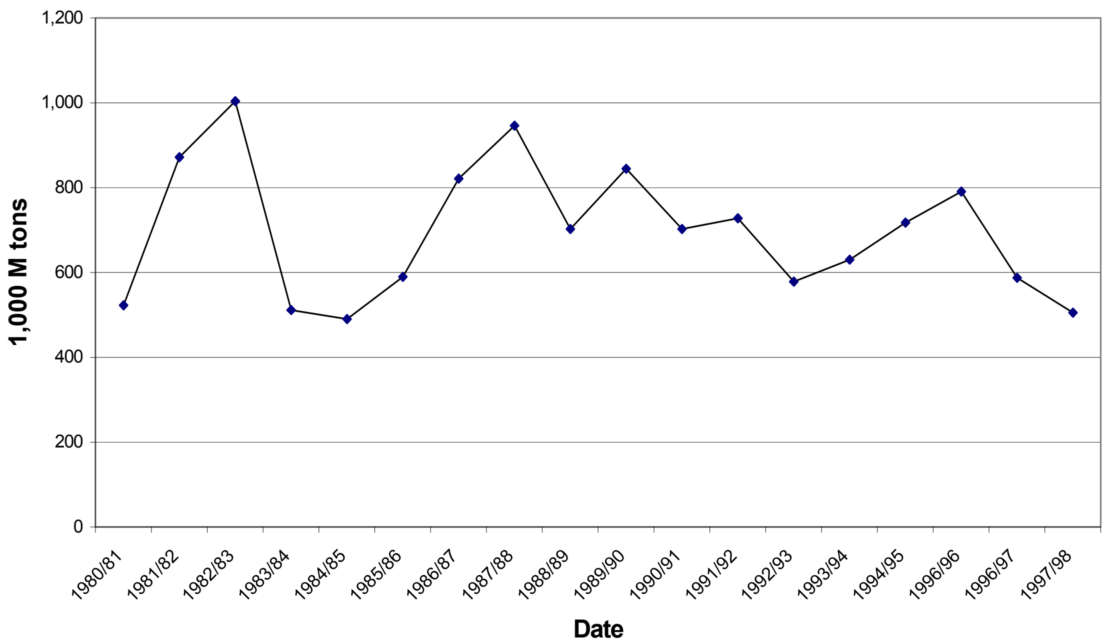
Table 3.16 Final Disposition of "Other" Crops

	Sesame Seed	Bissap	Tomato	Okra	Vegetables (other)	Manioc	Cotton
Total Production (kg)	820	238	432	457	225	300	12,459
% of Total Production	100	100	100	100	100	100	100
Autoconsumption (kg)	250	26	50	75	34		0
% of Crop	30.5	10.9	11.6	16.4	15.1	0.0	0.0
Reserved for seed (kg)	40	0	0	0	0		0
% of Crop	4.9	0.0	0.0	0.0	0.0	0.0	0.0
Reimbursed (kg)	0	0	0	0	0		560
% of Crop	0.0	0.0	0.0	0.0	0.0	0.0	4.5
Sold (kg)	530	142	382	377	191	300	11,897
% of Crop	64.6	59.7	88.4	82.5	84.9	100.0	95.5
To Be Sold (kg)	0	70	0	5	0	0	0
% of Crop	0.0	29.4	0.0	1.1	0.0	0.0	0.0
Other (kg)	0	0	0	0	0		2
% of Crop	0.0	0.0	0.0	0.0	0.0	0.0	0.0

3.8 Perceptions as to the Causes of a Decline in Groundnut Production

In the two years prior to the current survey, groundnut production in Senegal as a whole declined. (See Graph 3.2.) Although groundnut production in Senegal has fluctuated, production has fallen nearly fifty percent since 1987/88. To shed light on the problems farmers faced in their attempts to grow groundnuts, farmers were asked to identify reasons other than rain why their groundnut production may have fallen, if indeed it had, during the past three years. (See Table 3.17.)

Graph 3.2: Senegalese Groundnut Production 1980/81 - 1997/98



Over forty percent (or 101) of the farmers identified a shortage of seed (or *manque de semence*) as the primary reason for the decline in their production. Nearly a quarter (52) listed the shortage of seeds as the second reason, and eleven percent said it was third in importance.

It is difficult to evaluate whether or not the farmers were correct in their perceptions. It is impossible to measure a “shortage of seed”. Naturally, what doesn’t get planted never gets harvested. It may be possible to obtain some insight, however, if one looks at the farmers' use of "improved seed." Improved seed, or N2 seed,[11] has been specially bred for beneficial characteristics including increased yield. In the survey, only 57 farmers (27%) used N2 seed. Although "ordinary seed" may be specially selected by the farmer for particular characteristics or purchased in the market, ordinary seed is similar to the groundnuts consumed by the family. When the family is hungry, there may be more of a tendency to eat "ordinary seed" than N2 seed.

Table 3.17: Perceptions of Reasons for Any Decline in Groundnut Production

Reason for the decline in groundnut production	1st Reason		2nd Reason		3rd Reason	
	#	%	#	%	#	%
No answer	4	1.8	11	4.8	18	7.9
Shortage of seed	101	44.3	52	22.8	26	11.4
Shortage of fertilizer	47	20.6	71	31.1	51	22.4
Shortage of material	40	17.5	40	17.5	43	18.9
Poverty of the soil	18	7.9	35	15.4	46	20.2
Phyto-sanitary problems	8	3.5	3	1.3	15	6.6
Shortage of labor	6	2.6	7	3.1	15	6.6
Preference for other cultures/activities	1	0.4	0	0.0	13	5.7
Other	3	1.3	9	3.9	1	0.4
Totals	**228**	**100**	**228**	**100**	**228**	**100**

The farmers in the survey identified a shortage of fertilizer as the second most important reason for any fall in groundnut production. Just over one fifth of the farmers listed it as the most important reason for the fall in production, and almost seventy-five percent felt it was one of the top three reasons. Anecdotally, a decline in production caused by a shortage of fertilizer may be supported in the survey since less than half the farmers surveyed (98) used fertilizer on their groundnuts.

Fifty-four percent of the farmers indicated that a shortage of material was an important reason for the decline in their groundnut production, although only eighteen percent thought it was the main reason. Material (equipment and animals), combined with sufficient seed, enables a farmer to cultivate a larger area and do so more quickly and

[11] Improved seed is called N2, indicating that it is a second generation offspring from a hybrid N1 seed.

more efficiently. Although equipment may be available within a household, it may not be available in a timely manner to every member of the household. Equipment will probably be used first on the common fields and then on the fields belonging to the household head. It may not be available for several days to the women or to the hired workers in the household. At the time of planting, this equipment distribution may be critical for it is important to get the crops planted soon after the first rains and before the weeds take hold. The actual distribution of equipment and animals among and within the households is discussed below. As is the case with a shortage of seeds, it is impossible to know how much more production would have occurred if the household owned more equipment or animals.

Eight percent of the farmers surveyed said that the poverty of the soil was the most important reason for the decline in their groundnut production, and another thirty-six percent rated it as second or third in importance. This may be closely related to a shortage of fertilizer since it is difficult to imagine that the soil becomes significantly more impoverished from one season to another. Over time the poverty of the soil may become quite noticeable, but probably not from one season to another. Farmers may be able to improve both groundnut and millet production by rotating their crops more frequently on a particular plot.

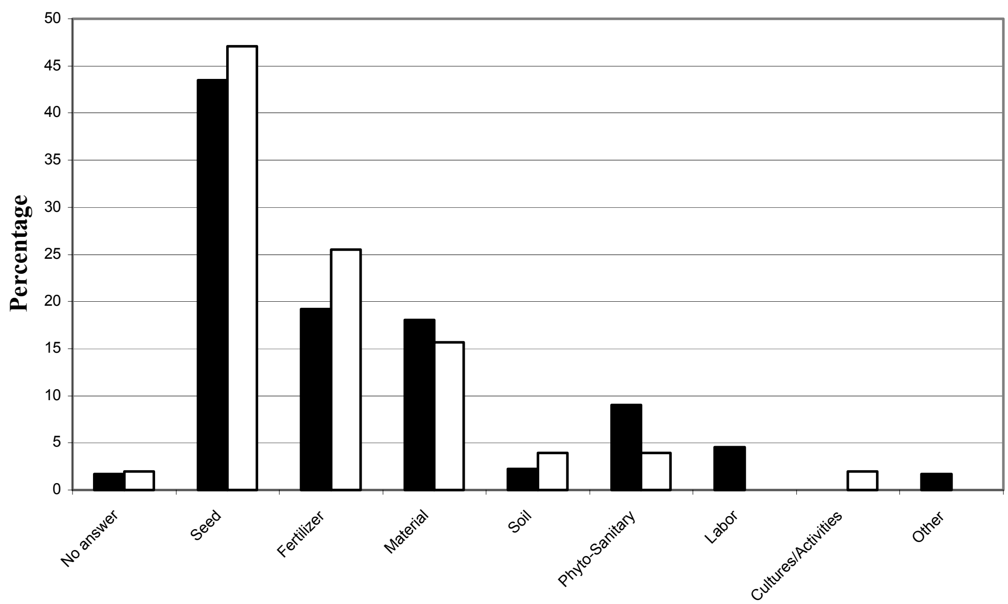
It is easy to see why farmers felt that the poverty of their soil was a cause in the decline of their groundnut production, if not in the past year then at least over recent history. Although groundnuts are nitrogen fixing, demands placed on all the land by increasing population have reduced or even eliminated the traditional fallow period. In addition, the increasingly larger numbers of animals grazing on the land have stripped it of much of its cover and made the soil susceptible to wind erosion. The soil also suffers when the groundnut grass is sold rather than being left on the field. The removal of the groundnut grass not only removes a source of green manure, it also removes cover that can help prevent wind erosion. Also, as population increases and less and less land is available for grazing, it is more common for animals to eat increasing amounts of other crop residue and grasses that could provide protection and nourishment for the soil. Finally, the increase in population has been accompanied by an increased demand for wood, both for cooking and for construction. As a result, trees have disappeared, and with them another barrier to wind erosion. This author heard stories of the recent past in the Kaolack/Fatick area when the grasses were tall enough and the trees dense enough to make it impossible to see from one village to another. Today, trees are sparse, the grasses are eaten close to the ground, and there is nothing to prevent someone from seeing for miles and miles.

A shortage of labor was noted as an important factor in a decline in groundnut production by only twelve percent of the farmers. Less than five percent of the CEs identified a shortage of labor as the most important reason. Of course, if there is not enough seed, there is less need for additional laborers to prepare additional land or tend to and harvest additional crops.

Only eleven percent of the farmers thought the phyto-sanitary problems contributed to any fall in their production. A preference for other crops or activities was thought to be important by only six percent of the farmers, and less than a half percent thought it was of paramount importance. Since Senegal is still in the process of weaning itself away from governmental support of the groundnut industry, it is perhaps too early to detect any shifts out of groundnuts into other crops. Also since there are few employment opportunities in Senegal besides agriculture, farmers may decide to continue doing what they have done for years—growing groundnuts.

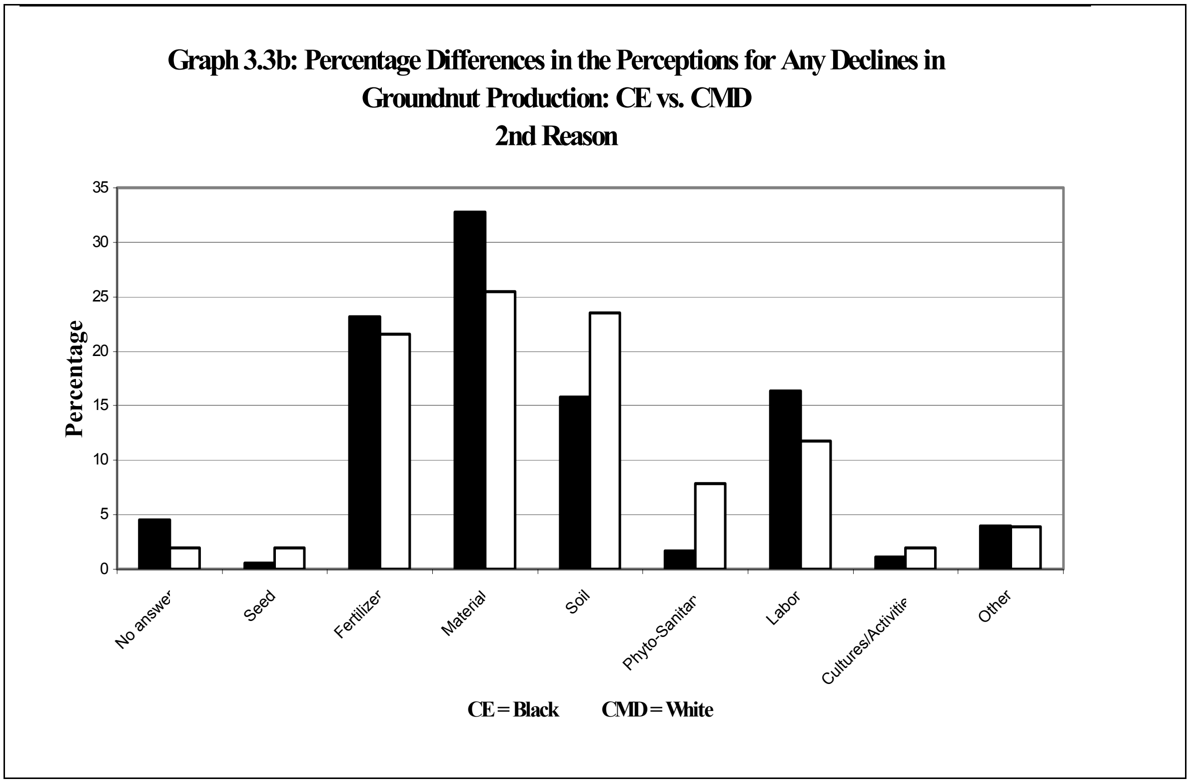
It is interesting to note that there was little difference between the perceptions of the CEs and the perceptions of the CMDs as to the reasons for any decline in groundnut production. According to their own perceptions, the CMDs did not feel penalized by an inability to access equipment or labor in a timely manner. (See Graphs 3.3a, 3.3b, and 3.3c[12] and Table 3.18)

Graph 3.3a: Percentage Differences in the Perceptions for Any Declines in Groundnut Production: CE vs. CMD 1st Reason

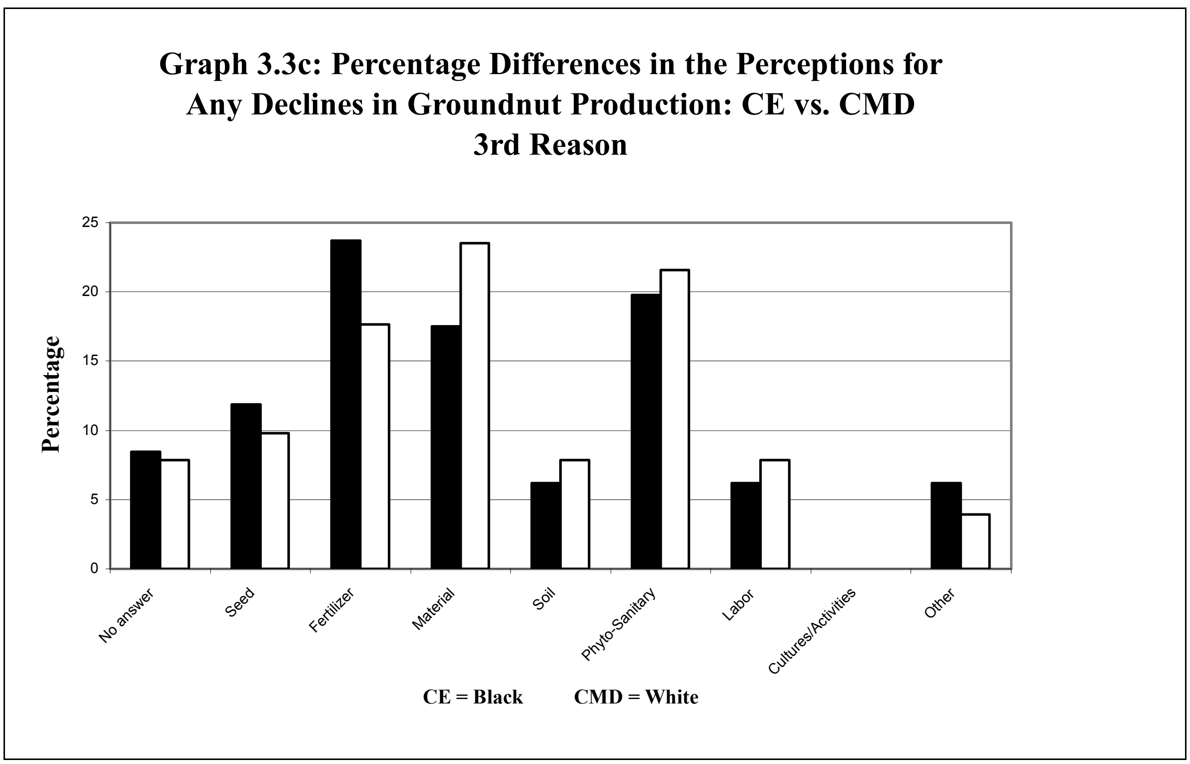


CE = Black CMD = White

[12] Graphs 3.3a, 3,3b, and 3.3c show the differences between responses of CEs and CMDs for their first, second and third reasons for any decline in their groundnut production.



Graph 3.3b: Percentage Differences in the Perceptions for Any Declines in Groundnut Production: CE vs. CMD
2nd Reason
Percentage
35
30
25
20
15
10
5
0
No answer
Seed
Fertilizer
Material
Soil
Phyto-Sanitar
Labor
Cultures/Activitie
Other
CE = Black
CMD = White



Graph 3.3c: Percentage Differences in the Perceptions for Any Declines in Groundnut Production: CE vs. CMD
3rd Reason
Percentage
25
20
15
10
5
0
No answer
Seed
Fertilizer
Material
Soil
Phyto-Sanitary
Labor
Cultures/Activities
Other
CE = Black
CMD = White

Table 3.18: Differences Between CE and CMD in the Perceptions of the Reasons for Any Decline in Production

Reason for decline in groundnut production	First Reason				Second Reason				Third Reason			
	CE		CMD		CE		CMD		CE		CMD	
	#	%	#	%	#	%	#	%	#	%	#	%
No answer	3	1.7	1	2.0	8	4.5	1	2.0	15	8.5	4	7.8
Shortage of seed	77	43.5	24	47.1	1	0.6	1	2.0	21	11.9	5	9.8
Shortage of fertilizer	34	19.2	13	25.5	41	23.2	11	21.6	42	23.7	9	17.6
Shortage of material	32	18.1	8	15.7	58	32.8	13	25.5	31	17.5	12	23.5
Poverty of the soil	4	2.3	2	3.9	28	15.8	12	23.5	11	6.2	4	7.8
Phyto-sanitary problems	16	9.0	2	3.9	3	1.7	4	7.8	35	19.8	11	21.6
Shortage of labor	8	4.5	0	0.0	29	16.4	6	11.8	11	6.2	4	7.8
Preference for other cultures/activities	0	0.0	1	2.0	2	1.1	1	2.0	0	0.0	0	0.0
Other	3	1.7	0	0.0	7	4.0	2	3.9	11	6.2	2	3.9
Totals	**177**	**100**	**51**	**100**	**177**	**100**	**51**	**100**	**177**	**100**	**51**	**100**

3.9 Input Utilization: Seeds

3.9.1 Seed Usage

As mentioned above, over seventy-eight percent of the farmers in the survey felt they did not have access to enough groundnut seed. Without enough seed or enough improved seed, the farmers' production of groundnuts should be less than possible given available land, labor, and equipment.

Table 3.19: Number of Farmers Who Planted and Harvested Groundnuts

	Arachide huilerie	Arachide bouche	Arachide semence	Total Groundnuts
Farmers who planted	214	49	8	216
N1	0	0	0	0
N2	18	37	8	57
Ordinary	206	12	0	206
Farmers who harvested	210	49	8	213

Almost ninety-five percent (or 216) of the 228 households planted groundnuts, and 213 households harvested their crop. *Arachide huilerie* was by far the most popular groundnut crop used by ninety-seven percent of the farmers who planted groundnuts. (See Table 3.19) Twenty-one percent of the farmers planted the more profitable *arachide* *de bouche*. Only eight farmers (or four percent) planted *arachide semence*, and since no farmers planted N1 seed, it seems than no one in the survey was involved in a commercial seed multiplication program.

Whether the availability of seed was really a problem for the farmer is difficult to confirm by looking at the data because one cannot observe the effects of seed not planted. However, only fifty-seven (25%) farmers used the improved N2 seed, a seed they typically had to purchase and which is bred to be better than "ordinary" seed. Most farmers (206 or 89%) relied totally on their own "ordinary" seed or added to their own seed by purchasing "ordinary" or N2 seed in the market.

3.9.2 Seed Prices

Only seventy-two percent of the households purchased any groundnut seed. The rest used their own seed stock or saved seed from the past season. More than ninety percent (45) of the farmers who planted *arachide de bouche* and all of the farmers who planted *arachide semence* purchased seed. By contrast, just over sixty percent (131) of the farmers who planted *arachide huilerie* purchased seed, and many of these supplemented purchase seed with their own seed stock.

Of the forty-nine farmers who planted *arachide de bouche*, thirty-seven planted and thirty-six purchased N2 seed. (See Tables 3.20, 3.21, and 3.22.) Twelve farmers used ordinary seed, and nine of these purchased it on the open market. (See Table 3.21) All eight farmers who planted *arachide semence* purchased N2 seed. Since *arachide de bouche* and *arachide semence* usually command a higher price than *arachide huilerie*, one would expect farmers to be more concerned about the quality of their seed for these groundnut categories. Very few (18) of the farmers who planted *arachide huilerie* used the more expensive N2 seed.

Table 3.20: Seed Summary by Groundnut Category

	Arachide Huilerie	*Arachide de bouche*	*Arachide Semence*	*Total Groundnuts*
# of Farmers Who Used Seed	214	49	8	216
Total Seed Quantity Used (kg)	138,116	12,178	1,843	152,137
Mean Seed Quantity Used (kg)	645 (724)	249 (145)	230 (197)	704 (756)
Median Seed Quantity Used (kg)	386	175	145	450
# of Farmers Who Purchased Seed	131	45	8	154
Total Seed Quantity Purchased (kg)	62,377	11,198	1,843	75,418
Average Seed Quantity Purchased (kg)	476 (660)	249 (143)	230 (197)	490 (649)
Mean Seed Price (fCFA/kg)	211 (113)	254 (154)	364 (322)	220 (120)
Median Seed Price (fCFA/kg)	172	191	247	172

Note: Under the mean figures, in parentheses, are the standard deviations.

The prices paid for the various types of seeds partially confirm the hypothesis that *arachide de bouche* and *arachide semence* are higher valued products. As can be seen in Table 3.20, the mean prices of N2 seed for *arachide semence* (364) and *arachide de bouche* (254) both exceed the mean price of *arachide huilerie* (211). The same is true of the median prices. However, given the variation of the data, the null hypothesis (H_0: $P_{AS}=P_{AH}$) cannot be rejected (Z-Score = 1.34), nor can the null hypothesis (H_0: $P_{AB}=P_{AH}$) (Z-Score = 1.72).

When we look at the prices for ordinary seed, there is no statistical difference between the price paid for seeds to plant the two categories of groundnuts, although the average price of ordinary seed used to plant *arachide huilerie* is slightly less than that used to plant *arachide de bouche*. If we compare the price of all seed used to plant the various types of groundnut, we reject the hypothesis that the price of seed used to plant *arachide de bouche* and *arachide huilerie* are equal (H_0: $P_{AB}=P_{AH;}$ Z-Score = 1.98). When we compare the prices of N2 and ordinary seed for all categories of groundnut, we cannot reject the hypothesis that the two prices are the same (H_0: $P_{N2}=P_{O;}$ Z-Score = 1.93)

Table 3.21: Seed Price Summary by Groundnut Category and Seed Type

N2 Seed								
	Arachide de bouche				*Arachide huilerie*			
	Quantity (kgs)		Value	Price	Quantity (kgs)		Value	Price
	Used	Bought	fCFA	fCFA/kg	Used	Bought	fCFA	fCFA/kg
# HHs	37	37	36	35	18	16	16	16
Sum	9,041	9,041	2,064,781		8,541	8,201	1,353,830	
Avg.	244	244	57,355	253	474	513	84,614	169
StDev	153	153	27,745	121	460	475	77,023	11
Ordinary Seed								
	Arachide de bouche				*Arachide huilerie*			
	Quantity (kgs)		Value	Price	Quantity (kgs)		Value	Price
	Used	Bought	fCFA	fCFA/kg	Used	Bought	fCFA	fCFA/kg
# HHs	12	9	9	9	206	118	118	116
Sum	3,137	2,292	370,297		129,576	54,177	9,613,472	
Avg.	261	255	41,144	163	629	459	81,470	156
StDev	123	88	12,988	13	711	671	100,680	96
Total Seed by Groundnut Category								
	Arachide de bouche				*Arachide huilerie*			
	Quantity (kgs)		Value	Price	Quantity (kgs)		Value	Price
	Used	Bought	fCFA	fCFA/kg	Used	Bought	fCFA	fCFA/kg
# HHs	49	45	45	44	214	131	131	129
Sum	12,178	11,198	2,412,578		138,116	62,377	10,967,302	
Avg.	249	249	53,613	234	645	476	83,720	202
StDev	145	143	26,485	114	724	660	99,451	86
Total Seed by Seed Type								
	N2				Ordinary			
	Quantity (kgs)		Value	Price	Quantity (kgs)		Value	Price
	Used	Bought	fCFA	fCFA/kg	Used	Bought	fCFA	fCFA/kg
# HHs	57	54	54	52	206	125	125	124
Sum	19,424	18,949	3,951,491		132,713	56,814	9,983,769	
Avg.	341	351	73,176	236	644	455	79,870	201
StDev	332	338	55,241	118	720	663	99,881	86

3.10 Input Utilization: Fertilizer

3.10.1 Fertilizer Usage

The inability to acquire chemical fertilizer (*manque d'engrais*) was second to a shortage of seed in the farmers' perceptions as a reason for any decline in their groundnut production. When the Government of Senegal ceased giving subsidies for chemical fertilizer (mainly phosphate fertilizers), many small-scale farmers lacked the resources to purchase it on the open market. In the survey, only forty-six percent (or 99) of the farmers who planted groundnuts used any chemical fertilizers. The percentages, however, were much higher for those farmers who planted the usually more profitable *arachide de bouche* (94%) or *arachide semence* (88%). Only sixty-three (or 29%) of the 214 farmers who planted *arachide huilerie* applied chemical fertilizers. (See Table 3.22.)

Table 3.22: Fertilizer Prices

Crop	# Farmers Who Used	# Farmers Who Purchased	Mean Price	StDev.
Arachide huilerie	63	59	138	19.7
Arachide de bouche	46	41	147	12.6
Arachide semence	7	6	151	6.5
Total	**99**	**94**	**141**	**19.6**
		Z-Score		
H_0: $P_{AH} = P_{AB}$		-2.75		
H_0: $P_{AH} = P_{AS}$		-3.38		

Legend: P = price; AH = arachide huilerie, AB = arachide de bouche, AS = arachide semence

Farmers were also not applying organic fertilizers to their groundnuts. Of the 213 farmers who grew groundnuts, only one reported that he applied manure systematically to his fields.[13]

Since groundnuts are a nitrogen-fixing legume, it may not be as important to fertilize the fields prior to or during the growing season. To improve groundnut yields, it may be better to apply fertilizer to the previous crop. If the farmer rotated between groundnuts and millet, for example, then it would be important to fertilize the millet fields. Since millet is the most important staple crop in this part of Senegal, the survey also looked at the inputs applied to millet fields. Of the 220 farmers who grew millet, less than thirty percent (65 farmers) applied chemical fertilizer to their fields. They were more likely to apply manure to their millet fields. Sixty-five percent (or 143 farmers) applied on average

14.6 *charrettes* (animal-drawn carts) of manure to their fields in addition to whatever manure was deposited on the fields during the *parcage*.

3.10.2 Fertilizer Prices

Farmers surveyed were able to purchase fertilizer for an average price of 141 fCFA/kg. In theory, farmers should be more willing to pay more for the fertilizer to be used on more valuable groundnut crops *arachide de bouche* and *arachide semence.* As seen in Table 3.22, there is confirmation for the hypothesis that the price paid for fertilizer used on *arachide huilerie* is not equal to the price paid for fertilizer used on the more valuable groundnut crops. Since the survey did not elicit information as to the type of fertilizer used, it is possible that a different type of fertilizer was used on the more valuable groundnut crop.

3.11 Input Utilization: Fungicide

3.11.1 Fungicide Usage

Phyto-sanitary problems with seeds are often an important cause of the decline in marketable production. Thus it is common for farmers to treat their seed before planting. In the survey, eighty-five percent (181) of all the farmers treated their seed in advance with fungicide. A slightly higher percentage (88%) of the farmers who planted *arachide de bouche* treated their seed, while for *arachide huilerie* the figure was only seventy-four percent. Five of the eight farmers who planted *arachide semence* treated their seed. (See Table 3.23.)

On average, farmers used about 1.5 grams of fungicide for every kilogram of seed planted. They planted just over seven hundred kilograms of seed.

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[13] No data were collected on the practice of *parcage*, i.e. allowing nomads to graze their animals on farmers' fields during the dry season, and in any case the amount of manure deposited during the *parcage* is difficult to measure.

Table 3.23: Fungicide Prices

Crop	# Farmers Who Used	# Farmers Who Purchased	Mean	StDev.
Arachide huilerie	158	139	7.6	3.9
Arachide de bouche	43	43	16.6	16.6
Arachide semence	5	3	8.0	3.5
Total	**181**	**169**	**8.4**	**4.6**
			Z-Score	
$H_0: P_{AH} = P_{AB}$			-3.53	
$H_0: P_{AH} = P_{AS}$			-0.21	

3.11.2 Fungicide Price

The average price of fungicide in the survey was just over eight fCFA per gram. (See Table 3.23.) Thus the average farmer would have to spend less than 6,000 fCFA to treat all his seeds. Despite the relatively low cost, fifteen percent of the farmers did not treat their seed. Farmers paid more on average for fungicide used on *arachide de bouche* than on *arachide huilerie*. However, there was no difference in the price paid for the fungicide used on *arachide huileri*e and for that used on *arachide semence* (There are only three farmers who purchased fungicide for use on *arachide semence.*) As with fertilizer, no information on the type of fungicide used was collected.

3.12 Input Utilization: Agricultural Equipment

On the small-scale farms in the survey, agricultural equipment is limited to simple hand tools or animal powered seeders and plows. (See Table 3.24.) The most important implements are the seeder (*semoir)* and the mechanical hoe (*houe)*. Ninety-one percent of the 180 CEs own both a seeder and a hoe. Forty-two percent of the CEs own more than one seeder, and forty-three percent own more than one hoe. Other pieces of equipment are less widely used. Only twenty-nine percent of the CEs own a groundnut harvester (*arara*), and only eight percent own more than one. Only fourteen percent (14) of the CEs own a plow (*charrue*). Despite the importance of an animal drawn cart in the movement of people and in getting produce to market, only sixty-eight percent of the CEs own a cart (*charrette)*, and only thirteen percent own more than one.

Table 3.24: Agricultural Equipment (CE vs. CMD)

		Seeder	Hoe	Groundnut Harvester	Plow	Cart
CE	# of CEs Who Own	163	163	53	14	122
	Percent	91	91	29	8	68
	Who Own More Than One	76	77	15	2	24
	Percent	42	43	8	1	13
	Average Number Owned	1.8	1.9	1.4	1.1	1.2
	StdDev	1.1	1.4	0.7	0.4	0.4
CMD	# of CMDs Who Own	14	17	1	0	11
	Percent	29	35	2	0	23
	Who Own More Than One	3	3	0	0	1
	Percent	6	6	0	0	2
	Average Number Owned	1.2	1.2	0	0	1.1
	StdDev	0.4	0.4			0.3

NOTE: In the survey, there are 180 CEs and 48 CMDs

Farmers in the current survey reported that on average they sold their groundnuts within one kilometer of their village. Less than a quarter of the farmers surveyed travel further than two kilometers, and less than six percent have to travel further than five kilometers. Under the government controlled system for marketing groundnuts, either official collection points were nearby, or official buyers came to individual villages to purchase the farmers' output. Therefore, on most occasions the cart was not necessary to transport the groundnuts to market, although it was useful for getting the crop from the fields to the collection point. If the GOS liberalizes the marketing of groundnuts and eliminates state interventions in the market, then farmers who are unable to transport their groundnuts to seek out the most favorable price will be at the mercy of whatever trader arrives in the village with a truck. If they refuse an initial offer, they risk the possibility that a second buyer may not arrive.

Most equipment in the household is the property of the CE. Although the CMD may own his own equipment, the number is almost always less than that owned by the CE. In the current survey, the forty-eight dependent household heads own much less equipment than the CEs. This was not unexpected since one of the responsibilities of the CE is to make equipment available to the CMDs. Only twenty-nine percent of the CMDs own a seeder, thirty-five percent own a hoe, and only two percent own a groundnut harvester. Only twenty-three percent of the CMDs own a cart, and no CMD owns a plow.

Table 3.25: Delays in Planting: CE vs. CMD

	Delay in Planting					
	CE			CMD		
	#	%	Cum. %	#	%	Cum. %
0 days	128	71	71	24	50	50
1-3 days	9	5	76	7	15	65
4-7 days	17	9	86	11	23	88
8-14 days	6	3	89	1	2	90
> 14 days	7	4	93	4	8	98
No Answer	13	7	100	1	2	100
Total	**180**	**100**		**48**	**100**	

The disparity between equipment owned by the CE and that owned by the CMD can be seen in the timing of their respective seeding of groundnuts. (See Table 3.25.). As mentioned above, farmers want to seed as soon as possible after the first significant rain. Seventy-one percent of the CEs planted immediately. (In answer to the survey question, these farmers said that the delay was zero days.) By contrast, only fifty percent of the CMDs seeded immediately. This difference in timing is consistent with the fact that the CEs are more likely to own a seeder. By the end of a week, however, nearly the same percentage of CEs as CMDs had planted their seed.

The differences between CEs and CMDs are not as evident when we look at the number of days spent seeding (See Table 3.26.). At the end of one week, just over fifty percent of CEs have finished seeding, whereas seventy-five percent of CMDs have completed their seeding. Perhaps the delay is explained by the fact that CEs have more fields to seed.

Table 3.26: Days Spent Seeding: CE vs. CMD

	Days Spent Seeding					
	CE			CMD		
	#	%	Cum. %	#	%	Cum. %
1 day	7	4	4	6	13	13
2 days	15	8	12	17	35	48
3 days	17	9	22	8	17	65
4 days	18	10	32	0	0	65
5 days	11	6	38	2	4	69
6 days	9	5	43	0	0	69
7 days	18	10	53	3	6	75
8-14 days	41	23	76	7	15	90
> 14 days	30	17	92	4	8	98
No Answer	14	8	100	1	2	100
Total	**180**	**100**		**48**	**100**	

3.13 Input Utilization: Animal Traction

Animals provide the power for seeders, plows, hoes, and harvesters. (See Table 3.27) Horses, oxen, and donkeys are the principal draft animals used in Senegal. As with equipment, ownership of animals differs between CEs and CMDs. Although 166 (or 94%) of the 177 CEs have access to some sort of animal traction, only 23 (or 43%) of the CMDs own an animal. The most common animal owned by the households in the survey was the horse, important not only for plowing, but also for transport. Most CEs (87%) own a horse, and fifty-two percent own more than one. However, only thirty-six percent of the CEs own a donkey, and only eleven percent own more than one. Oxen were the least common animals in the survey. Less than twenty-five percent of the CEs (44) own an ox. Since oxen are used in teams, most farmers (32) who own at least one ox own more than one.

As with equipment, the CMDs own fewer animals than their CEs. Only thirty-five percent of the CMDs own a horse, four percent own a donkey, and six percent own an ox. The limited ownership of animals by CMDs can also explain why they delayed the planting of their groundnuts. If they were to borrow an animal from the CE, they would have to wait until the CE had finished using it.

Table 3.27: Animals Owned (CE vs. CMD)

		Horse	Donkey	Ox
CE	Number	156	64	45
	Percent	87	36	25
	More than one	94	20	32
	Percent	52	11	18
	Average	2.1	1.5	2.3
	StdDev	1.4	1.1	1.5
CMD	Number	17	2	3
	Percent	35	4	6
	More than one	7	0	3
	Percent	4	0	6
	Average	1.5	1.0	2.7
	StdDev	0.8	0.0	1.2

Despite their importance in farming and transport, animals are expensive and, like humans, suffer from the droughts that regularly occur in this region. Even when there is no drought, feeding animals during a normal dry season is difficult. Purchased feed is expensive, and there are many demands for the available grazing grasses. Groundnut grass is an especially important feed for livestock. The demand for groundnut grass, particularly in Dakar, is increasing. Groundnut grass now sells for 150 fCFA per kilogram, the same as the official price for groundnuts. Harvesting groundnut grass to use as animal feed or to sell removes an important source of nutrients from the soil. Of course, the manure from the animals is an important source of organic fertilizer especially for use on household garden plots.

3.14 Input Utilization: Labor

Labor is a difficult variable to measure in a small-scale farm household. Labor is seasonal; a Senegalese farmer is mainly engaged in farm work only from the time of field preparation to harvest. During the dry season, there is little farm activity. Even during the agricultural season, activity is episodic, and timing is often critical. For example, the time of planting depends on the rains. Before planting the farmer must await the first rainfall of the season and must be convinced that this rainfall is the beginning of the season and not just an anomaly.

Before the rains begin, the fields must be ready to plant. Weeds and crop residue must be removed. These need not be urgent activities; typically a farmer has a good idea when the first rain is expected. However, once that first rain begins, it is important to plant immediately. If one waits too long, weeds, which can crowd out the crop, begin to grow. Having sufficient labor and equipment at this time is critical.

After the seeds have been planted, the urgent need for labor decreases. Usually two weedings are done during the growing season, and some plant thinning may be required. Vigilance against insects and birds is also important in the case of cereals. However, these tasks do not usually require all available labor, and in some cases, such as protecting the crops against birds, children may be responsible.

As is true everywhere, agriculture is not an eight-to-five job. In some cases the farmer works from dawn to dusk. In other cases a few hours per day will suffice. In a previous study in the same region of Senegal [Akobundu, 1998], data were collected on the number of days each category of worker (household head, women, hired laborers) worked. Unfortunately when labor[14] was analyzed as a determinant of groundnut production, its effect was found to be negative. This is counter-intuitive.

In the current survey, information on the number of days each worker toiled in the fields was not collected because this author felt that this data, dependent as it was on recall, was

[14] Actually only family labor was used in the estimation equation. In 66 of the 147 households in the survey, family labor was the only type of labor available to the household.

unreliable. Instead only the number of workers in each category was recorded. As an example of the difficulty of obtaining a measure for effective labor, the number of laborers is only weakly correlated with both the quantity of seed groundnut seed planted and the amount of groundnuts harvested (see Table 3.28.)

Table 3.28: Correlations

	Labor (#)	Groundnuts Harvested (kg)	Groundnut Seed Planted (kg)	Millet Seed Planted (kg)
Labor	1			
Groundnuts	0.399	1		
Groundnut Seed	0.519	0.567	1	
Millet Seed	0.412	0.303	0.515	1

3.15 Seed Multiplication

Goetz [1990, p. 74], citing a 1987 study, noted, “the seed-output conversion ratio is low (approximately 1:10 in the Peanut Basin).” In the current survey, seed multiplication ratios are even lower for most farmers. (See Table 3.29.) Fewer than ten percent of the farmers achieve seed multiplication ratios of ten or higher.

Of the 210 farmers who grew *arachide huilerie*, sixteen reported harvesting fewer groundnuts than they planted. More than half (118) achieved a multiplication ratio less than four. Only twenty-nine farmers achieved a multiplication ratio greater that eight. The fact that twenty-one farmers reported multiplication ratios greater than ten may lead one to suspect that there are some inaccuracies in the data since seed multiplication ratios of ten or greater compare favorably to multiplication ratios in areas with soils and climates better suited for groundnuts than the regions of Kaolack and Fatick.

In the survey, farmers were asked how much seed they used and how much they paid for seed. However, many farmers used their own seed, and although this seed should have been included in their response to the amount of seed used, some farmers may have only reported the seed they purchased. This partial reporting, if it existed, may explain the very high seed multiplication ratios.

Table 3.29: Seed Multiplication Ratios
***Arachide huilerie* (AH) and *Arachide de bouche* (AB)**

Multiplication Rate	AH		AB	
	#	Cum. %	#	Cum. %
<1	16	8	2	4
<2	38	26	8	20
<3	29	40	4	29
<4	35	56	5	39
<5	22	67	10	59
<6	19	76	4	67
<7	13	82	3	73
<8	9	86	3	80
<9	4	88	1	82
<10	4	90	1	84
<11	5	92	2	88
<12	3	94	1	90
<13	2	95		
<14	3	96	2	94
<15	3	98		
>15	1	98	1	96
<17			1	98
<18	1	99		
<19				
<20	2	99.5	1	100
=25	1	100		

The seed multiplication ratios were similar for the forty-nine farmers who grew *arachide de bouche* (AB). While only two farmers reported harvesting less *arachide de bouche* than they planted, almost forty percent achieved a multiplication ratio less than four. Only nine farmers achieved a multiplication ratio greater than eight. As with the farmers who grew *arachide huilerie*, a higher than expected number of farmers (12%) achieved a multiplication ratio greater than ten.

Only eight farmers harvested *arachide semence*, and all of them used the improved N2 seed. The multiplication ratios (3.1, 4.7, 6.6, 7.4, 9.3, 11.3, 18.7, and 22.2) were higher for the farmers who grew *arachide semence* than for the farmers who grew other types of groundnuts. Three of the eight multiplication ratios were greater than ten, and only one was less than four. All farmers achieved a multiplication ratio greater than three. The higher-than-expected ratios of 18.7 and 22.2 may be due to poor reporting on the part of the farmers.

3.16 Commercialization of Groundnuts: Official Market

3.16.0 Introduction

Traditionally the Government of Senegal has been heavily involved in the groundnut market. Table 3.30 shows percentages of groundnut production sold through official channels in the two years prior to the current survey. Farmers were forced to sell their product to a state agency, input prices were subsidized, and producer prices were fixed. At the insistence of international donors, the government has begun to liberalize the market. In the two years prior to the current survey, farmers were allowed to sell groundnuts on the open market.

Table 3.30: Groundnut Sales on the Official Circuit as a % of Production

Department	**1995/96**	**1996/97**
Kaolack	77%	72%
Fatick	70%	72%
Foundiougne	84%	82%
Gossas	63%	46%
Nioro	65%	76%
Kaffrine	69%	50%
Total	**72%**	**65%**

Source: Gaye, March 1998

3.16.1 Quantity Sold on Official Market

Approximately one fourth (55) of all the farmers in the current survey took advantage of the opportunity to sell their groundnuts on the open market. (See Section 3.17.) However, almost three-quarters (169) of the 228 households, including those who also sold part of their product on the open market, continued to sell through official channels. (See Tables 3.31 and 3.32.) Despite beginning steps towards liberalization, the parastatals continue to own the oil processing plants and still employ agents to purchase the farmers' crop at the fixed (1997) price of 150 fCFA per kilogram.

Various members of the household—the *chef du ménage* (CM), either a CE or a CMD, a dependent male (*homme dépendent* or HD), or an adult woman (F)—sell groundnuts on the official market. Normally, the CM sells the most since he has overall responsibility for the household.

All three types of groundnuts are sold on the official market. Prices should vary depending on the type of groundnut since the farmer handles each type differently. In the case of *arachide semence*, a government-marketing agency may contract with a farmer to multiply N1 seed to produce the improved N2 seed. This may require special handling and the use of fertilizer and fungicide. A second category, *arachide de bouche*, may have to be specially selected for the size and aesthetic appeal of the groundnuts.

Most of the groundnuts sold on the official market, however, are destined to the mills to make oil. In the current survey, over seventy-seven percent (or 343 metric tons) of the 440 metric tons of groundnuts marketed by the farmers surveyed through official channels was *arachide huilerie*. Another twenty percent was *arachide de bouche*, while less than three percent was *arachide semence*. The 169 households in the survey who sold groundnuts sold on average 2.6 tons. The 59 households who sold *arachide de bouche* sold on average 1.4 metric tons; the 145 households who sold *arachide huilerie* sold on average 2.3 metric tons; and the eight households who sold *arachide semence* sold on average 1.5 metric tons.

Table 3.31: Commercialization of Groundnuts on the Official Market

Crop	Seller	# HHs	Quantity (kg)	Value (fCFA)	Avg. Qty. (kg)	Avg. Val. (fCFA)	Avg. Price (fCFA)
Arachide de bouche	**CM**	57	63,682	9,746,717	1,117.2 (873.5)	170,995.0 (136,483.1)	152.2 (5.0)
	HD	8	16,570	2,511,020	2,071.3 (2,602.7)	313,877.5 (395,885.5)	150.9 (1.4)
	F	10	3,658	548,700	365.8 (264.3)	54,870.0 (39,650.6)	150.0 (0.0)
	Total	59	83,910	12,806,437	1,422.2 (1,410.1)	217,058.3 (216,278.7)	152.0 (4.8)
Arachide Huilerie	**CM**	124	184,950	27,606,700	1,491.5 (1,896.3)	222,634.7 (282,857.7)	149.6 (6.2)
	HD	81	86,956	13,043,400	1,073.5 (1,234.6)	161,029.6 (185,192.9)	150.0 (0.0)
	F	100	70,957	10,616,950	709.6 (1,094.7)	106,169.5 (164,226.6)	149.7 (4.0)
	Total	146	342,863	51,267,050	2,348.4 (3,162.6)	351,144.2 (473,862.6)	149.6 (5.4)
Arachide Semence	**CM**	9	12,872	2,049,520	1,430.2 (1,114.1)	227,724.4 (178,769.2)	158.9 (3.3)
	HD	1	600	90,000	600.0 (0.0)	90,000.0 (0.0)	150.0 (0.0)
	F	2	200	31,000	100.0 (0.0)	15,500.0 (707.1	155.0 (7.1)
	Total	9	13,672	2,170,520	1,519.1 (1,091.5)	241,168.9 (174,373.3)	158.9 (3.3)

Note: Standard deviations are in parentheses under the averages.

3.16.2 Official Market Price

As mentioned above, in theory different prices are paid for each type of groundnut, with *arachide huilerie* receiving the lowest price. In the current survey, this was partially confirmed at least for *arachide semence.* The mean price received by the sixty farmers who sold *arachide de bouche* was 151.7 fCFA per kilogram while the mean prices for *arachide huilerie* and *arachide semence* were 149.7 and 157.5 respectively.

Of the seventy-five people (CMs, dependent males, and women) who sold *arachide de bouche*, forty-eight percent received exactly 150 fCFA per kilogram while another eighteen received only 151. Only five farmers received more than 160 fCFA per kilogram; and only nine received more than 155 fCFA/kg. Similarly, there was practically no variation in the price of *arachide huilerie*; 293 (97%) of the 302 people who sold *arachide huilerie* on the official market received the fixed price of 150 fCFA per kilogram. Three people reported that they received less than the official price (102, 109, 110). This seems unreasonable given the apparent ease of realizing the official price. If it were not simply a case of bad salesmanship, perhaps it was an error in the reporting. Only twelve people sold *arachide semence*. Three received 150 fCFA/kg, while the rest received 160. Thus there was almost no price variation in the sale of groundnuts on the official market. (See Table 3.32)

Table 3.32: Official Groundnut Sales Prices

	Arachide de bouche	***Arachide huilerie***	***Arachide semence***
Mean	151.7	149.7	157.5
Std.	4.4	4.6	4.5
N	75	302	12

3.16.3 Women's Role in the Commercialization of Groundnuts on the Official Market

Women selling groundnuts from their private fields accounted for only seventeen percent (or 75 metric tons) of the total groundnut tonnage officially marketed. The CMs sold fifty-nine percent (or 261 metric tons) of the groundnuts, and the dependent males sold twenty-nine percent (or 104 metric tons.) On average men (both the household heads and the dependent males) sold over three times as many groundnuts per person as women. As can be seen in Table 3.33, the average quantities sold by men and the money they received for their groundnuts exceed that of women.

Table 3.33: Men Versus Women in the Sale of Groundnuts on the Official Market

Mean Quantities Sold:	
H_o: $Q_F = Q_{CM}$	Z=Score = -5.25
H_o: $Q_F = Q_{HD}$	Z=Score = -2.67
H_o: $Q_F = Q_{Men}$	Z=Score = -6.11
Mean Value Received:	
H_o: $V_F = V_{CM}$	Z=Score = -5.27
H_o: $V_F = V_{HD}$	Z=Score = -2.68
H_o: $V_F = V_{Men}$	Z=Score = -6.12
Mean Price Received:	
H_o: $P_F = P_{CM}$	Z=Score = -1.13
H_o: $P_F = P_{HD}$	Z=Score = -0.72
H_o: $P_F = P_{Men}$	Z=Score = -0.85

Although women received a lower average price than men for their groundnuts, the difference, as can be seen on Table 3.33, is not significant. Women did receive significantly less money on average than the men, reflecting, of course, the fact that they sold fewer groundnuts. However, it demonstrates that women in the surveyed households earn much less money than do men, especially on the official groundnut market.

3.17 Commercialization of Groundnuts: Open Market

3.17.1 Quantity Sold on Open Market

Almost a quarter of the households (55) have an individual who sold groundnuts on the open, parallel market (see Table 3.34). Over half of these households (31) also sold on the official market. In all, eighty-two individuals participated in the open market. Less than forty-five metric tons of groundnuts were marketed via this channel with each household selling on average 813 kilograms. The range however is quite wide, ranging from forty-five kilograms to 7.7 tons. The forty-five tons sold on the open market by the fifty-five farmers represented only thirty-five percent of the 128 tons that these households marketed and only twenty-seven percent of the amount of groundnuts grown.

Twenty-five of the farmers who sold on both the official and the open market sold less than half their product on the open market. These farmers accounted for twenty-six of the forty-five tons of groundnuts sold on the open market. Farmers who sold their entire product on the open market accounted for only fourteen of the forty-five ton total. On average, farmers who sold on the open market sold 1.8 tons of *arachide de bouche* and 2.7 tons of *arachide huilerie* through official channels, but only one ton of groundnuts on the open market.

On the open market, groundnuts were sold in a variety of forms. Most were sold in the shell (*coque sèche* or CS). Groundnuts were also marketed as shelled and treated (*décortiquée et triée* or D&T), peanut butter (*sax-sax triturés* or SST) and green groundnuts (*vert* or VERTE). Ninety-five percent of the sales on the open market were groundnuts still in the shell. This is also how most groundnuts are sold on the official market. Groundnuts sold in all other forms on the open market amounted to just over two metric tons and yielded less than half a million fCFA.

Table 3.34: Sales of Groundnuts on the Open Market

		CM			HD			F			All Men			Total		
		Qty	**Value**	**Price**	**Qty**	**Value**	**Price**	**Qty**	**Value**	**Price**	**Qty**	**Value**	**Price**	**Qty**	**Value**	**Price**
CS	**#**	38	38	38	18	18	18	14	14	14	45	45	45	46	46	46
	sum	26,690	4,702,200	—	11,290	1,911,750	—	5,240	959,500	—	37,980	6,613,950		43,220	7,573,450	—
	avg	702	123,742	169	627	106,208	164	374	68,536	162	844	146,977	169	940	164,640	168
	std.	642	123,758	25.3	755	136,746	19.5	482	100,383	27	1,020	186,238	24	1,246	232,776	24
D&T	**#**	3	3	3	2	2	2	1	1		3	3	3	3	3	3
	sum	423	97,625		323	56,625		170	28,900	—	745	154,250		915	183,150	—
	avg	141	32,542	223	161	28,313	210	170	28,900		248	51,417	223	305	61,050	223
	std.	143	37,207	46.2	196	32,085	56.6				183	34,961	46	263	44,496	46.2
SST	**#**	2	2	2	0			1	1	1	2	2	2	3	3	3
	sum	360	126,000	—				100	35,000	—	360	126,000		460	161,000	
	avg	180	63,000	350				100	35,000	350	180	63,000	350	153	53,667	350
	std.	170	59,397	0							170	59,397	0	129	45,004	0
VERTE	**#**	2	2	2	1	1		0			3	3	3	3	3	3
	sum	390	63,600	—	350	63,000	—				740	126,600		740	126,600	—
	avg	195	31,800	163	350	63,000	180				247	42,200	168	247	42,200	168
	std.	64	11,031	3.5							100	19,630	10	100	19,630	10.4
TOTAL	**#**	45	45	45	21	21	21	16	16	16	53	53	53	55	55	55
	sum	27,863	4,989,425	—	11,963	2,031,375	—	5,510	1,023,400	—	39,825	7,020,800	—	45,335	8,044,200	—
	avg	619	110,876	181	570	96,732	169	344	63,963	174	751	132,468	179	824	146,258	181
	std.	622	118,216	47	713	128,654	26	456	94,290	53	966	175,200	44	1,169	216,992	49
	min.	23	5,625	125	23	5,625	125	50	7,000	107	45	9,000	125	45	9,000	125
	max.	2,700	500,000	350	3,400	612,000	250	1,800	374,000	350	5,900	1,062,000	350	7,700	1,436,000	350

NOTE: CS = *coque sèche* or groundnuts in the shell
D&T = *décortiquée et triée* or shelled and treated
SST = *sax-sax titurés* or groundnut pâte
VERTE = *verte* or green groundnuts

3.17.2 Open Market Price

The prices received for open market sales of groundnuts ranged from a low of 107 fCFA/kg for groundnuts in the shell to a high of 350 fCFA/kg for shelled and treated groundnuts and for peanut butter. This price difference partially reflects the extra work involved handling the groundnuts and the weight of the shell. On average, individuals received a price of 168 fCFA/kg groundnuts in the shell, 223 fCFA/kg for shelled and treated groundnut, 350 fCFA/kg for peanut butter, and 168 fCFA/kg for green groundnuts.

To compare the average price received by households for the sale of groundnuts on the official market with the average price received on the open market, it is best to compare the price received for groundnuts still in the shell. Table 3.35 shows the results of comparing the average price of groundnuts in the shell sold on the open market with the official prices of *arachide huilerie* and *arachide de bouche*. In each case, the price that households received from their sale of groundnuts in the shell on the open market significantly exceeds that which they received from sales of groundnuts on the official market.

Table 3.35: Prices Received From the Sale of Groundnuts: Open vs. Official Market

Groundnuts in the Shell (Open Market) versus *arachide huilerie* (Official Market):	
H_o: $P_{CS} = P_{AH}$	Z=Score = 5.10
Groundnuts in the Shell (Open Market) versus *arachide de bouche* (Official Market):	
H_o: $P_{CS} = P_{AB}$	Z=Score = 4.41
Groundnuts in the Shell (Open Market) versus Total Groundnuts Sold (Official Market)	
H_o: $P_{CS} = P_{Total}$	Z=Score = 4.94

It is difficult to draw too many conclusions from these data. First, only six percent of the agriculturally active population was involved in open market sales. Second, although the prices realized on the open market exceeded official prices, there was too little sold to make a fair comparison. If a larger volume of the groundnut crop is made available for sale on the open market, one would expect prices to be lower than those in the current survey. The higher prices received for the other forms of groundnuts in most cases reflected the extra labor expended on them.

3.17.3 Women's Role in the Commercialization of Groundnuts on the Open Market

As can be seen in Table 3.36, although women sold significantly less on average than the men, the prices received for the sale of groundnuts in the shell was no different. Since women sold so much less, they also received significantly less money for sales on the open market.

Table 3.36: Men Versus Women in the Sale of Groundnuts on the Official Market

Groundnuts in the Shell (*Coque sèche*)	
Mean Quantities Sold:	
H_o: $Q_F = Q_{CM}$	Z=Score = -141.5
H_o: $Q_F = Q_{HD}$	Z=Score = -33.9
H_o: $Q_F = Q_{Men}$	Z=Score = -236.3
Mean Price Received:	
H_o: $P_F = P_{CM}$	Z=Score = -0.93
H_o: $P_F = P_{HD}$	Z=Score = -0.24
H_o: $P_F = P_{Men}$	Z=Score = -0.79

3.18 Commercialization of Other Crops

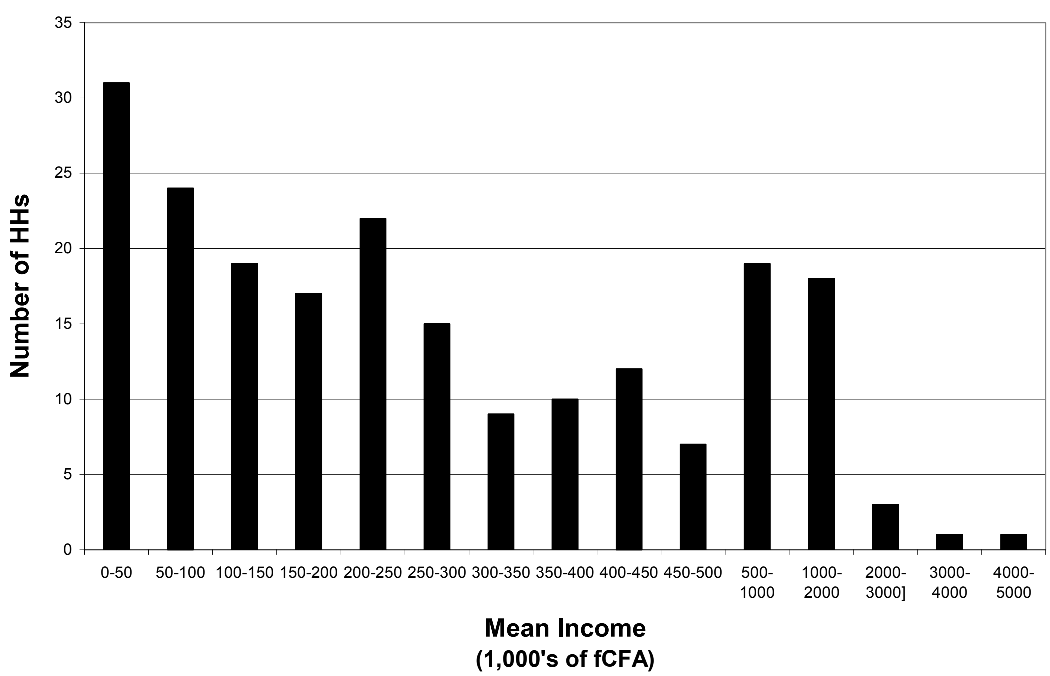
As discussed in Section 3.6, farmers in the survey sold other crops besides groundnuts (see Table 3.12). Cotton is the only other crop for which an official market exists. Twelve of the nineteen farmers who sold their cotton sold it on the official market, realizing an average price of 183 fCFA/kg.

All other crops were sold on the open market. Millet was the crop sold most often, mainly because nearly all the farmers grew it. The fifty-four farmers who sold millet in the market place received, on average, 69,393 fCFA. Only a few farmers sold other cereals in the market. Seven sold sorghum, receiving on average 32,179 fCFA. Only four farmers sold maize, receiving on average 41,630 fCFA. Fifteen farmers grew rice, but all either consumed their output or donated it to others as part of the *deem* (a gift to the poor required by the Koran).

Watermelon and minor crops such as *bissap* are grown primarily as cash crops. The thirty-three farmers who grew watermelon realized on average 78,167 fCFA from their sale. Ten farmers sold *bissap,* realizing an average price of 30,350 fCFA.

Eleven farmers sold part of their vegetable production in the marketplace, obtaining on average 24,055 fCFA. Although examples were obtained of farmers selling crops such as manioc or sesame seed, no crop other than those mentioned above were grown by a significant number of households in the survey.

Graph 3.4: Household Income From Agriculture



3.19 Household Income

Farmers in this survey earned most of their income from agricultural production. However, they also received income from the sale of livestock and fowl, fish, wood,[15] fruit, salt, and from non-agricultural work and. On average, the farmers surveyed earned over 408,000 fCFA (σ=578,997) from their agricultural production. The median producer earned just over 231,000 fCFA. Incomes from crop production ranged from a low of just 3,000 fCFA to almost 4.5 million fCFA. (See Graph 3.4.) Nearly a quarter of the households earned 100,000 fCFA or less from their agricultural production, and fifty percent earned 250,000 fCFA or less. Only ten percent of the households earned more than one million fCFA.

In the survey, farmers were asked about sources of income other than from crops during thirty days prior to the survey. As can be seen from Table 3.37, only sixty percent (or 137) of the households reported income from non-crop sources. Forty percent of the households reported no outside income during the previous thirty days. The mean income for the 137 households reporting non-crop income is just over 113,000 fCFA (σ=287,529). The median income from other sources was 39,000 fCFA, which was, like crop production, below the average. Total household income for the 137 households reporting income in the past thirty days varied widely from a low of just 1,125 fCFA to three million fCFA.

The sale of sheep and goats was the income source of approximately twenty-five percent (56) of the households, yielding an average return of almost 38,000 fCFA (σ=38,000). Twenty households sold a cow or an ox for an average return of 142,500 fCFA

[15] Although the survey collected data on wood sold by the farmers, all wood is not the same. For example, wood from an acacia tree costs more than wood from a eucalyptus tree. Also dried wood is more valuable than wet wood, especially when sold by the kilogram. These quality differences, which affect prices, also exist with other products sold by farmers.

(σ=147,197). Thirty-four household sold a fowl, earning an average return of 6,454 fCFA (σ=7,272).

Table 3.37: Annual Household Income From Non-Crop Sources (Past 30 Days)

Income Source Sales From:	# of HHs	Mean Income	Std Dev	Minimum	Maximum
Sheep/Goats	56	37,455	37,281	7,500	175,000
Cows/Oxen	20	142,500	147,197	40,000	645,000
Horses	15	80,500	49,246	25,000	200,000
Donkeys	2	36,000	33,941	12,000	60,000
Fowl	34	6,454	7,272	1,000	30,000
Eggs	1	7,200		7,200	7,200
Milk	5	8,700	6,221	3,000	18,000
Artisan Work	33	54,883	56,300	1,125	287,000
Boutique	12	208,146	337,054	3,750	1,000,000
Fish	3	15,333	12,858	6,000	30,000
Wild Fruit	6	4,250	2,806	1,000	7,500
Domestic Fruit	1	9,000		9,000	9,000
Wood	9	22,333	28,861	2,000	90,000
Salt	1	20,000		20,000	20,000
Total for Survey	**137**	**113,712**	**287,529**	**1,125**	**3,000,000**

Twelve households report owning a shop (*boutique)*. These shops yielded an average return of over 208,000 fCFA (σ=337,054). Thirty-three report skilled work (*artisanat*) outside the household earning an average return of 54,883 fCFA (σ=56,300). Among the reported occupations were mason, carpenter, mechanic, chauffeur, hotel guard, tailor, shop employee, brick maker, trader, domestic worker, blacksmith, and electronic repair specialist.

During the non-agricultural season, many Senegalese migrate to the cities or to other countries in search of work. In some cases, these migrants are household heads; in other cases they are other adults in the household. The remittances of migrants is an important source of household income. Similarly there are members of the household who are permanently away. It is also typical for these people to send money back to their families.

In the survey, only fifty-three percent (121) of the households admit having a member living outside the village. Most of these households (107) report that the household member lives elsewhere in Senegal. Only thirteen percent report that a household member resides in another country. Perhaps because the survey did not specifically ask about remittances, no household reported either off-season remittances or remittances from those permanently away from the household as a source of income.[16] Only three households listed receiving gifts. Since the survey did not ask whether household members living away worked or if they sent money back to the family, one cannot determine the effect of these individuals on household income.

One potential problem with the survey was the fact that it was conducted during the non-agricultural season. Protocol dictates that before any survey is administered, the village chief be contacted. His help is solicited to choose the households to be interviewed. Although the surveyors explained to the chief that they needed a "random" selection of households, there were no secondary checks on the randomness of the households selected. One certainty was that households whose head was not in the village on the day the survey was conducted were not interviewed.

3.20 Household Expenditures

3.20.0 Introduction

Farmers reported spending money in a wide variety of categories in the thirty days prior to the survey. (See Table 3.38.) Some categories of expenditures can be thought of as regular expenses, such as food, toiletries, energy, or transportation. Other expenditures are episodic, such as clothing, education, medical, ceremonies, taxes, or gifts. Finally, some categories may be one-time expenditures, such as housing, agricultural equipment, or animals. The survey did not ascertain how often expenditures in different categories were made during the year. Instead, expenditures reflect only money spent during the past thirty days.

Farmers report spending, on average, over ninety-five thousand fCFA (σ=127 899) in the thirty days prior to the survey.[17] The median monthly expenditure is 66,380 fCFA.

Since this survey was taken just before and just after Tabaski,[18] the expenditures reported may not be typical of other thirty-day periods. Although Senegal has a number of religious and civil holidays, Tabaski is one of more significant holidays, and expenditures for clothing and rams or goats may be more common during Tabaski than during other thirty-day periods. However, income for the past thirty days may also be different as farmers, for example, may sell more animals during Tabaski.

Food is an important expense for households in the survey. Eighty percent of the households (182) bought an average of 123 kilograms (σ=97) of cereal in the previous thirty days, spending an average of over 22,000 fCFA. Other food expenditures purchased by ninety-four percent of the households (215) total almost 10,000 fCFA.

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[16] During the survey, I met a CE's son visiting Senegal from New York where he was working as a taxi driver. As a good son and husband, he was sending back part of his earnings. These had been used to construct and furnish several buildings in the household. The household did not report any gifts from this son.

[17] Only 227 farmers answered this question and the question on other income. In the household from which no information was received, the person who knew the information was not present at the time of the survey.

[18] Tabaski is the Islamic celebration of Allah's intervention to save Isaac from being sacrificed by his father Abraham. In lieu of Isaac, Allah provided a ram for Abraham to sacrifice. Thus the celebration usually entails the slaughter of a ram or a goat and a subsequent feast.

Table 3.38: Expenditures by Category (Past 30 Days)

Expense Category	# of Farmers Spending Money on this Category	Mean Expenditure Per Category	Std Dev	Minimum Expense	Maximum Expense
Cereal	182	22,633	18,302	1,000	154,500
Other Food	215	9,583	7,065	1,000	39,940
Clothing	133	23,746	21,772	200	100,000
Housing	40	79,737	189,118	1,000	1,000,000
Toiletries	189	2,547	2,016	550	15,000
Energy	219	1,281	2,043	65	22,750
Transportation	93	5,956	8,490	200	60,000
Education	70	3,327	5,141	200	35,000
Medical	109	13,628	48,889	100	500,000
Ceremonies	82	23,005	33,914	350	163,700
Storage	34	2,849	6,184	100	35,000
Taxes	75	5,610	7,427	400	60,000
Gifts	3	16,667	9,713	6,000	25,000
Ag Equipment	25	82,778	94,304	700	450,000
Animals	94	28,906	27,317	1,000	160,000
Other	23	5,885	3,312	1,000	12,800
TOTAL	**227**	**95,639**	**127,899**	**615**	**1,389,750**
Savings	81	108,852	262,400	100	1,375,000

In the past thirty days, over half the farmers (133) report buying new clothes at an average cost of just under 24,000 fCFA. Over forty percent (94) purchased animals at an average cost of nearly 29,000 fCFA, and thirty-six percent of the households (82) spent an average of over 23,00 fCFA to cover ceremonial expenses (*e.g.* weddings, funerals, or baptisms.)

By far the largest expenditures reported by any of the surveyed households are for housing and agricultural equipment, although only a small number of households (17.5% and 11% respectively) reported these expenditures. However, since these expenditures may be considered capital expenditures, one might expect a larger percentage of the surveyed households to expend a similar amount at sometime during the year.

Expenditures on energy, transportation, health needs, education, storage, taxes, and toiletries represent more regular monthly outlays. Only expenditures on energy and toiletries were made by a majority of the households, and the total for both categories is less that 5,000 fCFA in the month.

3.20.1 Income Deficit Households

Almost sixteen percent (36) of the households report spending more than one hundred percent of annual earnings from the sale of their crops in the thirty days prior to the survey. Another nine percent (20) reported no crop income at all. The households who had no crop income report expenditures ranging from 625 to 625,700 fCFA in the thirty days prior to the survey (μ=98,663; σ=134,121.) Another twenty-one percent of the households report spending between fifty and one hundred percent of their yearly crop income in the thirty days prior to the survey.

In order to compare yearly income and expenditure data, some assumptions are made. Although there is no way to tell whether the thirty days prior to the survey are typical of any other thirty-day period, the analysis below assumes that non-crop income and expenditure data are typical and examine the ramifications.

To compare the annual income for the household with annual expenditures, the thirty-day non-crop income and expenditure figures are multiplied by twelve. Then the non-crop income figure is added to the annual crop income from the survey to obtain total household income. This figure is compared with the yearly estimate of expenditures.

Table 3.39: Income Deficit Households

Income Deficit (fCFA)	# HHs	Percentage
Less than 100,000	19	8.3
100,000 - 200,000	9	3.9
200,000 - 300,000	17	7.5
300,000 - 400,000	16	7.0
400,000 – 500,000	9	3.9
500,000 - 600,000	10	4.4
600,000 - 700,000	13	5.7
700,000 - 800,000	6	2.6
800,00 – 900,000	7	3.1
900,000 – 1,000,000	4	1.8
1,000,000 - 2,000,000	23	10.1
Greater than 2,000000	9	3.9
Total Income Deficit Households	**142**	**62.3**

These estimates indicate that sixty-two percent (142) of the households spend more money than they earn. Sixteen percent of these households will spend over one million fCFA more than they earn. (See Table 3.39.) If this is accurate, it is clearly a non-sustainable spending pattern.

Table 3.40 summarizes the annual crop income data reported by households in the survey and the income from other sources and expenditure data in the thirty days prior to the survey. As can be seen, the average income from other sources minus expenditures is -27,011 (σ=243,321). If this is projected over the year, the household average net "profit" from all income and expenditures is less than fifty thousand fCFA, a very modest sum and an amount that would leave little available to cover an emergency or to allow for investment in new and better equipment.

One explanation for the high level of expenditures in relation to income may be the existence of unreported or under-reported remittances. Another explanation may be the prevalence of gifts in Senegalese culture. Over forty percent (97) of the farmers said they gave a gift of money during the previous thirty days, averaging just over 8,000 fCFA; the median gift was just under 5,000 fCFA. However, no one reported receiving a monetary gift. Besides these gifts of money, adherence to Islamic principles require farmers to donate ten percent of their agricultural production to others. Fifty-three percent (121) of the farmers gave away an average of just over 200 kilograms of millet. Nearly a third of the farmers producing sorghum, corn, and cowpeas also said they gave away a portion of their production. Only ten percent of the farmers reported giving away any of their cash crop, groundnuts.

Table 3.40: Income and Expenditure Summary and Annual Estimates

	Total Annual Crop Income	30-day Non-Crop Income	30-day Expenditures	30-day Income - Expenditures	Yearly (estimate) Total Income - Expenditures
Count	208	137	227	227	228
Average	408,156	113,713	95,639	-27,011	49,644
StDev	578,997	287,529	127,899	243,321	2,846,766
Min.	3,000	1,125	615	-1,099,750	-10,347,000
Max.	4,470,000	3,000,000	1,389,750	2,752,375	33,276,000
Median	231,875	39,000	66,380	-39,300	-198,510

3.20.2 Cereal Purchases

In the thirty days prior to the survey, farmers report substantial expenditures on cereals. On average, farmers report spending over 22,000 fCFA for rice and nearly 18,000 for millet/sorghum. Farmers in the survey produced on average 1,762 kilograms of cereals. Thus, the average household purchase of 123 kilograms of cereals in the thirty days prior to the survey represents over seven percent of the yearly household production.

As mentioned above, eighty percent of the households purchased cereals in the thirty days prior to the survey, amounting to over seventeen percent of the household's total expenditures during the period. The most frequent purchase was rice, bought by almost eighty percent (179) of the households and accounting for nearly two-thirds of all cereals purchased. These households purchased an average of seventy-six kilograms of rice in the thirty days prior to the survey. Since only sixteen farmers in the survey produced rice, these purchases most likely were for rice grown outside the survey area. This reflects a significant demand for rice in non-urban areas of Senegal.

Millet and sorghum, the major staples in the diet of households in the Kaolack and Fatick regions, were bought by only sixty households and comprised just over a quarter of the cereals purchased. The households who purchase millet or sorghum purchased an average of 128 kilograms.

Of the 177 households who reported both cereal purchases and some income during the month prior to the survey, almost eleven percent spent more than fifty percent of their estimated annual income on cereals. Slightly over twenty-one percent spent more than twenty-five percent, and almost fifty-four percent spent over ten percent of their income on cereals.

3.20.3 Savings

In the survey, a question was also asked about the level of household savings. Only thirty-five percent of the households responded to this question. The surveyors reported that farmers felt this information was very sensitive and, as a result, their answers were not very reliable. In some cases, the surveyors were reluctant to ask questions about savings. In other cases, a suggestion as to the level of the savings may have been proposed by the surveyor and accepted by the respondent. The eighty-one households who responded to the question indicated an average of almost 109,000 fCFA in savings, although this number varied widely (σ=262,400).

Since there are no banks in the villages and no place to safely stash large amounts money, it is not surprising that information about one's savings is not readily given out. Also a widespread knowledge that a household has a great deal of savings would probably attract friends, family, and neighbors wanting to obtain a “loan”. If we compare the average level of savings with the average of over 100,000 fCFA in expenditures during the thirty days prior to the survey, we can see that household savings do not provide much of a cushion against unforeseen circumstances.

3.21 Caloric Production versus Caloric Requirements

Most farmers in the current survey are small-scale farmers who produce groundnuts for sale and grains and other food crops for household consumption. However, in most cases the farmers are not producing enough food to meet the caloric requirements of the household. To achieve the required caloric needs, they must purchase food on the open market.

Table 3.41: Kilocalories Available Per 100 grams of Whole Grain

Crop	Before Processing	After Processing
Millet	353	281
Sorghum	354	281
Maize	357	285
Niébé		342
Rice		363

Source: Kelly, 1993

To reach this conclusion, the total grains and beans produced were converted into kilocalories.[19] Table 3.41 gives the caloric content of the grains produced in the survey region. The “after processing” figure was used to determine the total calories produced by the farmers.

The caloric needs of the household were determined by adding the daily needs of every member of the household. Table 3.42 gives the average caloric requirements for each age group in the survey.

[19] Although the layperson may use the word “calorie,” the word kilocalorie (kcal) is more precise. Throughout this paper, references to “calorie” will mean “kilocalorie.”

Table 3.42: Daily Caloric Requirements

Age	Males	Females
0-14	1,870	1,790
15-65	2,740	2,116
> 65	2,300	1,900

Source: National Research Council, 1989

A comparison of the number of calories obtainable from the grains produced (Table 3.41) and the caloric needs of the household (Table 3.42), reveals the households who did not produce enough calories. Almost eighty-nine percent of the households did not produce enough calories from their grain and bean production to satisfy their nutritional needs. (See Table 3.43.)

The households in the survey obviously consumed foods other than grains and beans. In the calculations presented here, no account was made of the calories obtained from household produced vegetables or non-groundnut oils. Furthermore no account was taken of household consumed groundnuts. However, according to Kelly, *et al.*, 1993, grains and pulses provide almost ninety percent of the caloric requirements for households in Senegal's Groundnut Basin.[20]

In the current survey, almost sixty percent of the households produced less than fifty percent of their caloric needs from grains and pulses. Fewer than twelve percent of the households produced a caloric surplus from the staple grain and bean production. To put this caloric deficit into perspective, the total caloric deficit for all households in the survey (1,097,970,145 kcal) was converted into the equivalent amount of millet. The caloric deficit is equivalent to 390 tons of millet. This exceeds the total of 349 tons of millet produced by all households in the survey. Thus for all households in the survey,

[20] Kelly *et al.*, 1993, Table 8.2, page 159.

the total calories produced from grains and pulses (1,090,485,175) are less than half the caloric needs (2,188,455,320) of the households.

Table 3.43: Calorie Deficit Households

Percentage of Household Caloric Requirement Produced	Number of Households	Percent of Total Number of Households	Cumulative Percent
0	5	2.2	2.2
< 10	19	8.3	10.5
< 20	29	12.7	23.2
< 30	34	14.9	38.2
< 40	31	13.6	51.8
< 50	18	7.9	59.6
< 60	21	9.2	68.9
< 70	17	7.5	76.3
< 80	16	7.0	83.3
< 90	10	4.4	87.7
< 100	2	0.9	88.6
< 110	8	3.5	92.1
< 120	2	0.9	93.0
< 130	6	2.6	95.6
< 140	2	0.9	96.5
< 150	4	1.8	98.2
>= 150	4	1.8	100.0
Total	**228**	**100**	

If these data are a valid reflection of the situation in the Kaolack and Fatick regions, many of the farm households are facing nutritional as well as economic difficulties. When the caloric production data is joined with the data on household spending, one sees an alarming pattern. First, many households are not producing enough to satisfy their caloric needs. Second, their spending on non-food items takes a very large percentage of their profits from cash crop production. There are two conclusions. First, the households are destined for severe economic hardship and will require outside support in order to receive enough to eat. Second, the data on total family income are inaccurate, and further investigation is necessary to discover sources of any extra income. Since the data provided in the survey on groundnut production and sales agreed with one another and were often verified by examining official receipts, it is likely that extra sources for income are non-agricultural. As mentioned above, a likely source for the unreported income is remittances from off-farm income.

3.22 Conclusions

If the surveyed households are typical of households in villages throughout the Kaolack and Fatick regions, then these households are living on the edge and are vulnerable both to weather and economic or government policy changes. Rainfall is always a concern, and if the rains are not sufficient, government policy changes will have little effect on the households' welfare. The households in the survey do not produce an over abundance now. As Section 3.21 shows, most households are not producing enough food to meet caloric requirements. Also, if Section 3.20 provides an accurate picture of household expenditures, then many households are not generating enough revenue from agriculture to cover expenses such as clothing, transportation, or medical expenses. Thus anything that threatens crop productivity can have serious consequences.

Some change is inevitable. As the population of the area increases, there will be a greater demand for additional farmland. This will result in less and less land left fallow and allowed to recover its fertility. An increasing population will also demand more wood for cooking and construction, and thus more trees will be cut. An increase in population will also mean an increase in livestock—particularly sheep and goats—placing an increased demand for grass and making the land more susceptible to wind erosion. Similarly, as population demands more land for farming, the land available to traditional herders for grazing will be reduced. If these herders are then allowed to graze their animals on the fields after the harvest (*parcage*), grasses and crop residues will be eaten. This will increase the chance of wind erosion, and the land will not benefit from the decaying crop residues.

Households in the survey have few resources to increase production. An examination of their input usage suggests they are not using inputs such as fertilizer that could help increase production. Less than half the households in the survey applied fertilizer. Also, farmers in the survey are not taking advantage of improved seed. Only a fourth of the farmers used the improved N2 groundnut seed.

Even if farmers in the survey are covering all household food requirements, they are not producing enough to purchase or upgrade agricultural equipment. Not all households have enough equipment to efficiently plant and harvest their crops, especially their groundnuts. No household in the survey uses mechanized equipment. If we consider both CEs and CMDs, over twenty percent of the farmers (and less than ten percent of the *exploitations*) do not own a seeder. This piece of equipment is important for the efficient seeding of groundnuts. The situation for other pieces of equipment—hoes, groundnut harvesters, and plows—is much worse. As this equipment ages, households may not have enough resources to purchase new or better equipment.

The situation is similar with respect to animals used in agriculture. Seventeen percent of the surveyed households own no horse, donkey, or ox. In these households, animals must be borrowed or rented, or all planting and harvesting must be done by hand. Considering the separate animals, just over twenty percent of the farmers (CEs and CMDs) own an ox, and less than five percent own more than one. Although three-quarters of all households own a horse, less than ten percent own more than one. Similarly, less than thirty percent of the households own a donkey and less than three percent own more than one. Horses and donkeys, however, are used not only for agriculture, but also for transportation.

Under the current marketing system, most farmers sell their groundnuts on the official market, and official buying stations are close to the village. Over three-quarters of the farmers in the survey sold their product within two kilometers of their village. Therefore, a change in official purchasing policies or in the organization of the market requiring farmers to transport their own product will place an extra burden on the farmers. This is especially true for the more than forty percent of the farmers (and more than thirty percent of the *exploitations*) who do not own a cart they can use to transport their products to market.

A liberalization of the groundnut market may help the Government of Senegal balance its books, but it may cause a disruption among the farmers. Although the prices received for groundnuts sold on the open market were higher than the official price, only a quarter of the farmers in the survey sold groundnuts in this market. If the quantity of groundnuts available for sale on the open market increases, the open market price may go down from what it is when there is so little offered for sale. Farmers who live far from the groundnut oil mills, the ultimate destination of the groundnuts, will likely face a price that takes into account the cost of transportation and thus not receive a price equivalent to the official pan-territorial price they currently receive. In addition, those farmers living in hard-to-reach villages may have few potential buyers, and thus not be able to benefit from the competition normally expected in a more open market.

It is likely that the households surveyed may not have reported all their income since their report of expenditures is too high for their reported crop income. Almost half of the households said they had no family member living outside the household and thus, had no family member who could send them money. Also only seven percent of the farmers reported receiving off-farm income. Perhaps because the related survey question was poorly understood, off-farm income and remittances were probably under-reported.

With regard to women, those in the survey region participate in all aspects of agricultural activity within the households. They control and market groundnuts, the major cash crop in the region. The fact that women control fewer groundnut fields and sell fewer groundnuts may reflect the fact that women have primary responsibility for raising children, cooking meals, and general care of the household. Also, women control a higher percentage of the “other” crop fields, frequently vegetable gardens close to the house. Although the survey did not concentrate completely on eliciting gender-specific differences, there is no compelling evidence that the problems faced by women in the survey are appreciably different from those faced by other household members.

In conclusion, in the future, farmers in the Kaolack and Fatick regions of Senegal will continue to face the traditional uncertainties of the rains. However, the pressures that will be placed on the land by population growth will cause new problems. The farmers in the survey have a small cushion of economic security. Therefore, it is important that before changes in government groundnut policy or in the organization of the groundnut market are made, their effect on the farmers be more fully considered.

Chapter 4: Theory

4.0 Introduction

This chapter presents the theory used to analyze the behavior of the small-scale farm households as described in Chapter 3 in order to assess the impacts of different economic policies.

4.1 Analysis of Household's Production Decisions

Each household in the survey is assumed to act as a small firm producing outputs from various combinations of inputs. It is further assumed that any household consumption decision is made separately from decisions about production. The technological relationship between the quantities of inputs used and outputs produced can be expressed mathematically by an implicit *production function*.

4.1 $$F(\mathbf{y}, \mathbf{x}, \mathbf{k}) = 0$$

Where **y** is a vector of outputs, **x** is a vector of variable inputs, and **k** is a vector of fixed inputs or environmental variables. The function F(•) is a quasi-concave function, increasing in outputs **y**, and non-decreasing in inputs **x** and **k**. The production function represents a technology that constrains the choices of inputs used by the household in producing the outputs.

We assume that each household in the survey acts as a profit-maximizing firm. Each household will choose the mixture of outputs and inputs, **(y, x)**, constrained by a production function, that will guarantee the household the maximum profit for a given level of fixed factors, **k**. We further assume that each household takes prices of both its inputs and outputs as given.

By definition, profit is the value of the outputs minus the cost of the inputs.

4.2 $\Pi = \mathbf{p} \cdot \mathbf{y} - \mathbf{w} \cdot \mathbf{x}$

where **p** represents the vector of expected output prices, and **w** represents the vector of input prices.

The household attempts to maximize its profits subject to the constraint imposed by the production technology. The *Lagrangian* function for this case is:

4.3 $\text{Max}_{\mathbf{y},\mathbf{x}}\ L = (\mathbf{p} . \mathbf{y} - \mathbf{w} . \mathbf{x}) + \lambda F(\mathbf{Y}, \mathbf{X}, \mathbf{K})$

The first order conditions for maximization are

4.4 $\frac{\partial L}{\partial y_i} = p_i + \lambda F_{y_i} = 0$

4.5 $\frac{\partial L}{\partial x_j} = w_j + \lambda F_{x_j} = 0$

4.6 $\frac{\partial L}{\partial \lambda} = F(\mathbf{y}, \mathbf{x}, \mathbf{k}) = 0$

The solution to these first order conditions for inputs **x** give ordinary input demand functions. These expressions for **x** can now be substituted into 4.1 to obtain an equation for **y** as a function of **p** and **w**. Then this new expression for **y** and the ordinary demand functions for **x** can be substituted into 4.2 to yield an indirect, short-term profit function written as a function of input and expected output prices and the fixed factors, **k**.

4.7 $\Pi = \Pi(p, w, k)$

This indirect profit function is a convex function, continuous for all **p** and **w** greater than zero. It is increasing in **y** and non-decreasing in **w**. Further, it is homogeneous of degree one in prices (**p, w**).

Using Hotelling's Lemma, we can derive the output supply functions and the input demand functions as follows:

4.8 $$\frac{\partial \Pi}{\partial \mathbf{p}} = \mathbf{y}$$

4.9 $$\frac{\partial \Pi}{\partial \mathbf{w}} = -\mathbf{x}$$

It remains only to define an appropriate functional form for the indirect profit function.

In this study the following prices[1] were used:

PPEA	Producer price of groundnuts
PCER	Producer price of cereal
POC	Producer price of "other" crops
PICER	Price of cereal seed
PIOC	Price of "other" crop seed
PIFERT	Price of chemical fertilizer
PIFUNG	Price of fungicide

The environmental variables and fixed inputs were used:

IPEA	Quantity of groundnut seed used (proxy for land[2])

[1] Since decisions are made before the crops are sown, all prices should be the prices the farmer expects to receive for his production. Similarly, if the prices of inputs such as fertilizer are also not known in advance, these are expected prices also.

[2] Groundnuts are typically sown using a mechanical seeder. It was assumed that the seeding density among households was similar. Therefore the amount of seed sown could adequately serve as a proxy for the amount of land.

LABOR	composite labor variable
	(Adult female = .7 * male; Children = .5 * male)
RAIN_QTY	Quantity of Rain (mm)
RAIN_DUR	Number of days of rain
RAIN_DEV	Deviation of rain quantity from historical average

Since the profit function should be homogenous of degree one in prices, we can enforce this by scaling the entire function by dividing by one of the prices, thus reducing the number of parameters to be estimated. In this study the price of groundnut seed was chosen as the numeraire. Profit and all prices were divided by the price of groundnut seed, PIPEA. Thus the price variables are preceded by an "N" to indicate that they have bee normalized.

As was indicated in Chapter 3, most households did not produce crops other than groundnuts and cereals. Furthermore, a large number of households did not use either fertilizer or fungicide. These facts have an impact on the functional form chosen for the analysis. Since there are a large number of zeros in the quantity data, any function involving logarithms could not be used. Thus a normalized quadratic profit function was chosen.

The normalized quadratic profit function has the advantage of yielding simple supply and demand functions having real quantities as dependent variables. The demand and supply functions are linear functions of relative prices, and elasticities are easily evaluated at the sample means of quantities and prices. One problem with the normalized quadratic function is that it is not globally convex in prices and homogeneity of degree one in prices is imposed and not tested. [Huffman, p. 33.] The quadratic profit function can be written:

$$4.10 \qquad \Pi_n = \alpha_0 + \sum_{i=1}^{12} \alpha_i p_i + \frac{1}{2}\sum_{i=1}^{12} \beta_i p_i^2 + \frac{1}{2}\sum_{i=1}^{11}\sum_{j=2}^{12} \gamma_{ij} p_i p_j$$

where p_i represents either a price or an environmental or fixed factor, and α, β, and γ are coefficients. There are twelve prices or environmental or fixed factors in the model to be estimated here.

This form, as written, will contain two terms, (p_i p_j) and (p_j p_i). Since multiplication is symmetric, these two terms will be the same, but will have different coefficients, γ_{ij} and γ_{ji}. Obviously, these two terms can be added to produce a single term. This is reflected in the following equation where all terms, γ_{ji}, are dropped when j>i, leaving a single term, p_{ij}, having the coefficient, γ_{ij}.

4.11 $\Pi_n = \alpha_0 + \alpha_1\text{NPPEA} + \alpha_2\text{NPCER} + \alpha_3\text{NPOC} + \alpha_4\text{NPICER} + \alpha_5\text{NPIOC} +$
$\alpha_6\text{NPIFERT} + \alpha_7\text{NPIFUNG} + \alpha_8\text{IPEA} + \alpha_9\text{LABOR} + \alpha_{10}\text{RAIN\_QTY} +$
$\alpha_{11}\text{RAIN\_DUR} + \alpha_{12}\text{RAIN\_DEV} + ½[\beta_1\text{NPPEA}^2 + \beta_2\text{NPCER}^2 + \beta_3\text{NPOC}^2$
$+ \beta_4\text{NPICER}^2 + \beta_5\text{NPIOC}^2 + \beta_6\text{NPIFERT}^2 + \beta_7\text{NPIFUNG}^2 + \beta_8\text{IPEA}^2 +$
$\beta_9\text{LABOR}^2 + \beta_{10}\text{RAIN\_QTY}^2 + \beta_{11}\text{RAIN\_DUR}^2 + \beta_{12}\text{RAIN\_DEV}^2] +$
$\gamma_{12}(\text{NPPEA})(\text{NPCER}) + \gamma_{13}(\text{NPPEA})(\text{NPOC}) + \gamma_{14}(\text{NPPEA})(\text{NPICER}) +$
$\gamma_{15}(\text{NPPEA})(\text{NPIOC}) + \gamma_{16}(\text{NPPEA})(\text{NPIFERT}) + \gamma_{17}(\text{NPPEA})(\text{NPIFUNG})$
$+ \gamma_{18}(\text{NPPEA})(\text{IPEA}) + \gamma_{19}(\text{NPPEA})(\text{LABOR}) +$
$\gamma_{1,10}(\text{NPPEA})(\text{RAIN\_QTY}) + \gamma_{1,11}(\text{NPPEA})(\text{RAIN\_DUR}) +$
$\gamma_{1,12}(\text{NPPEA})(\text{RAIN\_DEV}) + \gamma_{23}(\text{NPCER})(\text{NPOC}) + \gamma_{24}(\text{NPCER})(\text{NPICER})$
$+ \gamma_{25}(\text{NPCER})(\text{NPIOC}) + \gamma_{26}(\text{NPCER})(\text{NPIFERT})$
$+ \gamma_{27}(\text{NPCER})(\text{NPIFUNG}) + \gamma_{28}(\text{NPCER})(\text{IPEA}) + \gamma_{29}(\text{NPCER})(\text{LABOR}) +$
$\gamma_{2,10}(\text{NPCER})(\text{RAIN\_QTY}) + \gamma_{2,11}(\text{NPCER})(\text{RAIN\_DUR}) +$
$\gamma_{2,12}(\text{NPCER})(\text{RAIN\_DEV}) + \gamma_{34}(\text{NPOC})(\text{NPICER}) + \gamma_{35}(\text{NPOC})(\text{NPIOC})$
$+ \gamma_{36}(\text{NPOC})(\text{NPIFERT}) + \gamma_{37}(\text{NPOC})(\text{NPIFUNG}) + \gamma_{38}(\text{NPOC})(\text{IPEA}) +$

γ_{39}(NPOC)(LABOR) + $\gamma_{3,10}$(NPOC)(RAIN_QTY) +
$\gamma_{3,11}$(NPOC)(RAIN_DUR) + $\gamma_{3,12}$(NPOC)(RAIN_DEV) +
γ_{45}(NPICER)(NPIOC) + γ_{46}(NPICER)(NPIFERT)
+γ_{47}(NPICER)(NPIFUNG) + γ_{48}(NPICER)(IPEA) + γ_{49}(NPICER)(LABOR)
+ $\gamma_{4,10}$(NPICER)(RAIN_QTY) + $\gamma_{4,11}$(NPICER)(RAIN_DUR) +
$\gamma_{4,12}$(NPICER)(RAIN_DEV) + γ_{56}(NPIOC)(NPIFERT)
+γ_{57}(NPIOC)(NPIFUNG) + γ_{58}(NPIOC)(IPEA) + γ_{59}(NPIOC)(LABOR) +
$\gamma_{5,10}$(NPIOC)(RAIN_QTY) + $\gamma_{5,11}$(NPIOC)(RAIN_DUR) +
$\gamma_{5,12}$(NPIOC)(RAIN_DEV) + γ_{67}(NPIFERT)(NPIFUNG) +
γ_{68}(NPIFERT)(IPEA) + γ_{69}(NPIFERT)(LABOR) +
$\gamma_{6,10}$(NPIFERT)(RAIN_QTY) + $\gamma_{6,11}$(NPIFERT)(RAIN_DUR) +
$\gamma_{6,12}$(NPIFERT)(RAIN_DEV) + γ_{78}(NPIFUNG)(IPEA) +
γ_{79}(NPIFUNG)(LABOR) + $\gamma_{7,10}$(NPIFUNG)(RAIN_QTY) +
$\gamma_{7,11}$(NPIFUNG)(RAIN_DUR) + $\gamma_{7,12}$(NPIFUNG)(RAIN_DEV) +
γ_{89}(IPEA)(LABOR) + $\gamma_{8,10}$(IPEA)(RAIN_QTY) + $\gamma_{8,11}$(IPEA)(RAIN_DUR)
+ $\gamma_{8,12}$(IPEA)(RAIN_DEV) + $\gamma_{9,10}$(LABOR)(RAIN_QTY) +
$\gamma_{9,11}$(LABOR)(RAIN_DUR) + $\gamma_{9,12}$(LABOR)(RAIN_DEV) +
$\gamma_{10,11}$(RAIN_QTY)(RAIN_DUR) + $\gamma_{10,12}$(RAIN_QTY)(RAIN_DEV) +
$\gamma_{11,12}$(RAIN_DUR)(RAIN_DEV)

where Π_n is the household's profit divided by the numeraire, PIPEA.

Following Hotelling's Lemma, differentiating the profit function with respect to the normalized output prices, NPPEA, NPCER, and NPOC yields the output supply functions for the outputs QPEA, QCER, and QOC respectively as functions of all the input and output prices.

4.12 $$\frac{\partial \Pi}{\partial NPPEA} = \alpha_1 + \beta_1 NPPEA + \gamma_{12} NPCER + \gamma_{13} NPOC + \gamma_{14} NPIOC + \gamma_{15} NPIOC + \gamma_{16} NPIFERT + \gamma_{17} NPIFUNG + \gamma_{18} IPEA + \gamma_{19} LABOR + \gamma_{1,10} RAIN\_QTY + \gamma_{1,11} RAIN\_DUR + \gamma_{1,12} RAIN\_DEV$$

4.13 $$\frac{\partial \Pi}{\partial NPPEA} = QPEA(NPPEA, NPCER, NPOC, NPICER, NPIOC, NPIFERT, NPIFUNG, IPEA, LABOR, RAIN\_QTY, RAIN\_DUR, RAIN\_DEV)$$

In a similar manner, we can obtain output supply equations for QCER and QOC.

4.14 $$\frac{\partial \Pi}{\partial NPCER} = QCER(NPPEA, NPCER, NPOC, NPICER, NPIOC, NPIFERT, NPIFUNG, IPEA, LABOR, RAIN\_QTY, RAIN\_DUR, RAIN\_DV)$$

4.15 $$\frac{\partial \Pi}{\partial NPOC} = QCER(NPPEA, NPCER, NPOC, NPICER, NPIOC, NPIFERT, NPIFUNG, IPEA, LABOR, RAIN\_QTY, RAIN\_DUR, RAIN\_DV)$$

Similarly, according to Hotelling's Lemma, differentiating the profit function with respect to the normalized input prices, NPICER, NPIOC, NPIFERT, and NPIFUNG yields the negative of the input demand functions for inputs ICER, IOC, IFERT, and IFUNG respectively.

4.16 $$\frac{\partial \Pi}{\partial NPICER} = -ICER(NPPEA, NPCER, NPOC, NPICER, NPIOC, NPIFERT, NPIFUNG, IPEA, LABOR, RAIN\_QTY, RAIN\_DUR, RAIN\_DV)$$

4.17 $$\frac{\partial \Pi}{\partial NPIOC} = -IOC(NPPEA, NPCER, NPOC, NPICER, NPIOC, NPIFERT, NPIFUNG, IPEA, LABOR, RAIN\_QTY, RAIN\_DUR, RAIN\_DV)$$

4.18 $$\frac{\partial \Pi}{\partial NPIFERT} = -IFERT(NPPEA, NPCER, NPOC, NPICER, NPIOC, NPIFERT, NPIFUNG, IPEA, LABOR, RAIN\_QTY, RAIN\_DUR, RAIN\_DV)$$

4.19 $$\frac{\partial \Pi}{\partial NPIFUNG} = -IFUNG(NPPEA, NPCER, NPOC, NPICER, NPIOC, NPIFERT, NPIFUNG, IPEA, LABOR, RAIN\_QTY, RAIN\_DUR, RAIN\_DV)$$

Equations 4.13 through 4.19 are estimated as a system, using a technique called *Seemingly Unrelated Regression (SUR)*. In estimating this system of equations, we must restrict the parameters of the various equations to reflect the actual functional form. For example, the coefficient of NPCER in the output supply equation for QPEA is the same as the coefficient of NPPEA in the output supply equation for QCER; the coefficient of NPIFERT in the output supply equation for QPOC is the negative of the coefficient of NPOC in the input demand equation for IFERT.

The estimated parameters from these equations yield the change in either output supply (equations 4.13 through 4.15) or input demand (equations 4.16 through 4.19) for a unit change in one of the output or input prices or for a unit change in an environmental or fixed factor. Using these estimates, output and input price elasticities can be calculated as follows:

4.20 $$\varepsilon_{ij} = \frac{\partial Y_j}{\partial p_i} \frac{\overline{p_i}}{\overline{Y_j}}$$

where Y_j is either an output or input quantity, and p_i is either an output or input price, and $\overline{p}_i$ and $\overline{Y}_j$ represent the mean of the data.

4.2 Empirical Modeling[3]

The profit function model described above derives from a theory as to how variables related to the production of agricultural crops are related. To assess the validity of the theory, data must be collected on the variables of interest. Once the data are collected, however, the analyst must be concerned not with the theoretical model, but a statistical model.

The traditional approach to empirical modeling begins with the theory, then proceeds to the creation of a mathematical model of the theory. It is usually straightforward to convert the mathematical model to an econometric model. Spanos notes "the statistical (econometric) model is just the theory model with an error attached." [p. 28] Data are then collected and used to estimate the parameters of the model. Finally, these parameters are used either to test the validity of the theory or to make a prediction. Under the traditional approach, Spanos notes that the "nature and structure of the data plays no role in specifying the appropriate statistical (econometric) model." [p. 28] Thus, Spanos argues for a different approach, one he calls the *reduction approach* to empirical modeling.

For Spanos, there is a gap between the theory and the observed data that is not explained simply by adding a random error. The theory determines the choice of the observed data. The data will then underlie the specification of the statistical model. It is hoped that the resulting statistical model will enable the analyst to answer the theoretical questions of interest. However, the actual form of the statistical model is determined by the data—by how well it captures the information contained in the data.

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[3] This section relies heavily of Spanos [1999].

Spanos states that besides the “fact that the data were suggested by the theory in question, the only connection between the statistical and the theoretical model is the requirement that the former be specified in a way that allows the modeler to ask theoretical questions of interest in its context.” The statistical model is built ensuring that its probabilistic assumptions are “data-acceptable”.

Therefore, before results from the theoretical model can be accepted, tests to assure the statistical adequacy of the model will be performed.

Chapter 5:

Analysis of Farmers' Responses to Price Changes

5.0 Introduction

This chapter gives the results from the analysis to determine the effects of both input and output price changes on the production of groundnuts and other crops. A profit function model as discussed in Chapter 4 is used for the analysis.

At the end of this chapter, the survey instrument and its implementation are critically examined, suggesting what changes would be made if the survey were conducted again. The chapter also discusses problems encountered in the analysis including the appropriateness of the profit function approach, the choice of a unitary as opposed to a collective model of the household, and problems resulting from the data itself.

Finally, this chapter includes suggestions as to further research including the examination of gender differences within the household and how to study the household without assumptions of profit maximization.

In the study, production data were collected on three varieties of groundnuts, several types of cereal including millet, sorghum, and rice, and a significant number of other crops. To simplify the analysis and since all farmers did not produce all crops or even all varieties of groundnuts, data on both outputs and inputs were aggregated.

The analysis was done under two different levels of aggregation. In the first phase of the estimation, farmers were assumed to produce three crops using inputs of seeds, fertilizer, fungicide, and labor. The three types of groundnuts were combined to form a single "groundnut" variable. The various cereals were aggregated to form a "cereal" variable, and all other crops were combined to form an "other crops" variable. The seed variables for each of these three aggregate products were similarly formed.

As explained in Chapter 4, the labor variable was formed by calculating the number of adult male equivalents in the household using the following equivalences:

One adult female = .7 * male   One child = .5 * male

In the analysis, labor is used as a fixed variable. Implicitly this assumes that there is no market for labor. Thus no price of labor was included in the analysis.

The amount of land available to the farmer was estimated by assuming that it was closely related to the amount of land planted in groundnuts. (Land sown in cereals and other crops would have to be sufficient to support the laborers on the groundnut fields.) Since groundnuts are typically sown using mechanical seeders with uniform seeding densities, the quantity of groundnut seed sown was used as a proxy for the amount of land under cultivation.

Data on the quantity of rainfall during the previous season, the duration in days of these rains, and amount the current season's rains deviated from the historical mean were included as exogenous variables.

In a second phase of the estimation, data were aggregated to a higher level. Cereals were aggregated with other crops to form a single "other crops" variable. Thus farmers produced only two crops, groundnuts and "other crops". Similarly, all cereal seed and all other crop seeds were aggregated to form an "other crop" seed. All chemical inputs, fertilizers and fungicides were aggregated to form a single chemical input. Thus farmers produced two crops, groundnuts and "other crops," using seeds and chemicals plus a fixed amount of labor. As in the previous analysis, rain variables were included.

In both levels of aggregation, three different sets of data were used to estimate the output supply and input demand equations. First, the data collected by both Akobundu [1997] and Gray [1998] were analyzed together. This data set will be referred to as the *combined data set.* Then, the estimation was done separately using only the data collected by Akobundu and then using the data collected by Gray. These data sets will be identified as *Akobundu [1997]* and *Gray [1998]* respectively.

5.1 Estimation of Output Supply and Input Demand—Combined Dataset[1]

5.1.1 Estimates—First Level of Aggregation

Tables 5.1, 5.2, and 5.3 give the coefficients for the output supply and input demand equations obtained from the Seemingly Unrelated Regression (SUR) estimation of the combined data sets under the first level of aggregation.

Table 5.1 gives the coefficients for the three output supply equations. In the output supply equation for groundnuts, only the price of cereal seed (-52.8), the quantity of groundnut seed planted (2.1), the amount of labor (110.6) and the quantity of rain (12.8) are significant at the 95% level and have the expected sign. The signs associated with the coefficients of the producer prices of groundnuts and cereals are opposite to what was expected. One would expect farmers to plant more groundnuts when the producer price increased and less groundnuts and more cereal when the producer price of cereal increased. In any case, neither coefficient is significantly different from zero at the 95% level.

[1] Before any estimation was done with the *combined data set,* all price data from the Akobundu dataset was expressed in current prices.

Table 5.1: Coefficient Estimates for Output Supply Equations: Combined Data Set – 1st Level of Aggregation

Sample size 147 + 228 = 375 Variable	Variable Name	Groundnuts Supply		Cereal Supply		"Other Crops" Supply	
		ß s.e.	t-stat Prob > |T|	ß s.e.	t-stat Prob > |T|	ß s.e.	t-stat Prob > |T|
Intercept		-5,961.9 1,477.1	-4.0 <.0001	-2,169.6 777.1	-2.8 0.0	1,209.5 602.0	2.0 0.1
Producer Price of Groundnuts (fCFA/kg)	NPPEA	-1,021.0 1,342.4	-0.8 0.5	1,467.2 920.3	1.6 0.1	-231.4 240.1	-1.0 0.3
Producer Price of Cereals (fCFA/kg)	NPCER	1,467.2 920.3	1.6 0.1	-1,021.0 890.2	-1.2 0.3	-190.3 127.9	-1.5 0.1
Producer Price of Other Crops (fCFA/kg)	NPOC	-231.4 240.1	-1.0 0.3	-190.3 127.9	-1.5 0.1	-442.9 95.4	-4.6 <.0001
Price of Cereal Seed (fCFA/kg)	NPICER	-52.8 19.9	-2.7 0.0	23.4 16.4	1.4 0.2	1,084.9 447.8	2.4 0.0
Price of Other Crop Seed (fCFA/kg)	NPIOC	-4.9 5.4	-0.9 0.4	0.1 2.9	0.0 1.0	-0.3 1.5	-0.2 0.8
Price of Fertilizer (fCFA/kg)	NPIFERT	-259.0 322.3	-0.8 0.4	97.8 265.0	0.4 0.7	31.6 38.8	0.8 0.4
Price of Fungicide (fCFA/kg)	NPIFUNG	262.0 453.6	0.6 0.6	-204.4 407.0	-0.5 0.6	100.8 48.8	2.1 0.0
Groundnut Seed (kg)	IPEA	2.1 0.2	9.0 <.0001	1.0 0.1	8.7 <.0001	0.0 0.1	-0.1 1.0
Labor ("equivalent" males)	LABOR	110.6 31.8	3.5 0.0	133.5 16.7	8.0 <.0001	14.4 13.4	1.1 0.3
Quantity of Rain (mm)	RAIN_QTY	12.8 2.2	5.8 <.0001	3.0 1.2	2.6 0.0	-0.4 0.9	-0.5 0.6
Rain Duration (days)	RAIN_DUR	-9.2 31.5	-0.3 0.8	10.7 16.6	0.7 0.5	-18.4 13.5	-1.4 0.2
Rain Deviation from Historical Mean (mm)	RAIN_DEV	-31.1 17.5	-1.8 0.1	-7.7 9.2	-0.8 0.4	11.3 7.4	1.5 0.1

Table 5.2: Coefficient Estimates for Seed Input Demand Equations: Combined Data Set - 1st Level of Aggregation

Sample Size 147+228 = 375 Variable	Variable Names	Cereal Seed Demand		"Other Crop" Seed Demand	
		ß s.e.	t-stat Prob > |T|	ß s.e.	t-stat Prob > |T|
Intercept		14.8 10.9	1.35 0.18	32.1 43.1	0.75 0.46
Producer Price of Groundnuts (fCFA/kg)	NPPEA	52.8 19.9	2.65 0.01	4.9 5.4	0.91 0.37
Producer Price of Cereals (fCFA/kg)	NPCER	-23.4 16.4	-1.43 0.15	-0.1 2.9	-0.02 0.98
Producer Price of Other Crops (fCFA/kg)	NPOC	0.3 1.5	0.20 0.84	0.3 1.5	0.20 0.84
Price of Cereal Seed (fCFA/kg)	NPICER	-22.6 14.0	-1.61 0.11	-0.1 0.0	-1.68 0.09
Price of Other Crop Seed (fCFA/kg)	NPIOC	-0.1 0.0	-1.68 0.09	-0.4 0.2	-2.39 0.02
Price of Fertilizer (fCFA/kg)	NPIFERT	-15.5 9.4	-1.65 0.10	0.6 0.8	0.76 0.45
Price of Fungicide (fCFA/kg)	NPIFUNG	-44.5 56.8	-0.78 0.43	0.2 1.0	0.22 0.83
Groundnut Seed (kg)	IPEA	0.01 0.0	8.01 <.0001	0.02 0.0	2.76 0.01
Labor ("equivalent" males)	LABOR	0.9 0.2	4.13 <.0001	0.1 1.2	0.06 0.95
Quantity of Rain (mm)	RAIN_QTY	-0.01 0.0	-0.61 0.55	0.0 0.1	0.38 0.70
Rain Duration (days)	RAIN_DUR	0.1 0.2	0.30 0.77	-0.6 1.2	-0.48 0.63
Rain Deviation from Historical Mean (mm)	RAIN_DEV	-0.1 0.1	-0.92 0.36	1.1 0.6	1.69 0.09

Table 5.3: Coefficient Estimates for Fertilizer and Fungicide Input Demand Equations: Combined Data Set - 1st Level of Aggregation

Sample size 147 + 228 = 375 Variable	Variable Names	Fertilizer Demand		Fungicide Demand	
		ß s.e.	t-stat Prob > |T|	ß s.e.	t-stat Prob > |T|
Intercept		-713.5 222.8	-3.20 0.00	407.0 278.5	1.46 0.14
Producer Price of Groundnuts (fCFA/kg)	NPPEA	259.0 322.3	0.80 0.42	-261.9 453.6	-0.58 0.56
Producer Price of Cereals (fCFA/kg)	NPCER	-97.8 265.0	-0.37 0.71	204.3 407.0	0.50 0.62
Producer Price of Other Crops (fCFA/kg)	NPOC	-31.6 38.8	-0.81 0.42	-100.8 48.8	-2.06 0.04
Price of Cereal Seed (fCFA/kg)	NPICER	-15.5 9.4	-1.65 0.10	-44.5 56.8	-0.78 0.43
Price of Other Crop Seed (fCFA/kg)	NPIOC	0.6 0.8	0.76 0.45	0.2 1.0	0.22 0.83
Price of Fertilizer (fCFA/kg)	NPIFERT	-225.0 169.7	-1.33 0.19	61.0 227.8	0.27 0.79
Price of Fungicide (fCFA/kg)	NPIFUNG	61.0 227.8	0.27 0.79	-4,740.8 1,426.4	-3.32 0.00
Groundnut Seed (kg)	IPEA	0.2 0.0	6.82 <.0001	0.3 0.0	7.59 <.0001
Labor ("equivalent" males)	LABOR	8.9 4.6	1.93 0.05	13.2 5.7	2.31 0.02
Quantity of Rain (mm)	RAIN_QTY	1.8 0.3	5.63 <.0001	0.1 0.4	0.31 0.76
Rain Duration (days)	RAIN_DUR	-5.7 4.6	-1.24 0.22	4.0 5.8	0.68 0.49
Rain Deviation from Historical Mean (mm)	RAIN_DEV	-8.1 2.6	-3.09 0.00	4.6 3.3	1.39 0.17

In the output supply equation for cereals, only the amount of groundnut seed planted (1.0), the amount of labor (133.5) and the quantity of rain (3.0) are significant at the 95% level. The sign on the own price of cereal is different than expected, but not significant at the 95% level of confidence. The sign on the producer price of groundnuts is different than expected, although it may be argued that if a household produces more groundnuts because of a rise in the producer price, it would need more cereal to feed the additional labor required to handle the groundnuts.

In the output supply equation for “other crops,” only the own price coefficient (-442.9) and the coefficients of the price of cereal seed (1,084.9) and fungicide (100.8) are significant at the 95% level. It is interesting that in contrast to the other two output supply equations, neither land (assuming groundnut seed serves as an adequate proxy for land planted), labor, nor rainfall has a significant coefficient in the supply equation for “other crops”. This may be due to the “catch-all” nature of “other crops” that includes such varied crops as okra and watermelon.

In any supply equation, one would expect the coefficient on the “own” producer price to be positive rather than negative. However, in each of the three supply equations, the coefficient of “own price” is negative. However, only the coefficient of the own price or “other crops” is significant at the 95% or at any reasonable level.

In the input demand equation for cereal seed (Table 5.2), the coefficients for the producer price of groundnuts (52.8)[2], the quantity of groundnut seed (0.01), and the quantity of labor (0.9) are the only significant coefficients at the 95% level. The coefficient on the own price of cereal seed (-22.6) is negative (though insignificant) as expected in a demand equation. Although not significant at the 95% level, the coefficient of the producer price of cereals (-23.4) does not have the expected sign. One would expect if the producer price of cereals increased, there would be an increased demand for cereal seed.

[2] This is consistent, but opposite in sign, with the coefficient of cereal seed in the groundnut supply equation.

In the input demand equation for “other crop” seeds (Table 5.2), the own price coefficient (-0.4) is both significant and of the expected sign. The only other significant coefficient is that for quantity of groundnut seed (0.02).

No coefficient of a price variable is significant in the input demand equation for fertilizer (Table 5.3). The four coefficients that are significantly at the 95% level are the coefficients of the quantity of groundnut seed (0.2), labor (8.9), the quantity of rain (1.8), and the deviation of rain from the historical mean (-8.1). The price of fertilizer, although insignificant at the 95% level, has the expected sign (-225.0).

The input demand equation for fungicide (Table 5.3) also has four coefficients significantly different from zero at the 95% level. The own price coefficient (-4,740.8) is significant and has the expected sign. The coefficients on the producer price of “other crops” (-100.8), the quantity of groundnut seed (0.3) and the number of laborers (13.2) are also significantly different from zero at the 95% level of confidence.

5.1.2 Estimates—Second Level of Aggregation

Tables 5.4 and 5.5 give the results obtained from the regression using data at the second level of aggregation for the combined data set.

In the analysis using the more aggregated data, *i.e.* producing only groundnuts and “other crops” and combining fertilizer and fungicide into a single “chemical input, more coefficients were significant than when the less aggregated data were used. However, as with the more aggregated data, some of the coefficients of most interest to this study had unexpected signs.

For example, although almost every coefficient in the output supply equation (Table 5.4) for groundnuts is significant, the coefficient of the producer price of groundnuts is negative, and the coefficient of the producer price of cereals is positive. As explained above, one would expect farmers to produce more when they expected a higher price and less when the price of a competing product increased. Similarly, one would expect the price of chemical inputs to negatively affect the production of groundnuts. In the results from the higher level of aggregation, the coefficient of the chemical variable is positive (608.9). Finally, one would expect the production of groundnuts to react negatively to the price of “other crop” seeds. However, in this analysis, the coefficient on the price of “other crop” seeds is positive (59.2).

Similarly, almost all the coefficients in the output supply equation for “other crops” (Table 5.4) are significant. As in the groundnut supply equation, the signs of the coefficients on the own price variable (-1,633.7), the competing crop variable (1,872.4), and the “other crop” seed input (28.0), although all significant, have the opposite sign than one would expect. The coefficient on chemicals (210.3), though insignificant, also has a sign opposite to what would be expected.

Fewer coefficients are significant in the two input demand equations (Table 5.5). In the input demand equation for “other crop” seeds, the coefficient of the producer price of “other crops” (28.0) is positive as expected. The own price coefficient (-0.37) is negative as expected, but insignificant. In the input demand equation for chemicals, the own price coefficient (826.5) is significant and positive. This upward sloping demand curve goes against conventional economic theory.

Table 5.4: Coefficient Estimates for Output Supply Equations: Combined Data Set – 2nd Level of Aggregation

Sample Size = 375 Variable	Variable Name	Groundnut Supply		Other Crop Supply	
		ß s.e.	t-stat Prob > |T|	ß s.e.	t-stat Prob > |T|
Intercept		-5,197.5 1,511.9	-3.44 0.00	-1,087.7 517.9	-2.10 0.04
Producer Price of Groundnuts fCFA/kg)	**NPPEA**	-3,139.0 983.2	-3.19 0.00	1,872.4 480.9	3.89 0.00
Producer Price of Other Crops (fCFA/kg)	**NPPEA**	1,872.4 480.9	3.89 0.00	-1,633.7 453.8	-3.60 0.00
Price of Other Crop Seed (fCFA/kg)	**NPOTH**	59.2 12.8	4.64 <.0001	28.0 8.7	3.22 0.00
Price of Chemicals (fCFA/kg)	**NPIOTH**	608.9 176.2	3.46 0.00	210.3 140.2	1.50 0.13
Groundnut Seed (kg)	**NPCHEM**	2.0 0.2	8.52 <.0001	0.4 0.1	4.77 <.0001
Labor ("equivalent" males)	**LABOR**	112.0 34.0	3.30 0.00	68.3 11.8	5.81 <.0001
Quantity of Rain (mm)	**RAIN_QTY**	12.3 2.3	5.27 <.0001	1.4 0.8	1.74 0.08
Rain Duration (days)	**RAIN_DUR**	-9.1 32.8	-0.28 0.78	-1.5 11.4	-0.13 0.90
Rain Deviation from Historical Mean (mm)	**RAIN_DEV**	-27.6 18.1	-1.53 0.13	-6.4 6.3	-1.01 0.31

Table 5.5: Coefficient Estimates for "Other Crop" Seed and Chemical Input Demand Equations: Combined Data Set - 2nd Level of Aggregation

Sample size = 375 Variable	Variable Name	Other Crop Seed Demand		Chemical Demand	
		ß s.e.	t-stat Prob > |T|	ß s.e.	t-stat Prob > |T|
Intercept		73.8 16.8	4.39 <.0001	27.7 199.6	0.14 0.89
Producer Price of Groundnuts fCFA/kg)	**NPPEA**	-59.2 12.8	-4.64 <.0001	-608.9 176.2	-3.46 0.00
Producer Price of Other Crops (fCFA/kg)	**NPPEA**	28.0 8.7	3.22 0.00	210.3 140.2	1.50 0.13
Price of Other Crop Seed (fCFA/kg)	**NPOTH**	-0.4 0.3	-1.14 0.26	0.02 3.1	0.01 0.99
Price of Chemicals (fCFA/kg)	**NPIOTH**	0.02 3.1	0.01 0.99	826.5 87.5	9.44 <.0001
Groundnut Seed (kg)	**NPCHEM**	0.01 0.00	4.19 <.0001	0.2 0.03	6.13 <.0001
Labor ("equivalent" males)	**LABOR**	0.5 0.4	1.37 0.17	9.0 4.2	2.12 0.03
Quantity of Rain (mm)	**RAIN_QTY**	-0.02 0.03	-0.93 0.36	0.5 0.3	1.55 0.12
Rain Duration (days)	**RAIN_DUR**	-0.4 0.4	-1.16 0.25	-2.9 4.1	-0.71 0.48
Rain Deviation from Historical Mean (mm)	**RAIN_DEV**	0.9 0.2	4.31 <.0001	-2.1 2.4	-0.89 0.37

5.2 Estimation of Output Supply and Input Demand—Gray [1998]

5.2.1 Estimates—First Level of Aggregation

Tables 5.6, 5.7, and 5.8 give the results obtained from the regression using data at the first level of aggregation collected during the current survey, Gray [1998]. The output supply functions are reported in Table 5.6.

Very few variables in the output supply equations are significant at the 95% level. No coefficient on any price variable is significant in any of the supply equations. Although insignificant at the 95% level of confidence in each of the three output supply equations, the own price coefficient is negative, contrary to expectations.

In the groundnut supply equation, only the coefficients on the groundnut seed variable (2.5) and the quantity of rainfall (12.1) are significant at the 95% level. In the cereal supply equation, only the coefficients of the quantity of groundnut seed (1.0) and the quantity of labor (109.1) are significant. In the supply equation for “other crops,” the coefficient of the duration of rainfall (-8.2) is the only coefficient significant at the 95% level.

Table 5.7 reports the results from the input demand equation for seed. In the input demand equation for cereal seed, only the coefficients of the quantity of groundnut seed (0.02) and the quantity of labor (1.1) are significant at the 95% level. In the “other crop” seed demand equation, the coefficients of the price of “other crop” seed (-80.7) and the quantity of groundnut seed (0.04) are the only two coefficients significant at the 95% level.

Table 5.8 gives the results from the demand equations for fertilizer and fungicide. In the fertilizer demand equation, only the coefficients of the quantity of groundnut seed (0.3) is significant at the 95% level. In the demand equation for fungicide, only the coefficients of the quantity of groundnut seed (0.4) is significant at the 95% level.

Table 5.6: Coefficient Estimates for Output Supply Equations: Gray [1998] – 1st Level of Aggregation

Sample size = 228 Variable	Variable Name	Groundnut Supply		Cereal Supply		"Other Crops" Supply	
		ß s.e.	t-stat Prob > |T|	ß s.e.	t-stat Prob > |T|	ß s.e.	t-stat Prob > |T|
Intercept		-4,239.2 1,948.8	-2.18 0.03	-342.1 845.0	-0.40 0.69	351.9 164.8	2.14 0.03
Producer Price of Groundnuts (fCFA/kg)	NPPEA	-2,167.2 1,705.1	-1.27 0.21	734.4 1,237.3	0.59 0.55	-88.5 196.2	-0.45 0.65
Producer Price of Cereals (fCFA/kg)	NPCER	734.4 1,237.3	0.59 0.55	-2,095.9 1,277.8	-1.64 0.10	68.0 112.9	0.60 0.55
Producer Price of Other Crops (fCFA/kg)	NPOC	-88.5 196.2	-0.45 0.65	68.0 112.9	0.60 0.55	-48.2 26.8	-1.80 0.07
Price of Cereal Seed (fCFA/kg)	NPICER	-14.8 43.1	-0.34 0.73	28.2 32.4	0.87 0.38	-174.4 229.9	-0.76 0.45
Price of Other Crop Seed (fCFA/kg)	NPIOC	115.4 138.8	0.83 0.41	-141.2 135.1	-1.05 0.30	-3.4 2.7	-1.29 0.20
Price of Fertilizer (fCFA/kg)	NPIFERT	152.8 477.1	0.32 0.75	212.7 380.1	0.56 0.58	-9.2 40.6	-0.23 0.82
Price of Fungicide (fCFA/kg)	NPIFUNG	314.5 851.3	0.37 0.71	671.7 684.2	0.98 0.33	1.8 58.1	0.03 0.98
Groundnut Seed (kg)	IPEA	2.5 0.3	7.64 <.0001	1.0 0.1	6.94 <.0001	0.0 0.0	-0.19 0.85
Labor ("equivalent" males)	LABOR	71.1 44.3	1.61 0.11	109.1 18.9	5.77 <.0001	7.3 3.7	1.97 0.05
Quantity of Rain (mm)	RAIN_QTY	12.1 3.2	3.72 0.00	0.7 1.4	0.51 0.61	0.3 0.3	1.09 0.28
Rain Duration (days)	RAIN_DUR	-21.4 39.6	-0.54 0.59	17.7 17.0	1.04 0.30	-8.2 3.4	-2.43 0.02
Rain Deviation from Historical Mean (mm)	RAIN_DEV	-11.2 21.4	-0.52 0.60	-5.3 9.4	-0.57 0.57	-1.1 1.9	-0.58 0.56

Table 5.7: Coefficient Estimates for Seed Input Demand Equations: Gray [1998] - 1st Level of Aggregation

Sample size = 228 Variable	Variable Names	Cereal Seed Demand		"Other Crop" Seed Demand	
		ß s.e.	t-stat Prob > |T|	ß s.e.	t-stat Prob > |T|
Intercept		26.6 16.4	1.63 0.10	180.9 88.4	2.05 0.04
Producer Price of Groundnuts (fCFA/kg)	NPPEA	14.8 43.1	0.34 0.73	-115.4 138.8	-0.83 0.41
Producer Price of Cereals (fCFA/kg)	NPCER	-28.2 32.4	-0.87 0.38	141.2 135.1	1.05 0.30
Producer Price of Other Crops (fCFA/kg)	NPOC	3.4 2.7	1.29 0.20	3.4 2.7	1.29 0.20
Price of Cereal Seed (fCFA/kg)	NPICER	-31.2 28.7	-1.09 0.28	-2.5 5.2	-0.49 0.62
Price of Other Crop Seed (fCFA/kg)	NPIOC	-2.5 5.2	-0.49 0.62	-80.7 29.9	-2.70 0.01
Price of Fertilizer (fCFA/kg)	NPIFERT	41.7 24.8	1.68 0.09	-47.3 64.5	-0.73 0.46
Price of Fungicide (fCFA/kg)	NPIFUNG	-29.1 119.3	-0.24 0.81	-140.8 109.1	-1.29 0.20
Groundnut Seed (kg)	IPEA	0.02 0.0	6.31 <.0001	0.04 0.0	3.10 0.00
Labor ("equivalent" males)	LABOR	1.1 0.3	3.46 0.00	0.4 1.9	0.18 0.86
Quantity of Rain (mm)	RAIN_QTY	-0.05 0.0	-1.75 0.08	-0.1 0.1	-0.98 0.33
Rain Duration (days)	RAIN_DUR	0.2 0.3	0.60 0.55	-0.2 1.7	-0.10 0.92
Rain Deviation from Historical Mean (mm)	RAIN_DEV	0.0 0.2	0.21 0.83	1.2 1.0	1.23 0.22

Table 5.8: Coefficient Estimates for Fertilizer and Fungicide Input Demand Equations: Gray [1998] - 1st Level of Aggregation

Sample size = 228 Variable	Variable Name	Fertilizer Demand		Fungicide Demand	
		ß s.e.	t-stat Prob > |T|	ß s.e.	t-stat Prob > |T|
Intercept		-247.8 273.2	-0.91 0.37	1,145.1 346.9	3.30 0.00
Producer Price of Groundnuts (fCFA/kg)	NPPEA	-152.8 477.1	-0.32 0.75	-314.5 851.3	-0.37 0.71
Producer Price of Cereals (fCFA/kg)	NPCER	-212.7 380.1	-0.56 0.58	-671.7 684.2	-0.98 0.33
Producer Price of Other Crops (fCFA/kg)	NPOC	9.2 40.6	0.23 0.82	-1.8 58.1	-0.03 0.98
Price of Cereal Seed (fCFA/kg)	NPICER	41.7 24.8	1.68 0.09	-29.1 119.3	-0.24 0.81
Price of Other Crop Seed (fCFA/kg)	NPIOC	-47.3 64.5	-0.73 0.46	-140.8 109.1	-1.29 0.20
Price of Fertilizer (fCFA/kg)	NPIFERT	62.2 334.0	0.19 0.85	595.2 485.7	1.23 0.22
Price of Fungicide (fCFA/kg)	NPIFUNG	595.2 485.7	1.23 0.22	-4,880.7 2573.3	-1.90 0.06
Groundnut Seed (kg)	IPEA	0.3 0.0	6.05 <.0001	0.4 0.1	6.84 <.0001
Labor ("equivalent" males)	LABOR	8.5 5.8	1.47 0.14	5.9 7.0	0.84 0.40
Quantity of Rain (mm)	RAIN_QTY	0.8 0.5	1.70 0.09	-0.9 0.6	-1.47 0.14
Rain Duration (days)	RAIN_DUR	-0.2 5.2	-0.03 0.98	3.5 6.4	0.54 0.59
Rain Deviation from Historical Mean (mm)	RAIN_DEV	-2.5 3.2	-0.78 0.44	9.2 4.0	2.29 0.02

5.2.2 Estimates—Second Level of Aggregation

Tables 5.9 and 5.10 give the results obtained from the regression using data at the second level of aggregation collected during the current survey, Gray [1998].

Similar to the results from the first level of aggregation, very few coefficients in the two output supply equations (Table 5.9) were significant at the 95% level of confidence. The coefficients on amount of groundnut seed planted (the proxy for the amount of land planted) were significant in both output supply equations (2.51 in the groundnut equation and 0.34 in the "other crops" equation). The coefficient on the quantity of rain (12.0) was the only other significant coefficient in the groundnut supply equation, and the coefficient on labor (36.6) was the only other significant coefficient in the output supply equation for "other crops".

Table 5.9: Coefficient Estimates for Groundnut and "Other Crop" Output Supply Equations: Gray [1998] - 2nd Level of Aggregation

Sample Size = 228		Groundnut Supply		Other Crop Supply	
Variable	Variable Name	ß s.e.	t-stat Prob > |T|	ß s.e.	t-stat Prob > |T|
Intercept		-3,671.2 2,108.0	-1.74 0.08	-76.1 347.1	-0.22 0.83
Producer Price of Groundnuts fCFA/kg)	NPPEA	-1,848.2 1,226.4	-1.51 0.13	-343.3 354.6	-0.97 0.33
Producer Price of Other Crops (fCFA/kg)	NPPEA	-343.3 354.6	-0.97 0.33	-242.8 342.8	-0.71 0.48
Price of Other Crop Seed (fCFA/kg)	NPOTH	-46.2 33.5	-1.38 0.17	12.8 28.7	0.44 0.66
Price of Chemicals (fCFA/kg)	NPIOTH	435.7 210.9	2.07 0.04	9.4 157.7	0.06 0.95
Groundnut Seed (kg)	NPCHEM	2.5 0.4	6.98 <.0001	0.3 0.1	5.81 <.0001
Labor ("equivalent" males)	LABOR	65.3 51.1	1.28 0.20	36.6 8.2	4.48 <.0001
Quantity of Rain (mm)	RAIN_QTY	12.0 3.5	3.38 0.00	1.1 0.6	1.90 0.06
Rain Duration (days)	RAIN_DUR	-26.5 42.9	-0.62 0.54	-3.1 6.9	-0.46 0.65
Rain Deviation from Historical Mean (mm)	RAIN_DEV	-11.9 23.3	-0.51 0.61	-5.8 3.9	-1.50 0.14

Table 5.10: Coefficient Estimates for "Other Crop" Seed and Chemical Input Demand Equations: Gray [1998] - 2nd Level of Aggregation

Sample size = 228 Variable	Variable Name	Other Crop Seed Demand		Chemical Demand	
		ß s.e.	t-stat Prob > |T|	ß s.e.	t-stat Prob > |T|
Intercept		76.0 25.1	3.03 0.00	150.3 257.5	0.58 0.56
Producer Price of Groundnuts (fCFA/kg)	**NPPEA**	46.2 33.5	1.38 0.17	-435.7 210.9	-2.07 0.04
Producer Price of Other Crops (fCFA/kg)	**NPPEA**	12.8 28.7	0.44 0.66	9.4 157.7	0.06 0.95
Price of Other Crop Seed (fCFA/kg)	**NPOTH**	-89.5 15.5	-5.78 <.0001	3.0 15.2	0.20 0.84
Price of Chemicals (fCFA/kg)	**NPIOTH**	3.0 15.2	0.20 0.84	733.9 135.5	5.42 <.0001
Groundnut Seed (kg)	**NPCHEM**	0.02 0.0	3.87 0.00	0.2 0.04	4.81 <.0001
Labor ("equivalent" males)	**LABOR**	0.9 0.6	1.59 0.11	9.9 5.9	1.67 0.10
Quantity of Rain (mm)	**RAIN_QTY**	-0.1 0.04	-2.23 0.03	0.1 0.4	0.22 0.83
Rain Duration (days)	**RAIN_DUR**	0.2 0.5	0.52 0.61	0.6 5.0	0.11 0.91
Rain Deviation from Historical Mean (mm)	**RAIN_DEV**	0.8 0.3	2.88 0.00	1.1 2.9	0.38 0.71

In the input demand equations (Table 5.10), only three variables had coefficients that were significant at the 95% level of confidence. In the input demand equation for "other crop" seeds, the own price coefficient (-89.5), the coefficient on the quantity of groundnut seed planted (0.02), and the coefficient on the quantity of rain (-0.1) were the only significant coefficients. In the input demand equation for chemicals, the coefficient on the producer price of groundnuts (-435.7), the own price coefficient (733.9), and the coefficient on the quantity of groundnut seed planted (0.2) were the only significant coefficients. Although the own price coefficient in the demand equation for "other crop" seeds was negative as expected, the own price coefficient in the demand equation for chemicals was positive.

5.3 Estimation of Output Supply and Input Demand—Akobundu [1997]

5.3.1 Estimates—First Level of Aggregation

Tables 5.11, 5.12, and 5.13 give the results obtained from the regression using data collected by Akobundu [1997]. The output supply functions are reported in Table 5.11. In the groundnut supply function, only the coefficients of quantity of groundnut seed (1.4), the quantity of labor (146.8), the quantity of rainfall (12.9) and rainfall's deviation from the historical mean (-112.0) are significant at the 95% level. In the cereal supply equation, the coefficients of price of fungicide (-1,258.6), the quantity of groundnut seed (1.1), the quantity of labor (150.1) and the quantity of rainfall (4.4) are significant at the 95% level. In the supply equation for "other crops," only the coefficient of the producer price of "other crops" (-2,170.2) is significant at the 95% level. Contrary to theory, however, it is negative in sign.

In the input demand equation for cereal seed (Table 5.12), the coefficients of quantity of groundnut seed (0.01), the quantity of labor (0.7) and the duration of rainfall (0.8) are significant at the 95% level. In the "other crop" seed demand equation, only the coefficient of labor (0.4) is significant at the 95% level.

Table 5.13 gives the results from the demand equations for fertilizer and fungicide. In the fertilizer demand equation, the coefficients of the price of fungicide (-1,272.8), the quantity of groundnut seed (0.2), the quantity of rain (3.6) and the rainfall deviation from the historical mean (-24.) are significant at the 95% level. In the input demand equation for fungicide, the coefficients of the producer price of cereal (1,258.6), the price of fertilizer (1,272.8), the price of fungicide (-7.767.5), the quantity of groundnut seed (0.2), the quantity of rain (1.6) and the duration of the rains (36.1) are significant at the 95% level.

Table 5.11: Coefficient Estimates for Output Supply Equations: Akobundu [1997] – 1st Level of Aggregation

Sample size = 147 Variable	Variable Name	Groundnuts Supply		Cereal Supply		"Other Crops" Supply	
		ß s.e.	t-stat Prob > |T|	ß s.e.	t-stat Prob > |T|	ß s.e.	t-stat Prob > |T|
Intercept		-12,531.7 2,873.5	-4.36 <.0001	-3,856.9 2,001.8	-1.93 0.06	4,136.0 2,162.6	1.91 0.06
Producer Price of Groundnuts (fCFA/kg)	NPPEA	1,546.9 2,350.1	0.66 0.51	1,111.0 1,489.9	0.75 0.46	439.3 645.6	0.68 0.50
Producer Price of Cereals (fCFA/kg)	NPCER	1,111.0 1,489.9	0.75 0.46	228.5 1,527.7	0.15 0.88	259.4 486.5	0.53 0.59
Producer Price of Other Crops (fCFA/kg)	NPOC	439.3 645.6	0.68 0.50	259.4 486.5	0.53 0.59	-2,170.2 492.1	-4.41 <.0001
Price of Cereal Seed (fCFA/kg)	NPICER	3.0 19.0	0.16 0.87	-22.1 14.8	-1.50 0.14	-823.3 1,419.2	-0.58 0.56
Price of Other Crop Seed (fCFA/kg)	NPIOC	-4.1 4.4	-0.93 0.36	3.2 3.2	0.98 0.33	1.7 2.0	0.85 0.40
Price of Fertilizer (fCFA/kg)	NPIFERT	-23.2 521.0	-0.04 0.96	45.6 427.5	0.11 0.92	17.1 134.4	0.13 0.90
Price of Fungicide (fCFA/kg)	NPIFUNG	-378.2 705.4	-0.54 0.59	-1,258.6 621.4	-2.03 0.04	261.3 174.0	1.50 0.14
Groundnut Seed (kg)	IPEA	1.4 0.3	5.18 <.0001	1.1 0.2	5.69 <.0001	0.0 0.2	-0.04 0.97
Labor ("equivalent" males)	LABOR	146.8 42.5	3.45 0.00	150.1 30.4	4.94 <.0001	25.4 33.6	0.75 0.45
Quantity of Rain (mm)	RAIN_QTY	12.9 3.0	4.35 <.0001	4.4 2.2	2.02 0.05	-0.7 2.2	-0.34 0.74
Rain Duration (days)	RAIN_DUR	72.6 61.7	1.18 0.24	16.3 44.6	0.36 0.72	-27.1 47.6	-0.57 0.57
Rain Deviation from Historical Mean (mm)	RAIN_DEV	-112.0 32.9	-3.41 0.00	10.3 23.7	0.44 0.66	43.1 25.5	1.69 0.09

Table 5.12: Coefficient Estimates for Seed Input Demand Equations: Akobundu [1997] - 1st Level of Aggregation

Sample size = 147 Variable	Variable Name	Cereal Seed Demand		"Other Crop" Seed Demand	
		ß s.e.	t-stat Prob > |T|	ß s.e.	t-stat Prob > |T|
Intercept		-12.1 16.1	-0.75 0.45	-5.6 8.5	-0.65 0.52
Producer Price of Groundnuts (fCFA/kg)	NPPEA	-3.0 19.0	-0.16 0.87	4.1 4.4	0.93 0.36
Producer Price of Cereals (fCFA/kg)	NPCER	22.1 14.8	1.50 0.14	-3.2 3.2	-0.98 0.33
Producer Price of Other Crops (fCFA/kg)	NPOC	-1.7 2.0	-0.85 0.40	-1.7 2.0	-0.85 0.40
Price of Cereal Seed (fCFA/kg)	NPICER	1.8 11.4	0.16 0.87	0.0 0.0	0.38 0.70
Price of Other Crop Seed (fCFA/kg)	NPIOC	0.0 0.0	0.38 0.70	0.0 0.0	-1.81 0.07
Price of Fertilizer (fCFA/kg)	NPIFERT	-8.2 7.9	-1.04 0.30	0.1 1.0	0.05 0.96
Price of Fungicide (fCFA/kg)	NPIFUNG	-17.1 45.4	-0.38 0.71	-1.0 1.2	-0.85 0.40
Groundnut Seed (kg)	IPEA	0.01 0.0	5.92 <.0001	0.0 0.0	0.00 1.00
Labor ("equivalent" males)	LABOR	0.7 0.2	2.84 0.01	0.4 0.1	2.65 0.01
Quantity of Rain (mm)	RAIN_QTY	0.0 0.0	-1.40 0.16	0.0 0.0	0.31 0.75
Rain Duration (days)	RAIN_DUR	0.8 0.3	2.34 0.02	0.2 0.2	1.02 0.31
Rain Deviation from Historical Mean (mm)	RAIN_DEV	0.4 0.2	2.00 0.05	0.1 0.1	0.93 0.35

Table 5.13: Coefficient Estimates for Fertilizer and Fungicide Input Demand Equations: Akobundu [1997] - 1st Level of Aggregation

Sample Size = 147 Variable	Variable Names	Fertilizer Demand ß s.e.	 t-stat Prob > |T|	Fungicide Demand ß s.e.	 t-stat Prob > |T|
Intercept		-1,011.9 529.6	-1.91 0.06	-1,299.6 635.1	-2.05 0.04
Producer Price of Groundnuts (fCFA/kg)	NPPEA	23.2 521.0	0.04 0.96	378.2 705.4	0.54 0.59
Producer Price of Cereals (fCFA/kg)	NPCER	-45.6 427.5	-0.11 0.92	1,258.6 621.4	2.03 0.04
Producer Price of Other Crops (fCFA/kg)	NPOC	-17.1 134.4	-0.13 0.90	-261.3 174.0	-1.50 0.14
Price of Cereal Seed (fCFA/kg)	NPICER	-8.2 7.9	-1.04 0.30	-17.1 45.4	-0.38 0.71
Price of Other Crop Seed (fCFA/kg)	NPIOC	0.1 1.0	0.05 0.96	-1.0 1.2	-0.85 0.40
Price of Fertilizer (fCFA/kg)	NPIFERT	-480.1 270.2	-1.78 0.08	-1,272.8 325.5	-3.91 0.00
Price of Fungicide (fCFA/kg)	NPIFUNG	-1,272.8 325.5	-3.91 0.00	-7,767.5 1,956.7	-3.97 0.00
Groundnut Seed (kg)	IPEA	0.2 0.1	3.89 0.00	0.2 0.1	3.82 0.00
Labor ("equivalent" males)	LABOR	2.5 7.7	0.32 0.75	12.0 9.5	1.27 0.21
Quantity of Rain (mm)	RAIN_QTY	3.6 0.6	6.52 <.0001	1.6 0.7	2.22 0.03
Rain Duration (days)	RAIN_DUR	-12.7 11.7	-1.09 0.28	36.1 14.2	2.54 0.01
Rain Deviation from Historical Mean (mm)	RAIN_DEV	-24.3 6.2	-3.93 0.00	-10.2 7.7	-1.33 0.19

5.3.2 Estimates—Second Level of Aggregation

Tables 5.14 and 5.15 give the results obtained from the regression using data at the second level of aggregation collected by Akobundu [1997]. The output supply functions are reported in Table 5.14.

Table 5.14: Coefficient Estimates for Groundnut and "Other Crop" Output Supply Equations: Akobundo [1997] - 2nd Level of Aggregation

Sample Size = 147 Variable	Variable Name	Groundnut Supply ß s.e.	 t-stat Prob > |T|	Other Crop Supply ß s.e.	 t-stat Prob > |T|
Intercept		-12,198.4 2,878.5	-4.24 <.0001	393.4 1,462.7	0.27 0.79
Producer Price of Groundnuts fCFA/kg)	NPPEA	951.9 2,332.0	0.41 0.68	1,959.2 1,033.3	1.90 0.06
Producer Price of Other Crops (fCFA/kg)	NPPEA	1,959.2 1,033.3	1.90 0.06	-3,463.8 780.0	-4.44 <.0001
Price of Other Crop Seed (fCFA/kg)	NPOTH	-3.7 9.8	-0.38 0.71	1.7 5.8	0.29 0.77
Price of Chemicals (fCFA/kg)	NPIOTH	668.9 365.6	1.83 0.07	26.6 212.4	0.13 0.90
Groundnut Seed (kg)	NPCHEM	1.4 0.3	5.12 <.0001	0.6 0.2	3.82 0.00
Labor ("equivalent" males)	LABOR	153.0 42.8	3.58 0.00	74.9 23.6	3.17 0.00
Quantity of Rain (mm)	RAIN_QTY	11.0 3.0	3.71 0.00	4.2 1.7	2.47 0.01
Rain Duration (days)	RAIN_DUR	89.2 60.2	1.48 0.14	-36.0 33.4	-1.08 0.28
Rain Deviation from Historical Mean (mm)	RAIN_DEV	-100.2 32.4	-3.10 0.00	-0.8 17.9	-0.04 0.97

Table 5.15: Coefficient Estimates for "Other Crop" Seed and Chemical Input Demand Equations: Akobundu [1997] - 2nd Level of Aggregation

<table>
<tr><th rowspan="2">Sample size = 147

Variable</th><th rowspan="2">Variable Name</th><th colspan="2">Other Crop Seed Demand</th><th colspan="2">Chemical Demand</th></tr>
<tr><th>ß
s.e.</th><th>t-stat
Prob > |T|</th><th>ß
s.e.</th><th>t-stat
Prob > |T|</th></tr>
<tr><td>Intercept</td><td></td><td>-17.7
10.7</td><td>-1.66
0.10</td><td>-205.1
416.4</td><td>-0.49
0.62</td></tr>
<tr><td>Producer Price of Groundnuts fCFA/kg)</td><td>NPPEA</td><td>3.7
9.8</td><td>0.38
0.71</td><td>-668.9
365.6</td><td>-1.83
0.07</td></tr>
<tr><td>Producer Price of Other Crops (fCFA/kg)</td><td>NPPEA</td><td>1.7
5.8</td><td>0.29
0.77</td><td>26.6
212.4</td><td>0.13
0.90</td></tr>
<tr><td>Price of Other Crop Seed (fCFA/kg)</td><td>NPOTH</td><td>0.1
0.1</td><td>1.46
0.15</td><td>-3.4
2.4</td><td>-1.42
0.16</td></tr>
<tr><td>Price of Chemicals (fCFA/kg)</td><td>NPIOTH</td><td>-3.4
2.4</td><td>-1.42
0.16</td><td>870.6
119.2</td><td>7.30
<.0001</td></tr>
<tr><td>Groundnut Seed (kg)</td><td>NPCHEM</td><td>0.0
0.0</td><td>1.23
0.22</td><td>0.2
0.04</td><td>4.26
<.0001</td></tr>
<tr><td>Labor ("equivalent" males)</td><td>LABOR</td><td>0.5
0.2</td><td>3.11
0.00</td><td>6.4
6.3</td><td>1.02
0.31</td></tr>
<tr><td>Quantity of Rain (mm)</td><td>RAIN_QTY</td><td>0.0
0.01</td><td>0.28
0.78</td><td>1.3
0.5</td><td>2.56
0.01</td></tr>
<tr><td>Rain Duration (days)</td><td>RAIN_DUR</td><td>0.5
0.2</td><td>1.96
0.05</td><td>-6.1
8.9</td><td>-0.69
0.49</td></tr>
<tr><td>Rain Deviation from Historical Mean (mm)</td><td>RAIN_DEV</td><td>0.2
0.1</td><td>1.77
0.08</td><td>-15.2
4.8</td><td>-3.15
0.00</td></tr>
</table>

The results from using the data collected by Akobundu [1997] were equally disappointing for the second level of aggregation. In the output supply equation for groundnuts, the same four coefficients in the second level of aggregation were significant as in the first level. The coefficients on the quantity of groundnut seed (1.4), labor (153.0), the quantity of rain (11.0), and the rainfall deviation from the historical mean (-100.2) were the only significant coefficients. In the supply equation for "other crops," the own price coefficient (-3,462.8) was significant, but, contrary to expectation, negative. The coefficients on the quantity of groundnut seed (0.6), labor (74.9), and the quantity of rain (4.2) were the only other significant coefficients.

In the input demand equation (Table 5.15) for "other crop" seeds, only the coefficient on the duration of the rains (0.4) was significant at the 95% level of confidence. The own price coefficient (0.1), although insignificant, was positive, contrary to expectation. In the input demand equation for chemicals, the own price coefficient (870.6) was significant, but was positive, contrary to expectation. The coefficients on the quantity of groundnut seed (0.2), the quantity of rain (2.6), and the rainfall deviation from the historical mean (-3.2) were the only significant coefficients.

5.4 Elasticities

Six scenarios were run in the analysis. Regressions were run for the combined data set, Gray [1998], and Akobundu [1997] for both the first and second levels of aggregation. Elasticities for the six scenarios are given in Table 5.16 through Table 5.21.

Given the lack of significance of most of the coefficients from the regressions, one cannot read too much into the resultant elasticities. For example, the sign on the producer price elasticity for groundnuts in the groundnut supply equation, contrary to expectation, is negative for the combined data set in both levels of aggregation. This elasticity is also negative for the two levels of aggregation for the Gray [1998] data. Only in the Akobundu [1997] datasets does this elasticity have the expected positive sign in the groundnut supply equation, although the own price coefficients from the estimation equations are not significantly different from zero at the ninety-five percent level of confidence. In fact, only in the combined dataset at the second level of aggregation is the coefficient on the producer price of groundnuts significantly different from zero in the estimation of the groundnut supply equation, and, as mentioned, this coefficient is negative.

Similar results hold for the producer price elasticity for cereal calculated from the supply equation for cereals in the first level of aggregation and for "other crops" in the supply equation for “other crops” in the second level of aggregation. Only in the cereal supply equation in the first level of aggregation using the Akobundu [1997] data is elasticity positive as expected. As is the case in computing the producer price elasticities for groundnuts, only the coefficient of the producer price of “other crops” in the supply equations for “other crops” are significantly different from zero at the 95 percent confidence level.

The input demand elasticities calculated from the various data sets seem more reasonable. In both the combined data set and Gray [1998], the signs on the input demand elasticities for cereal seed and “other crop” seed (for the first level of aggregation) and “other crop” seed (for the second level of aggregation) are negative. That is, as expected from economic theory, the results indicate that the demand for purchased seed declines as its price increases. However, in calculating these elasticities, only the coefficients on the price of “other crop” seed in the combined data set (first level of aggregation) and in Gray [1998] (in both levels of aggregation) are significant at the ninety-five percent level in the input demand equations for “other crop” seed. For the Akobundu [1997] data, the input price elasitities for cereal and “other crop” seed are all positive, but not significant.

The own price elasticities of demand for fertilizer and fungicide are negative (as expected by theory) for all three data sets. The coefficients for fungicide are significant in both the combined and Akobundu [1997] data sets. When these two inputs are combined to form the “chemical” variable in the second level of aggregation, the own price elasticity for chemicals is positive and significant in all three data sets. This result is had to understand. Perhaps, because of the higher level of aggregation not only for the “chemical” variable itself, but also for the “other crop” and “other crop” seed variables, this variable is picking up other influences.

Table 5.16: Output Supply and Input Demand Elasticities: Combined Data Set – 1st Level of Aggregation

Sample Size = 375		Supply Equations			Demand Equations			
Variable	Variable Name	Groundnuts	Cereal	"Other Crops"	Cereal Seed	"Other Crop" Seed	Fertilizer	Fungicide
Producer Price of Groundnuts (fCFA/kg)	NPPEA	-0.27	0.62	-2.24	1.33	0.07	0.71	-0.41
Producer Price of Cereals (fCFA/kg)	NPCER	0.34	-0.37	-1.59	-0.51	0.00	-0.23	0.28
Producer Price of "Other Crops" (fCFA/kg)	NPOC	-0.12	-0.16	-8.55	0.01	0.01	-0.17	-0.31
Price of Cereal Seed (fCFA/kg)	NPICER	-0.01	0.01	9.55	-0.52	0.00	-0.04	-0.06
Price of "Other Crop" Seeds (fCFA/kg)	NPIOC	0.00	0.00	0.00	0.00	-0.00	0.00	0.00
Price of Fertilizer (fCFA/kg)	NPIFERT	-0.06	0.04	0.26	-0.34	0.01	-0.53	0.08
Price of Fungicide (fCFA/kg)	NPIFUNG	0.00	0.00	0.05	-0.06	0.00	0.01	-0.42
Groundnut Seed (kg)	IPEA	0.51	0.41	-0.06	0.30	0.31	0.58	0.46
Labor ("equivalent" males)	LABOR	0.33	0.63	1.57	0.26	0.01	0.27	0.23
Quantity of Rain (mm)	RAIN_QTY	2.53	0.92	-3.10	-0.18	0.33	3.67	0.15
Duration of Rainfall (days)	RAIN_DUR	-0.12	0.23	-9.04	0.09	-0.40	-0.79	0.31
Rain Deviation from Historic Mean (mm)	RAIN_DEV	0.12	0.05	-1.58	0.04	-0.22	0.32	-0.10

Table 5.17: Output Supply and Input Demand Elasticities: Combined Data Set – 2nd level of Aggregation

Sample Size = 375		Supply Equations		Demand Equations	
Variable	Variable Names	Groundnuts	"Other Crops"	"Other Crop" Seed	Chemicals
Producer Price of Groundnuts (fCFA/kg)	NPPEA	-0.83	2.22	-1.40	-1.76
Producer Price of "Other Crops (fCFA/kg)	NPOTH	0.45	-1.75	0.60	0.55
Price of "Other Crop" Seed (fCFA/kg)	NPIOTH	0.01	0.03	-0.01	0.00
Price of Chemicals (fCFA/kg)	NPICHEM	0.04	0.07	0.00	0.63
Groundnut Seed (kg)	IPEA	0.50	0.43	0.25	0.49
Labor ("equivalent" males)	LABOR	0.34	0.91	0.14	0.29
Quantity of Rain (mm)	RAIN_QTY	2.44	1.27	-0.43	1.08
Duration of Rainfall (days)	RAIN_DUR	-0.12	-0.09	-0.52	-0.43
Rain Deviation from Historic Mean (mm)	RAIN_DEV	0.11	0.11	-0.30	0.09

Table 5.18: Output Supply and Input Demand Elasticities: Gray [1998] – 1st Level of Aggregation

Sample Size = 375		Supply Equations			Demand Equations			
Variable	Variable Name	Groundnuts	Cereal	"Other Crops"	Cereal Seed	"Other Crop" Seed	Fertilizer	Fungicide
Producer Price of Groundnuts (fCFA/kg)	NPPEA	-0.58	0.31	-0.86	0.37	-1.61	-0.42	-0.49
Producer Price of Cereals (fCFA/kg)	NPCER	0.17	-0.76	0.57	-0.62	1.70	-0.50	-0.91
Producer Price of "Other Crops" (fCFA/kg)	NPOC	-0.05	0.06	-0.93	0.17	0.10	0.05	-0.01
Price of Cereal Seed (fCFA/kg)	NPICER	0.00	0.01	-1.54	-0.71	-0.03	0.10	-0.04
Price of "Other Crop" Seeds (fCFA/kg)	NPIOC	0.02	-0.04	-0.02	-0.04	-0.78	-0.09	-0.15
Price of Fertilizer (fCFA/kg)	NPIFERT	0.03	0.08	-0.08	0.90	-0.57	0.15	0.80
Price of Fungicide (fCFA/kg)	NPIFUNG	0.00	0.02	0.00	-0.04	-0.11	0.09	-0.43
Groundnut Seed (kg)	IPEA	0.62	0.38	-0.05	0.37	0.58	0.67	0.53
Labor ("equivalent" males)	LABOR	0.21	0.52	0.79	0.32	0.05	0.26	0.10
Quantity of Rain (mm)	RAIN_QTY	2.39	0.23	2.17	-0.89	-1.52	1.57	-0.99
Duration of Rainfall (days)	RAIN_DUR	-0.29	0.38	-4.01	0.24	-0.12	-0.02	0.28
Rain Deviation from Historic Mean (mm)	RAIN_DEV	0.04	0.03	0.16	-0.01	-0.24	0.10	-0.21

Table 5.19: Output Supply and Input Demand Elasticities: Gray [1998] – 2nd level of Aggregation

Sample Size = 375		Supply Equations		Demand Equations	
Variable	Variable Names	Groundnuts	"Other Crops"	"Other Crop" Seed	Chemicals
Producer Price of Groundnuts (fCFA/kg)	NPPEA	-0.49	-0.41	1.09	0.13
Producer Price of "Other Crops (fCFA/kg)	NPOTH	-0.08	-0.26	0.27	0.03
Price of "Other Crop" Seed (fCFA/kg)	NPIOTH	-0.01	0.01	-1.78	-0.22
Price of Chemicals (fCFA/kg)	NPICHEM	0.03	0.00	0.02	0.00
Groundnut Seed (kg)	IPEA	0.62	0.37	0.35	0.55
Labor ("equivalent" males)	LABOR	0.20	0.49	0.24	0.32
Quantity of Rain (mm)	RAIN_QTY	2.38	1.00	-1.69	0.21
Duration of Rainfall (days)	RAIN_DUR	-0.36	-0.19	0.30	0.08
Rain Deviation from Historic Mean (mm)	RAIN_DEV	0.05	0.10	-0.28	-0.05

Table 5.20: Output Supply and Input Demand Elasticities: Akobundu [1997] – 1st Level of Aggregation

Sample Size = 147 Variable	Variable Name	Supply Equations			Demand Equations			
		Groundnuts	Cereal	"Other Crops"	Cereal Seed	"Other Crop" Seed	Fertilizer	Fungicide
Producer Price of Groundnuts (fCFA/kg)	NPPEA	0.41	0.47	4.22	-0.07	0.06	0.06	0.59
Producer Price of Cereals (fCFA/kg)	NPCER	0.26	0.08	2.16	0.48	-0.04	-0.11	1.70
Producer Price of "Other Crops" (fCFA/kg)	NPOC	0.23	0.22	-41.92	-0.08	-0.05	-0.09	-0.82
Price of Cereal Seed (fCFA/kg)	NPICER	0.00	-0.01	-7.24	0.04	0.00	-0.02	-0.02
Price of "Other Crop" Seed (fCFA/kg)	NPIOC	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Price of Fertilizer (fCFA/kg)	NPIFERT	0.00	0.02	0.14	-0.18	0.00	-1.13	-1.71
Price of Fungicide (fCFA/kg)	NPIFUNG	-0.01	-0.03	0.14	-0.02	0.00	-0.20	-0.69
Groundnut Seed (kg)	IPEA	0.36	0.44	-0.09	0.21	0.00	0.50	0.34
Labor ("equivalent" males)	LABOR	0.44	0.71	2.77	0.19	0.06	0.08	0.21
Quantity of Rain (mm)	RAIN_QTY	2.56	1.36	-5.40	-0.46	0.03	7.42	1.86
Duration of Rainfall (days)	RAIN_DUR	0.98	0.35	-13.30	1.04	0.15	-1.76	2.87
Rain Deviation from Historic Mean (mm)	RAIN_DEV	0.43	-0.06	-6.03	-0.14	-0.02	0.96	0.23

Table 5.21: Output Supply and Input Demand Elasticities:Akobundu [1997] – 2nd level of Aggregation

Sample Size = 375		Supply Equations		Demand Equations	
Variable	Variable Names	Groundnuts	"Other Crops"	"Other Crop" Seed	Chemicals
Producer Price of Groundnuts (fCFA/kg)	NPPEA	0.25	2.33	0.09	-1.94
Producer Price of "Other Crops (fCFA/kg)	NPOTH	0.47	-3.71	0.04	0.07
Price of "Other Crop" Seed (fCFA/kg)	NPIOTH	0.00	0.00	0.00	-0.01
Price of Chemicals (fCFA/kg)	NPICHEM	0.05	0.01	-0.02	0.67
Groundnut Seed (kg)	IPEA	0.36	0.65	0.03	0.47
Labor ("equivalent" males)	LABOR	0.46	1.00	0.13	0.21
Quantity of Rain (mm)	RAIN_QTY	2.19	3.71	0.06	2.74
Duration of Rainfall (days)	RAIN_DUR	1.20	-2.16	0.53	-0.90
Rain Deviation from Historic Mean (mm)	RAIN_DEV	0.39	0.01	-0.08	0.64

5.5 Tests for Statistical Adequacy

Spanos, McGuirk *et al*, and others have argued that a model should be checked for statistical adequacy before it is used to estimate parameters. According to these authors, a theoretical model identifies the parameters of interest. However, before estimation is done using a data set, a statistically adequate model should be formed. That is, a model needs to be created, existing variables transformed, and new variables added so that the statistical model created and the data set, including new variables and transformations, conforms to the underlying econometric theory for the data set being analyzed.

Spanos and McGuirk contend that anyone doing econometric analysis should always be conscious of the assumptions underlying the econometric tools. When one examines an existing data set, like the data collected by Akobundu [1997] and Gray [1998], the data theoretically must have originated from a joint probability distribution. In attempting to explain the relationship among the variables in the data set, an analyst theorizes a relationship between a set of variable called *dependent* variables (**y**) and others called *independent* variables (**X**). Variables **y** and **X** are a part of a joint probability distribution.

Symbolically, the model being explored can be written as:

$$\mathbf{y_t = B'X_t + u_t}$$

Where $\mathbf{y_t}$ is a J vector of endogenous variables.

$\mathbf{X_t}$ is a K+1 vector of exogenous variables and the constant.

B is a vector of unknown parameters.

$\mathbf{u_t}$ is a vector of random disturbances.

Table 5.22: Full-System Mispecification Tests

Normality	
Modified Small (1980) Normality test	p-value = 0.000
Modified Small (1980) Skewness test	p-value = 0.000
Modified Small (1980) Kurtosis test	p-value = 0.000
Mardia (1983) Normality test	p-value = 0.000
Mardia (1974) Skewness test	p-value = 0.000
Mardia (1970) Kurtosis test	p-value = 0.000
Multivariate Jarque-Bera Normality test	p-value = 0.000
Multivariate Jarque-Bera Slewness test	p-value = 0.000
Multivariate Jarque-Bera Kurtosis test	p-value = 0.000
System Linearity RESET Tests	
Wald test (trace form)	p-value = 0.000
LR test (Bartlett adj)	p-value = 0.000
LR F-test (Rao approximation)	p-value = 0.000
LM test (r=trace form)	p-value = 0.000
System Linearity KG2 Polynomial test	p-value = 0.000
Wald test (trace form)	p-value = 0.000
LR test (Bartlett adj)	p-value = 0.000
LR F-test (Rao approximation)	p-value = 0.000
LM test (r=trace form)	p-value = 0.000
Multivariate White Heteroskedasticity Tests	
Wald test (trace form)	p-value = 0.000
LR test (Bartlett adj)	p-value = 0.000
LR F-test (Rao approximation)	p-value = 0.000
LM test (r=trace form)	p-value = 0.000
Multivariate RESET Heteroskedasticity Tests	
Wald test (trace form)	p-value = 0.000
LR test (Bartlett adj)	p-value = 0.000
LR F-test (Rao approximation)	p-value = 0.000
LM test (r=trace form)	p-value = 0.000

The assumptions underlying the regression model are:

1. *Normality*: The conditional distribution $f(\mathbf{y_t} \mid \mathbf{X_t};\Theta)$ is multivariate normal, where $\mathbf{\Theta = (B,\Omega)}$ and $\mathbf{\Omega}$ is the JxJ conditional variance-covariance matrix.
2. *Functional form*: $E(\mathbf{y_t}|\mathbf{X_t};= \mathbf{x_t}) = \mathbf{B'x_t}$, i.e. the conditional mean is linear.

3. *Homoskedasticity*: The conditional variance Var($\mathbf{y_t}|\mathbf{X_t};= \mathbf{x_t}$) is static, i.e. does not depend on $\mathbf{x_t}$ nor on the past history of $\mathbf{y_t}$, $\mathbf{x_t}$, or $\mathbf{u_t}$.
4. *Parameter Stability*: $\Theta = (\mathbf{B},\Omega)$ is stable, i.e. the parameters of the conditional mean and variance do not vary with t.
5. *Weak Endogenity*: The marginal distribution of $\mathbf{X_t}$ contains no relevant information for the estimation of $\Theta = (\mathbf{B},\Omega)$ and thus can be ignored.
6. *No Perfect Collinearity*: Rank($\mathbf{X}$) = K+1.

If these six assumptions hold, then ordinary least squares yields the best, linearly unbiased estimators of **B** and **Ω**.

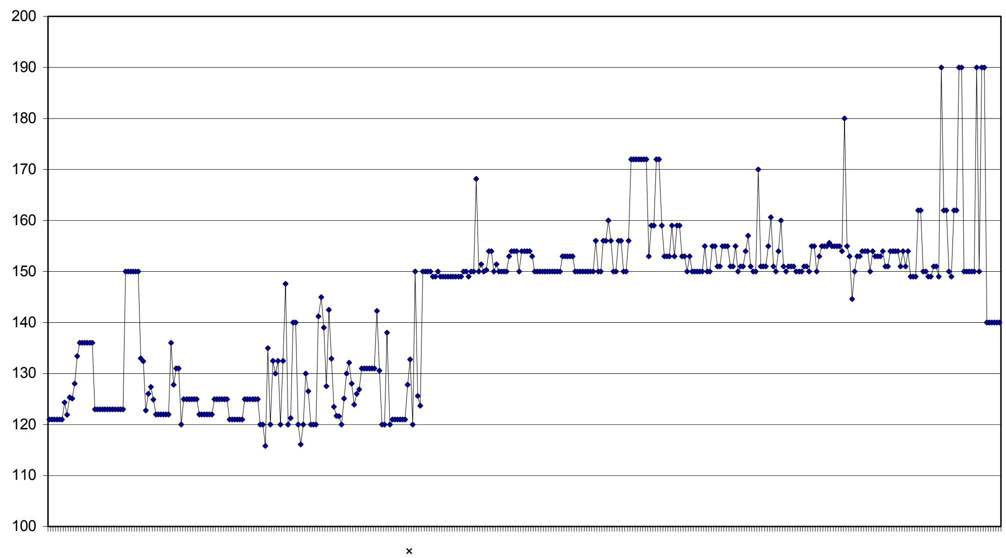
The assumptions above were tested to ensure the statistical adequacy of the model. Table 5.22 reports the results of these tests. The table reports the test and the associated p-value. In all cases, the p-values of the tests were 0.000, indicating that the evidence against the assumption being tested was quite strong.

5.6 Conclusions from the Analysis

5.6.0 Introduction

This author had hoped that the data from the current survey when combined with the data collected by Akobundu [1997] would yield some insights into the price responsiveness of the Senegalese households surveyed. The author understood the difficulty of learning too much from data taken from only two points in time. However, the author hoped there would have been enough open market transactions to yield sufficient price variability to gain some idea of the price-responsiveness of the households. This did not prove to be the case.

**Graph 5.1: Groundnut Prices from Survey Data:
Akobundu [1997] and Gray [1998]**



There are several reasons for the failure to obtain meaningful results from the data. In both the Akobundu [1997] survey and in the current survey, there was very little variation in the price paid to the farmers for their groundnuts. In the 1997 survey, the official price was 125 f/CFA/kg, and in the current survey, the official price was 150 fCFA/kg. Although the farmers had been allowed to sell groundnuts on the open market, most farmers still continued to sell their groundnuts on the official market at the government set price. Therefore, in both surveys most of the observations clustered quite close to the official prices. Graph 5.1[3] graphs the survey price data (actual prices) used in the analysis.

Another reason for why few meaningful results were obtained from the data was that the dataset used for the estimation was statistically inadequate for the assumptions

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[3] The small plus sign (+) on the X-axis marks the division between the two surveys.

underlying the regression analysis. In fact, when tested with the data, the model failed every test of statistical adequacy. Since the assumptions underlying the tools used to yield the conclusions did not hold, almost any conclusion drawn from the data would be open to question. The lack of variation in the price data undoubtedly contributed to the model's statistically inadequacy.

5.6.1 Results from Combined Dataset – First Level of Aggregation

The results of the analysis are probably impossible to interpret. In the seven equations estimated at the first level of aggregation using the combined dataset, no equation had more than four significant coefficients. Only one had as many as three significant coefficients of a price variable, the variables of most interest to this study. In the three output supply equations, only in the equation for "other crops" was the own price coefficient significant, and it was negative. In the other two supply equations, the coefficients of the own price variables were also negative (though insignificant).

The coefficients of the input prices in the output supply equations were also difficult to interpret. In the output supply equation for groundnuts, the coefficients on all the input prices except fungicide were negative as expected, although only the coefficient of the price of cereal seed was significant. For the other two output supply equations, three of the four coefficients of the input price variables were positive. In the output supply equation for cereals, no input price coefficient was significant. In the output supply equation for "other crops," the two significant coefficients were both positive, contrary to expectations.

The input demand equations fared better with respect to the signs of the own price variable coefficients. In all four input demand equations, the coefficient of the own price variable was negative, although only the own price coefficients in the input demand equations for "other crop" seeds and fungicide were significant at the 95% level of confidence. The coefficients on the own crop producer prices in the input demand equations for seeds were both insignificant although, contrary to expectation, negative in the cereal seed equation.

The results for the exogenous variables conformed more to expectations. In both the output supply equations for groundnuts and cereals, the coefficients of groundnuts seeds (used as a proxy for land), labor, and the quantity of rain were all positive, as expected, and significant. No exogenous variable was significant in the "other crop" equation. The coefficients on groundnut seed were also positive and significant in all the input demand equations. The coefficient on labor was also positive in all the input demand equations and insignificant only in the "other crop" seed equation.

5.6.2 Results from Combined Dataset –Second Level of Aggregation

More crudely aggregating the data resulted in more coefficients being significant. In the output supply equation for groundnuts, seven of the nine coefficients were significant including all four coefficients of the price variables. In the equation for "other crops," five coefficients were significant, including three of the four price coefficients. However, the signs on the coefficients were mostly contrary to expectations based on conventional theory. In both output supply equations, the own price coefficient was negative and significant. The coefficients of the input price coefficients were all positive.

In the input demand equations, the results were mixed. The own price coefficients were negative and insignificant for "other crop" seeds and positive and significant for chemicals. The coefficient on the producer price of "other crops" was, as expected positive (and significant) in the input demand equation for "other crop" seeds.

As in the first level of aggregation, the results for the exogenous variables also conformed more to expectations. In the two output supply equations and the two input demand equations, the coefficients of groundnut seeds were positive, as expected, and significant. The coefficients of the labor variable were also positive and significant (except in the demand equation for “other crop” seeds. The coefficients of quantity of rain variable were positive in both output supply equations, but significant only in the groundnut equation.

5.6.3 Results from Gray [1998] and Akobundu [1997] - First Level of Aggregation

The results from analyzing the datasets Gray [1998] and Akobundu [1997] individually were less encouraging. In the two individual datasets, only two coefficients of price variables were significant. In Akobundu [1997], the own price coefficient in the supply equation for “other crops” was significant, but negative. The price coefficient for fungicide in the cereals supply was also significant and negative. No price variables were significant using the Gray [1998] dataset alone. The coefficients for groundnut seed, labor and rain quantity were positive in both the groundnut and cereal equations for both datasets, although not always significant.

For Akobundu [1997], the own price coefficients in the output supply equations for groundnuts and cereals were positive as would have been expected from theory, although neither coefficient was significant.

Very few price coefficients were significant in the input demand equations. No price variable was significant using the Gray [1998] data. The exogenous variables had more significant coefficients, but not as many as when the combined dataset was used.

5.6.4 Results from Gray [1998] and Akobundu [1997] - Second Level of Aggregation

The results from the individual datasets were no better at the second level of aggregation. Only one price variable had a significant coefficient for the output supply equations in each of the two datasets. The coefficients on the variable groundnut seed, labor, and the quantity of rain were positive in both output supply equations for both datasets, although not always significant.

In the input demand equations, the own price coefficients were negative and significant only for "other crop" seeds in Gray [1998]. In both Gray [1998] and Akobundu [1997], the own price coefficients for chemicals were significant, but positive.

5.6.5 Final Thoughts on the Results of the Analysis

It was disappointing not to be able to say something more definite about the farmers' responses to price changes. However, perhaps data from only two points in time may be insufficient to allow the behavior of the farmers to be predicted with any degree of certainty. Perhaps what is needed is the collection of several more snapshots of data. Then perhaps sufficient price variation will allow the analytical tools to be useful.

The sections below discuss the survey instrument, the conduct of the survey, missing data, and problems with the study itself. These sections also suggest what might be done in future studies and alternatives to the profit function approach.

5.7 The Survey Instrument

In the view of this author, before any survey is conducted, the analytical framework including any econometric model using data from the survey should be well formulated. A well-formulated framework will determine, to a great extent, what data should be collected. After the survey has been conducted, it is generally too late to decide that other questions should have been asked and additional data collected for the analysis.

If possible, before the survey is conducted, test data should be used to expose problems that may exist in the model. It would also be best to collect a sub-sample of data and perform whatever analysis is planned. In this way, the analytical framework and the survey itself could be refined to take into account any aspects unique to the geographical location of the survey. However, time and money often preclude this last step.

For a variety of reasons, some of which were logistic, this advance work was not completely done for the current study. Although the analysis to be performed on the data was considered in the design of the survey instrument, the econometric model was not completely defined. Therefore, no test of the model was performed using test data, and no small sample data was collected to test the model.

5.8 Conduct of the Survey

5.8.1 Logistic, Language and Cultural Problems

The author arrived in Senegal with an initial draft of a survey instrument. Consultation with Senegalese colleagues and a pilot test of the survey resulted in some changes. Some of these changes were made because the original survey took too long to administer or because certain questions were inappropriate in the local culture. For example, detailed demographic information about each household member took too much time compared with simply listing the number of members by gender in various age categories. Questions regarding household savings were changed Senegalese colleagues explained that respondents would either not answer a particular question or not give a truthful answer.

As described in Chapter 3, the survey was conducted in Senegal's Groundnut Basin. Although French is an official language of Senegal, it is not widely spoken in the small villages surveyed. Therefore, the survey was administered in Wolof, the main language in the area. In most cases, the author was present when the survey was administered, but he did not administer the questionnaire, and the language barrier prevented him from helping to interpret questions to the farmers or from following up on the farmers' responses. Thus when an unusual answer appeared among a farmer's responses, there was no way to determine whether some misunderstanding may have occurred.

At regular intervals during the survey period, data were entered onto computer spreadsheets and initial checks were done to assure the rationality of the responses. When anomalies were detected, check with the surveyors allowed these to be corrected. However, much of the data entry and all of the analysis were done after the author left Senegal. As can always be expected, problems did crop up. There was confusion about what was meant by various responses, and there were inconsistencies in farmers' responses. Some needed information was not present. Obviously, it would have been better if there were sufficient time to have entered all the data during the survey period. Then if problems with the data were encountered, the surveyors could be consulted, and if necessary, a re-survey conducted.

5.8.2 Random Selection of Respondents

One problem was recognized during the survey. For both cultural and logistical reasons, the selection of farmers included in the survey may not have been random. Before attempting to interview members of any village, protocol dictated that the village chief be consulted and asked to designate individuals to be interviewed. Although the chief was asked to select individuals randomly, there was no attempt to verify the randomness of the farmers selected. Of course, those farmers absent from the village on the day of the survey were not interviewed, and no attempts were made to determine if there were systematic reasons why these farmers were absent.

To assure the randomness of the individuals selected, one would need more information about the village than the author possessed at the time of the survey. One way to select a random sample would be to have a list of every household in the village. Then households could be selected randomly from the list and "approved" by the village chief. In the current study, these lists were not available. Another way would have been to divide the village into geographic grids and select household from grids chosen at random. Since village maps were not available, this technique was not employed. Finally, characteristics of households actually selected for the survey could have been compared with overall village characteristics. In this way, one could see whether the households selected were in any way unusual. However, village socio-economic and demographic characteristics were also not available. Since asking village chiefs to select respondents was the technique employed in other ISRA monitored surveys and had been deemed reliable, this technique was used in the current study. However, at the very least, questions should have been asked about why certain household heads were absent from the village on the day of the survey.

5.9 Structure of the Analysis: A Recursive Household Model

Agricultural households, such as those surveyed, are both producers and consumers. Profits earned from household production are a component of income that influences both the level of consumption and decisions about work versus leisure. Since consumption and leisure are two elements of a household's utility, production decisions and consumption decisions are interrelated.

The production and consumption sides of the household can be modeled either jointly or separately. The analysis is simpler if the two sides can be modeled separately or recursively—*i.e.* if production decisions can be modeled first to determine farm profits which then become a part of household income. When this researcher went into the field to collect data to be used to analyze the responsiveness of small-scale groundnut farmers to price and policy changes, he envisioned a recursive household model.

A necessary condition to model the household recursively is that all markets exist—markets for goods and services. For example, a labor market must exist. If there is no labor market, all labor must come from the household. Thus, an increase in profit may lead to an increase in income that may increase the demand for leisure. Since leisure is an element of the household utility, the production decisions of the household cannot be modeled separately from the utility maximization decisions. With a missing market, the household model cannot be estimated recursively. Therefore in collecting data, one should ensure that markets exist and if so, information about the markets should be collected even if individual households in the survey did not participate in a particular market.

5.10 Data Needed for the Analysis

To investigate the production side of these small-scale Senegalese households, information is needed about the production and marketing activities of the household. Therefore, one should collect information about:

1) Household demographics
    a) Number of people in various categories broken down by gender
        i) Agriculturally active adults ages (15-65)
        ii) Children 5-15
        iii) Infants 0-4
        iv) Adults over 65
2) Crops under cultivation (broken down by household member)
    a) Area planted
    b) Distance from household
    c) Soil type
    d) Price expected at time of sale
3) Inputs used in production (broken down by household member)
    a) Seeds
        i) Type
        ii) Price per kilogram
    b) Fertilizer
        i) Type
        ii) Price per unit
    c) Fungicide
        i) Type
        ii) Price per unit
    d) Mechanical equipment

i) Type
ii) Cost
iii) Usage

e) Animals
i) Number
ii) Type
iii) Cost

f) Labor
i) Number of workers by type and gender
ii) Days worked by type and gender
iii) Wage rate by type and gender
iv) Breakdown in the use of non-labor inputs by gender

g) Credit
i) Farmers' access to credit
ii) Farmers' use of credit

4) Rainfall
a) Quantity
b) Duration
c) Deviation from normal

5) Marketing of crops
a) Amount sold broken down by crop or by form in which crop is sold (*e.g.* for groundnuts were they sold in the shell or unshelled or a peanut butter.)
b) Proceeds from the sale and cost per unit
c) Expensed related to the sale
i) Transportation costs
ii) Cost of sacks
iii) Labor expenses related to the sale
iv) Storage or processing fees
v) Taxes or tariffs

5.11 Missing Information

5.11.0 Introduction

If a well-formulated model exists before a survey is conducted, it is less likely that important data will be omitted. However, in the current study, the survey instrument failed to elicit some important information.

5.11.1 Non-Household Labor

In the region of Senegal where the survey was conducted, most people working on household fields live in the household concession. Besides family members, members of the households include sharecroppers who trade their labor for the right to farm a plot of household land. These laborers are paid not in cash, but in-kind. In times of agricultural urgency such as planting or harvest, households also exchange labor with other households. Several households may get together to work first in the fields of one household, then the fields of another. Over the course of an agricultural season, this labor sharing among households complicates the determination of labor usage within a household.

From information this author received, hiring outside laborers was rare, and when it occurred, it was only for a few days. In the survey, no household reported expenditures on labor. However, even if no household hired outside labor, the absence of questions about the availability of outside labor or about the prevailing wage rate in the villages prevented the examination of the household demand for labor.

5.11.2 Field Size

Data was also not collected on the size of the households' fields. The best way to obtain this information is to physically measure each field. This is a labor intensive and time-consuming task, and the time and resources available were insufficient for this study. Another option would have been to ask the household head about the size of each field, although the author felt this would yield inaccurate estimates. It was decided instead to use as a proxy for field size the amount of seed sown, relying on the knowledge that the sowing density does not vary significantly throughout the survey region. Sowing in most cases was done using a mechanical seeder with fixed disks that distribute seeds at a regular density. Thus, the crop area was approximated by the quantity of seed sown. This estimate was probably better for groundnuts given its large seed than for millet, which has a much smaller seed. One advantage of this method over directly measuring fields is that it accounts for cases where something was planted and nothing grew. In measuring a field, especially after the harvest, it is easy to omit the part of the field that was planted but failed to grow. Whether this method is an accurate substitute for direct field measure should be studied further.

5.12 Appropriateness of the Profit Function Model

The current study uses a profit maximization model to analyze the responses of households to price and policy changes. However, there are questions about whether the assumptions underlying this model are appropriate in the context of small-scale farm households in Senegal's Groundnut Basin. Färe *et al.* [1990. p. 709] point to "firms operating in regulated industries or in 'mixed' economies, firms that choose to follow noneconomic goals, and firms that face resource costs different from observed price data" as cases where assumptions of profit maximization may not be appropriate. As discussed previously, the groundnut market in Senegal is highly regulated. Also, small-scale farm households may indeed have other non-economic goals.

Historically, the decision of Senegalese farmers to plant groundnuts has involved considerations other than profit maximization. As mentioned in Chapter 2, French colonial authorities granted local religious leaders extensive tracts of land specifically to grow groundnuts in return for supporting these leaders in disputes with herders who had traditionally used the land for grazing. This cooperation between government and religious leaders continued after independence. This government involvement may cause more groundnuts to be planted than the profit maximization motive would suggest.

Also in Senegal, farmers have historical reasons to believe the government will intervene if drought occurs. After droughts in the 1970s, the government forgave all debts incurred by farmers. If farmers believe the government will intervene to cushion them against a bad harvest or other catastrophe, and this belief is not accounted for in the model, the results of the model about how farmers respond to price changes may be misleading.

Certainly the groundnut market in Senegal is not a completely open market. The government still sets the prices the oil processing mills will pay for groundnuts. Agents of the mills still travel throughout the Groundnut Basin purchasing groundnuts from farmers in or quite near their villages. The government controls the price and distribution of groundnut seed. Government owned warehouses selling seed and fungicide are located throughout the Groundnut Basin. The government has also been involved in the fertilizer market sometimes donating nitrate fertilizer to farmers. Although farmers can now purchase inputs and sell their product on a growing open market, the open market still occupies only a small share of the market for inputs and outputs.

Historically, farmers were forced (or strongly encouraged) to sell their groundnuts to government-owned oil mills. Although during the time of the current survey, farmers had some latitude to sell their groundnuts on the open market, almost every farmer continued to sell on the official market. Since the freedom of farmers to sell groundnuts outside the government chain is a relatively recent phenomenon, the open market is not well developed. Most farmers in the study sold their groundnuts in the village to an agent of the oil mill. Availing themselves of any benefits of an open market most likely would require farmers to transport their groundnuts out of the village. Since no farmer in the current survey owned any transport vehicle larger than a horse cart, this option would be logistically difficult and expensive. Further, during the time of the survey, there was no network of private buyers going from village to village contracting to purchase groundnuts. Today, the government still plays the dominant role in the groundnut market.

Even if the market were liberalized, farmers in more remote areas would have limited access to the benefits of the open market. If the farmers could not transport their own groundnuts to a central market, they would be at the mercy of traders who come to the village. There would be uncertainty about the number or frequency of the arrival of these buyers. In some cases, rather that being able to avail themselves of the best price, farmers may feel forced to sell their groundnuts to the first (and perhaps only) buyer who came to the village. In this case, the buyer may be in a strong bargaining position *vis-à-vis* the farmer.

Lopez [1982, pp. 356-357] suggests the assumption of profit maximization "may be substantially more difficult to support in agriculture than simple cost minimization because of risk related problems which are mainly related to the variability of output yields and price rather than to costs of production." Small-scale farm households must be concerned about one important non-economic goal—food security—since the quality of their land and the uncertainty of the rains always put their crops in jeopardy. If this risk is not taken into account in a model, the survey may find that farmers produce more food and less cash crops than would be suggested by assumptions of profit maximization.

Michael Lipton [1968] also argues that farmers may have more important objectives than profit maximization. Especially in environmentally fragile areas like Senegal, farmers might minimize the risk of total crop failure or maximize the chances of growing enough food to prevent their family from starving. In the neoclassical model, farmers allocate productive factors to equate their marginal value-product in each use. If farmers are maximizing profit, by definition they cannot benefit from reallocating the factors at their disposal.

In Senegal, the variable nature of the quantity and quality of rain implies that input factors do not have a unique marginal physical product (MPP), but only a probability distribution of MPPs. Even if the farmer operates on the expected value of MPP, the environmental variability means that expected value is a poor predictor of actual value. Since rainfall is critical to the farmers' decision process, their lack of knowledge about the coming rains can be disastrous to a decision based on marginal value product equalization (MVPE).

Any trade-offs between high value crops that may be affected by rainfall and lesser value crops more resilient to poor rainfall must be made at plowing time. In Senegal, rain can fall in one village, but not in the neighboring one. At harvest, however, the same average producer price will probably apply in both villages. Thus, the farmers cannot rely on price variability to offset rainfall variability.

If a farmer uses MVPE and has a poor harvest, besides starvation, he may incur crippling debt that may force him to sell assets or send family members off-farm to seek work. Environmental variability is accompanied by high risk. The choice for the farmer may not be between feast and famine, but between security and famine.

Therefore as Lipton argues, historical experience has taught farmers to seek survival algorithms, not maximizing ones. Lipton notes that this agrees with descriptions given by small-scale farmers of their own behavior and may explain why neighboring farmers use widely different bundles of resources. MVPE cannot explain these actions.

In order to incorporate risk into the current model, information on the farmer's expectations is needed. Richard Just [1974] suggests that the farmer's subjective evaluation of risk might be considered to be the variance between actual prices (or yields) and what the farmer expected that price (or yield) to be. The farmer's expectations would be a weighted average of past observations. To incorporate risk into a model, Just suggests including a weighted average of past variances (and perhaps covariances). For the current study, the historical data to incorporate risk into the profit function model was not available.

5.13 Unitary Versus Collective Models

Even if it were assumed that a profit function model is an appropriate model of the behavior of small-scale Senegalese households, there are other issues that may cause problems with the analysis or affect the results. Like most studies of household production, this study assumes the household behaves as a single decision maker. This unitary model of the household assumes that all resources of the household are held in common and governed by a single decision maker. Many of the problems found with aggregating individual household members into a single decision making unit occur on the consumption or utility maximizing side of the household model. However, it is not clear whether similar problems exist on the production side of the model. In any case, in supporting the ability of unitary models to shed light on the behavior of households, Alderman *et al*. [p. 14] note that unitary models still "retain an impressive ability to explain…[I]n many cases the choice of model will not affect either policy or research; Occam's razor argues that in these cases the simplest approach be taken."

Urdy [2000, p. 99] notes that assuming a unitary household "is convenient" and does not cause problems in many empirical studies. However, he points out that there is recent "evidence against the hypothesis that empirical demand systems are generated by households that act as though they are individuals." In particular, there is evidence that the pattern of household activity is influenced by the gender make-up of the household. Haddad and Hoddinott in an analysis of data from Côte d'Ivoire have shown that money earned by women is more likely to be spent on food [Bates, *et al.*, p. 72]. Thus an acceptance of a unitary model may lead to erroneously concluding that targeting a transfer to women is no different than a transfer to the household as a whole. To examine these cases, household models should examine relationships between individual members of the household.

Alderman *et al*. [p. 11], in further critique of unitary models, note, “Few researchers defend the unitary model on the basis of the validity of its assumptions; …” There are three main objections to the assumptions of the unitary models. First, income earned by various members of the household may not be pooled and controlled by a single decision maker. Income pooling implies that who earns the income has no affect on the household’s demand for goods and leisure except for the worker’s own choice between work and leisure. Second, unitary models imply that those who receive benefits from the household do not have any incentive to behave strategically. Unitary models assume that there are no “rotten children” who attempt to increase their own consumption at the expense of others in the household. Finally, contrary to assumptions of unitary models, an individual’s labor choice may be affected by choices made by other members of the household. Collective models may address these objections to the validity of the unitary model.

As discussed in Chapter 3, in Senegal as in many countries in Africa, the household is usually not a nuclear family. In the households interviewed for this study, most are multi-centered. Each household head usually has more than one wife, and one or more married children may live in the same household. Thus using a “collective model” concentrating on the bargaining process among household members may be more appropriate in the Senegalese context.

Collective models can assume either cooperation or non-cooperation among household members. Non-cooperative models assume that the actions of individuals are conditioned on the actions of other household members. The household is often pictured as consisting of separate gender-specific economies connected by reciprocal claims by members on incomes, land, goods, and labor. Spouses within the household respond to each other's decisions by voluntarily changing their own level of contribution to shared goods.

Cooperative models are more common in the literature. Like unitary models, they assume that individuals form households when they can receive more benefits than they can by remaining alone. Some of these benefits may result from increased efficiency of household production. Other benefits such as love or companionship may only be realizable in a union.

Cooperative models also assume that the allocation of resources within a household is Pareto efficient. Since household members are engaged in relatively stable, long-term relationships and have good information about the actions of other household members, this assumption seems reasonable. However, using results from Burkina Faso, Urdy [2000] has shown that Pareto efficiency may not hold for resource allocation within the household.

Urdy's study [2000] also found differences in the resources allocated to fields controlled by women and those controlled by men. For example, males in the household work less on land controlled by women than on land planted in the same crop controlled by men. Children also work less on women-controlled fields. This is especially surprising given women's traditional responsibility for childcare. When non-household labor is used, most often in inter-household exchanges, it is used more intensively on fields controlled by men. Non-labor resources are also allocated unevenly. Manure, a major source of fertilizer in Senegal as well as Burkina Faso, is used almost exclusively on fields controlled by men. In general, Urdy found fields controlled by men are farmed more intensively than fields planted in the same crop yet controlled by a woman. The law of diminishing returns suggests that a reallocation of resources within the household could increase household production.

5.14 Examining Gender Differences Within the Household

Following Urdy's lead, to understand how price changes or government policies will affect different members of Senegalese households, one must understand the differences between males and females in both their farming activities and their production. For example, do women and men plant the same crops on their private fields? Do women and men have access to the same quality and quantity of land? Are there differences between where women's fields are located with respect to the housing compound compared to men's fields? Do women and men have the same access to household or hired labor in their fields? Do women and men have the same access to equipment and draft animals? Do women and men sell similar products in the same markets? Finally, given the same crop, are yields from fields controlled by women the same as yields from fields controlled by men?

In the current study, the data are insufficient to answer these questions. As mentioned above, there are no data on field sizes or on land quality for fields within the household. Input usage (fertilizers, fungicides, equipment, animals, or labor) is not broken down by field or by the gender of the person who controls the field. Data exist with respect to sales of groundnuts by gender, but without inputs including field size and quality, there is no way to judge the comparative efficiency of males and females in the households or the yields from the various fields.

To explore the hypothesis that there are no differences between the way men and women within the household farm the fields they control, the following data should be collected:

1. Number of fields controlled by the various household members
2. What is planted on each field
3. Size of the fields
4. Quality of the fields by local soil type
5. Distance of the fields from living quarters

6. Inputs allocated to the various fields:
    a. Labor (by day)
    b. Equipment (timing and duration)
    c. Animal usage (timing and duration)
7. Production by field (and thus yield per hectare)
8. Sales of crops by gender

It is possible that men and women plant different crops on their privately controlled fields. This may be unrelated to any potential inequality of resource allocation. For example, in the Groundnut Basin, women may be more likely than men to plant vegetables. If this were true, it would be an interesting fact about Senegalese households.

On fields planted in the same crop, if indeed there were no gender differences within the household, one would expect similar yields on plots controlled by men and women. Also one would expect that the allocation of household resources would be unrelated to gender. Finally, one would expect no gender differences in where these fields were located and their soil quality.

5.15 Lack of Price Variability and Its Effect on the Analysis

The profit function model used to analyze the data from the survey produced few statistically significant results. One critical problem for the analysis was the lack of price variability in the data. This should not have been totally unexpected since the survey was essentially a snapshot in time, and the analysis involved this and one other snapshot from the previous season.

Three facts present at the time of the study are critical to the absence of price variability. First, early in the planting season, the government announced the price, valid throughout the Groundnut Basin, at which the relevant parastatal organization would purchase groundnuts. Second, most of the groundnuts produced in the Groundnut Basin were sold on the official market at a pre-announced price. Finally, farmers did not have to pay the cost of transporting their groundnuts from the farm to the government owned mills.

Historically, Senegalese farmers have been required to sell their groundnuts through a government parastatal at an officially announced price. Regardless of whether the price the farmers receive for their groundnuts is announced far enough in advance to directly determine planting decisions, farmers have learned to expect that the official price would be the same as or higher than the official price in the previous season. No matter what the official price however, all farmers in the Groundnut Basin faced the same expected price. Since farmers do not have to pay transportation costs to move their groundnuts to market, this is especially true.

There is no information from the survey about expected prices in the open market. However, few farmers sold their groundnuts in this market, and, in most cases, those who did so received a price very close to the official price. No farmer reported paying to transport his groundnuts to a distant open market.

In the current study, it was assumed that the price the farmers received was identical to the expected price. In the analysis, some artificial price variability was obtained by adding groundnuts sold on the open market. At times, the prices farmers received on the open market were higher than the official price. More variability was achieved by aggregation. The three types of groundnuts were aggregated into a single crop, as were the various cereal crops and the "other crops." However, this did not produce a great deal of variability except for the widely differing set of "other crops."

Although aggregation was necessary to simplify the model, aggregation has its own problems. For example, suppose farmers face the same prices for individual disaggregated commodities. When these commodities are aggregated, quantity weights are used to create a new aggregated commodity. Thus the price index created by aggregation is endogenous to each farm household. Since this endogeneity is not accounted for in the model, it would have been better perhaps to create a regional weighted average. However, this would have not solved the problem of little or no price variability. [Singh, Squire, Strauss, p. 64.]

5.16 Alternatives to Using a Profit Function Model

As discussed above, there are theoretical problems with the profit function approach to the study of small-scale Senegalese farmers. However, even if we assume households are profit maximizers, there will still be problems trying to estimate the input demand and output supply functions in a cross section study. At a single point in time, almost every farmer faces the same expected price while making production decisions. In a cross section study, there was and, as is likely in the near future, will continue to be too little price variability to gain insights into how farmers will respond to price or policy changes.

The current study used two years of data. However, having a second year did not result in sufficient price variation. Instead, groundnut prices clustered around the announced official prices in the two seasons.

With this in mind, the following paragraphs will address what might have been done to provide insights to the issue that prompted this study in the first place—how households in Senegal will respond to groundnut price and policy changes.

Regardless of whether farmers in Senegal make decisions based on the principle of profit maximization, we can safely assume that farm profits are a concern. However, as discussed above, measuring production and associating it with the "expected" price may not be the best way to determine how farmers responded to price incentives. Given the vagaries of the weather, a farmer's best-laid plans often go awry. Instead, a better insight into a farmer's response to an expected price at market time might be either what he plants or how much he plants. That is, if the farmer expects groundnut prices to be “good” in relation to previous year’s prices, he may plant more groundnuts than he planted the year before. He may also change the ratio of cash crops to food crops planted. That is, he may grow more groundnuts and less millet. Similarly, one could examine the level of input use in relation to previous years and previous prices. In response to expected high prices, a farmer may apply inputs, including labor, more intensively.

Thus to measure farmers’ responses to price or policy changes in the groundnut market, one might collect the following data:

1. Quantity of seed planted in most recent season for the following crops:
    a. Groundnuts
    b. Millet, sorghum and other cereals
    c. Other crops such as watermelon and vegetables
2. Quantity and associated quality of seed planted for the same crops in the most immediate past season.
3. Price expected for the crops at the time of planting for both the last two planting seasons
4. Whether seeds were purchased or saved from previous harvests.
5. Input usage during the current and past season.
6. Prices of all inputs during the current and previous seasons.

One hypothesis would be that when farmers expect the price of groundnuts to rise, they plant more groundnuts. A subsidiary hypothesis would be that the farmers would increase the ratio of groundnuts planted to food crops. This second hypothesis would account for the fact that some farmers, perhaps because of a previous bad season, will actually plant less groundnuts in response to an expected price rise because that was all they could afford to plant. Finally, in response to an expected producer price rise, farmers may invest in higher quality seed to obtain a better yield.

Chapter 6: Changes to Pan-Territorial Pricing

6.0 Introduction

Pan-territorial pricing means that the price for a particular commodity is the same over an entire country. This policy is often justified by an equity argument that says that remote or structurally weak regions will be economically supported. However, when pan-territorial pricing is in place, the ability of the market to determine outcomes is inhibited, and production decisions are no longer completely determined by comparative advantage. Pan-territorial pricing will place areas with the greatest comparative advantage in production at a disadvantage and may enable areas where the costs of productions including marketing are higher to expand their production. Also, pan-territorial pricing may lead to a decline in total welfare. The elimination of the policy of pan-territorial pricing will allow the market to take advantage of comparative advantages and may actually increase the overall efficiency of the groundnut sector.

This chapter examines what may happen if the groundnut market in Senegal is liberalized and producers are allowed to sell their groundnuts not only to the SONOCOS-operated oil mill, but also to any willing buyer. In the past, when groundnuts were required to be sold to the mill, farmers in all regions received a standard price for their groundnuts. The price the farmers received did not take into account the cost of transporting their groundnuts from their village to the mill. Thus differences in the cost of transportation were not passed along to the producers. Instead these costs were absorbed by SONOCOS and other parastatals that hired trucks to move groundnuts from the villages to the mill. If the groundnut market is liberalized, the GOS will no longer set a pan-territorial price. The cost of transporting groundnuts from the village to a market or to the mill will be factored into the price of the groundnuts paid the farmers.

This chapter will examine the impacts associated with the removal of pan-territorial prices. It will attempt to shed light on who are the winners, and who are the losers, the resultant pattern of groundnut production and marketing, and the prices that result from the new policy.

Using a quadratic programming model, an initial scenario is considered using what the author believes are realistic elasticities and transportation costs. Next, the cost of transportation will be internalized by the market. Two different costs of transportation will be examined to see their effect on consumers and producers, on the amount of groundnuts produced, and on the pattern of groundnut shipments.

6.1 Economic Background

A common way to examine the effects of changes in the economic situation is to determine how changes influence the economic surplus accruing to producers and consumers.

Harberger [1971, p. 785] lists three postulates that underlie the theory of economic surplus:

1. The value of a given unit to the demander is measured by the competitive demand price.
2. The value of a given unit to the supplier is measured by the competitive supply price.
3. When evaluating the net benefits or costs of any action, the benefits and costs accruing to members of a group should be added without regard to the actual distribution of the benefits and costs.

When these postulates hold, benefits to consumers can be found by measuring the area under the ordinary demand curve. Net changes in consumer welfare are what Marshall called changes in *consumer surplus*. Consumer surplus is the area under the demand curve above the competitive price. That is, consumer surplus is the total benefits accruing to consumers minus what they had to pay for the amount actually demanded.

Similarly the area beneath the supply curve represents the total costs to producers. *Producer surplus*, therefore, is the area above the supply curve and below the competitive price. Producer surplus is the benefits accruing to those producers who were willing to supply at a price below the equilibrium price.

The sum of the consumer and producer surpluses represents the total welfare change for the society. Therefore by maximizing the sum of consumer and producer surplus, one can examine the results of changes in the situation facing a set of consumers and producers. In this chapter, the situation facing Senegalese groundnut producers as they face market liberalization will be examined.

The total economic surplus—consumer surplus plus producer surplus—can be calculated by subtracting the area under the supply curve from the area under the demand curve. Therefore the shape of these curves is important for the calculation of economic surplus. Since for Senegal, there is little or no information about the underlying functional forms of the supply and demand curves, linear forms were chosen as first order approximations.[1]

The demand function is:

(6.1) $$y_i = \alpha_i - \beta_i p_i \text{, For all } i$$

where y_i is the quantity of groundnuts demanded and p_i is the demand price in the i^{th} region and $\alpha_i > 0$ and $\beta_i > 0$.

Similarly, the supply function is:

(6.2) $$x_i = \theta_i + \gamma_i p^i \text{, for all } i$$

where x_i is the quantity of groundnuts supplied and p^i is the supply price in the i^{th} region and $\gamma_i > 0$.

[1] The following formulation closely follows the work of Takayama and Judge [1971, pp. 129ff].

The inverse expressions of (6.1) and (6.2) are

(6.3) $p_i = \lambda_i - \omega_i y_i$, for all i

(6.4) $p^i = \nu_i + \eta_i x_i$, for all i

where $\lambda_i > 0$, $\eta_i > 0$, and $\omega_i > 0$ for all i.

The set of inverse demand relationships can be written in matrix form as follows:

(6.5) $$P_y \equiv \begin{bmatrix} p_1 \\ p_2 \\ \cdot \\ \cdot \\ \cdot \\ p_n \end{bmatrix} = \begin{bmatrix} \lambda_1 \\ \lambda_2 \\ \cdot \\ \cdot \\ \cdot \\ \lambda_n \end{bmatrix} - \begin{bmatrix} \omega_1 & & & & & \\ & \omega_2 & & & & \\ & & \cdot & & & \\ & & & \cdot & & \\ & & & & \cdot & \\ & & & & & \omega_n \end{bmatrix} \begin{bmatrix} y_1 \\ y_2 \\ \cdot \\ \cdot \\ \cdot \\ y_n \end{bmatrix}$$

This can be written in shorthand as

(6.6) $P_y = \lambda - \Omega \; y$

The set of inverse supply relationships can be written in matrix form as follows:

(6.7) $$p_x \equiv \begin{bmatrix} p^1 \\ p^2 \\ \cdot \\ \cdot \\ \cdot \\ p^n \end{bmatrix} = \begin{bmatrix} \nu_1 \\ \nu_2 \\ \cdot \\ \cdot \\ \cdot \\ \nu_n \end{bmatrix} + \begin{bmatrix} \eta_1 & & & & & \\ & \eta_2 & & & & \\ & & \cdot & & & \\ & & & \cdot & & \\ & & & & \cdot & \\ & & & & & \eta_n \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ \cdot \\ \cdot \\ \cdot \\ x_n \end{bmatrix}$$

This can be written in shorthand as

(6.8) $P_x = \nu + \mathrm{H} \; x$

The amount of groundnuts, y_i, demanded in region *i* must be less than or equal to the amount shipped from all the supply regions, *j*.

(6.9) $$y_i \leq \sum_{j=1}^{n} x_{ji}$$, for all *i*

Similarly, the amount of groundnuts, x_i, produced in supply region *i* must be greater than or equal to the amount shipped from that region to all other regions including region *i*.

(6.10) $$x_i \geq \sum_{j=1}^{n} x_{ij}$$, for all *i*

We can define a "quasi-welfare function" as the sum of the consumer and producer surpluses in each region. Graphically, this is the area under the demand curve minus the area under the supply curve. Thus the "quasi-welfare function" or net social payoff function is:

(6.11) $$W_i\left(y_i, x_i\right) \equiv \int_{\hat{y}}^{y_i} (\lambda_i - \omega_i y_i) dy_i - \int_{\hat{x}}^{x_j} (\nu_i + \eta_i x_i) dx_i$$

Since the demand and supply functions are assumed to be linear, this is a quadratic function.

(6.12) $$W_i\left(y_i, x_i\right) = K_i + \lambda_i y_i - \frac{1}{2}\omega_i y_i^2 - \nu_i x_i - \frac{1}{2}\eta_i x_i^2$$, for all *i*

where $\hat{y}$ and $\hat{x}$ are the pre-trade equilibrium quantities and K_i is a constant.

For simplicity, we assume that the nation-wide welfare function is Pigouvian or additive. Thus we can simply add the quasi-welfare functions (6.11) in each region to obtain an overall net social payoff function:

(6.13) $$W\left(y, x\right) = \sum_{i=1}^{n} W_i\left(y_i, x_i\right) = \sum_{i=1}^{n}\left(K_i + \lambda_i y_i - \frac{1}{2}\omega_i y_i^2 - \nu_i x_i - \frac{1}{2}\eta_i x_i^2\right)$$

$$= K + \lambda' y - \nu' x - \tfrac{1}{2} y' \Omega y - \tfrac{1}{2} x' \mathrm{H} x \text{ , for all } i$$

where

$$K = \sum_i K_i$$

$$\lambda = (\lambda_1, \lambda_2, \ldots, \lambda_n)'$$

$$\nu = (\nu_1, \nu_2, \ldots, \nu_n)'$$

$$y = (y_1, y_2, \ldots, y_n)'$$

$$x = (x_1, x_2, \ldots, x_n)'$$

$$\Omega = \begin{bmatrix} \omega_1 & & & & & \\ & \omega_2 & & & & \\ & & . & & & \\ & & & . & & \\ & & & & . & \\ & & & & & \omega_n \end{bmatrix}$$

$$\mathrm{H} = \begin{bmatrix} \eta_1 & & & & & \\ & \eta_2 & & & & \\ & & . & & & \\ & & & . & & \\ & & & & . & \\ & & & & & \eta_n \end{bmatrix}$$

The cost of transporting groundnuts between regions depends on the distance between regions, the amount shipped, and the cost per kilometer per units shipped. If d_{ij} represents the distance in kilometers from region *i* to region *j* and *c* is the cost per kilometer per metric ton of shipping the groundnuts, then the transport cost of shipping groundnuts from region i to region j is equal to ($c \times d_{ij}$). Thus the total cost of shipping groundnuts for all possible flows is:

$$(6.14) \quad \sum_i \sum_j t_{ij} x_{ij} = T' X$$

where $t_{ij} = (c \times d_{ij})$, $T = (t_{11} \cdots t_{1n} \cdots t_{n1} \cdots t_{nn})'$ and $X = (x_{11} \cdots x_{1n} \cdots x_{n1} \cdots x_{nn})'$

The transportation cost is a transfer payment to the transport sector of the economy. Therefore, we can describe a welfare function as follows:

$$(6.15) \quad W(y, x, X) = \lambda' y - \nu' x - \tfrac{1}{2} y' \Omega y - \tfrac{1}{2} x' \mathrm{H} x - T' X$$

$$(6.16) \quad \begin{pmatrix} G_y \\ G_x \end{pmatrix} X \geq \begin{pmatrix} y \\ -x \end{pmatrix}$$

and y ≥ 0, x ≥ 0, and X ≥ 0

where

$$\begin{pmatrix} G_y \\ G_x \end{pmatrix} = \begin{bmatrix}
1 & & & & 1 & & & & & 1 & & & \\
& 1 & & & & 1 & & & & & 1 & & \\
& & \ddots & & & & \ddots & & \cdots & & & \ddots & \\
& & & 1 & & & & 1 & & & & & 1 \\
-1 & -1 & \cdots & -1 & & & & & & & & & \\
& & & & -1 & -1 & \cdots & -1 & & & & & \\
& & & & & & & & \ddots & & & & \\
& & & & & & & & & -1 & -1 & \cdots & -1
\end{bmatrix} \equiv G$$

This is a ($2n \times n^2$) matrix.

To find (y^*, x^*, X^*) that maximizes (6.15) subject to the adding up constraints described in (6.16), we form the Lagrangian L(•):

$$
\text{(6.17)} \quad \begin{aligned} L\left(y, x, X, \rho\right) = & \lambda' y - \nu' x - \tfrac{1}{2} y' \Omega y - \tfrac{1}{2} x' \mathrm{H} x \\ & - T' X + \rho' \left(GX - \begin{pmatrix} y \\ -x \end{pmatrix} \right) \end{aligned}
$$

where $\rho \equiv (\rho_y', \rho_x') = (\rho_1, \rho_2, \ldots, \rho_n, \rho^1, \rho^2, \ldots, \rho^n)' \geq 0$

The Kuhn-Tucker conditions are:

$$
\text{(6.18)} \quad \frac{\partial L}{\partial y} = \lambda - \Omega y^* - \rho_y^* \leq 0 \quad \text{and} \quad \left(\frac{\partial L}{\partial y} \right)' y^* = 0
$$

$$
\text{(6.19)} \quad \frac{\partial L}{\partial x} = -\left(\nu + \mathrm{H} x^* - \rho_x^* \right) \leq 0 \quad \text{and} \quad \left(\frac{\partial L}{\partial x} \right)' x^* = 0
$$

$$
\text{(6.20)} \quad \frac{\partial L}{\partial X} = G' \rho^* - T \leq 0 \quad \text{and} \quad \left(\frac{\partial L}{\partial X} \right)' H^* = 0
$$

$$
\text{(6.21)} \quad \frac{\partial L}{\partial \rho} = G X^* - \begin{pmatrix} y^* \\ -x^* \end{pmatrix} \geq 0 \quad \text{and} \quad \left(\frac{\partial L}{\partial \rho} \right)' \rho^* = 0
$$

We can rewrite these four conditions in component form as follows.

$$(6.22)\quad \frac{\partial L}{\partial y_i} = \lambda_i - \omega_i y_i^* - \rho_i^* \leq 0 \text{ and } \left(\frac{\partial L}{\partial y_i}\right)' y_i^* = 0$$

$$(6.23)\quad \frac{\partial L}{\partial x_i} = -\left(\nu_i + \eta_i x_i^* - \rho^{*i}\right) \leq 0 \text{ and } \left(\frac{\partial L}{\partial x_i}\right)' x_i^* = 0 \text{ , for all } i.$$

$$(6.24)\quad \frac{\partial L}{\partial x_{ij}} = \rho_j^* - \rho^{*i} - t_{ij} \leq 0 \text{ and } \left(\frac{\partial L}{\partial x_{ij}}\right)' x_{ij}^* = 0 \text{ , for all } i \text{ and } j.$$

$$(6.25a)\quad \frac{\partial L}{\partial \rho_i} = \sum_{i=1}^{n} x_{ij}^* - y_i^* \geq 0 \text{ and } \left(\frac{\partial L}{\partial \rho_i}\right)' \rho_i^* = 0 \text{ , for all } i.$$

$$(6.25b)\quad \frac{\partial L}{\partial \rho^i} = -\sum_{i=1}^{n} x_{ij}^* - x_i^* \geq 0 \text{ and } \left(\frac{\partial L}{\partial \rho^i}\right)' \rho^{*i} = 0 \text{ , for all } i.$$

From the two parts of equation (6.22) we get

$$(6.26)\quad \lambda_i - \omega_i y_i^* = \overline{p}_i \leq \rho_i^* \text{, for all } i.$$

If ρ_i^* is the optimal market demand price for groundnuts in the i^{th} region, then when consumption in the i^{th} region is positive, the demand price in the region equals the market demand price ρ_i^*. When consumption, y_i, in the region is zero, the market demand price must be greater than or equal to the regional demand price.

Similarly on the supply side of the model, we can see from the two parts of equation (6.23) that we get

(6.27) $\nu_i + \eta_i x_i^* = \overline{p}^i \geq \rho^{*i}$, for all *i*.

where ρ^{*i} is the market supply price for groundnuts in the i^{th} region. As for demand, when supply, x_i, in the i^{th} region is positive, the supply price in the region equals the market demand price ρ^{*i}. When supply in the region is zero, the market supply price must be less than or equal to the regional supply price.

Equation (6.24) indicates that if inter-regional trade occurs, the difference between the market demand and supply prices will be equal to the cost of transportation, t_{ij}.

Equation (6.25a) indicates that when the optimal market demand price for groundnuts is positive, the optimal consumption, y_i^*, for region *i* is exactly fulfilled by shipments from all regions. If, however, the optimal demand price is zero, the total shipments into region *i*, may be greater than or equal to zero.

Similarly, equation (6.25b) indicates that when the optimal market supply price for groundnuts is positive, the total regional supply x_i^* for region *i* is exactly equal to all the shipments to all regions from region *i*. If, however, the optimal supply price is zero, the total production in region *i*, may be greater than or equal to self-supply plus the amount shipped to other regions.

6.2 Description of the Groundnut Market

As described in more detail in Chapter 2, in 1985, the groundnut market in Senegal was liberalized, and private buyers were allowed to compete with the government parastatals (SONACOS and SONAGRAINES) that traditionally had controlled the market. Despite the liberalization, the government parastatals still dominate the groundnut market.

Historically and at the time of this study, the Government of Senegal has set the price to be paid to producers for their groundnuts. Since 1994, a committee consisting of representatives of the GOS, the parastatals, cooperatives, and transporters has set the pan-territorial price. This committee considers primarily the international market price. However, out of concern for the livelihood of people in the rural areas, the government takes into account the amount of money that can be possibly mobilized to support the producers. In recent years, the government has not been able to mobilize funds for this purpose, and the world price is thus the determining factor in the pan-territorial price.

Groundnuts were originally introduced into Senegal as an industrial or commercial crop, and this remains the most common usage today. Most of Senegal's groundnuts are processed into groundnut oil at one of the oil processing mills owned by SONACOS. The four groundnut oil mills operated by SONACOS, in Kaolack, Diourbel, Ziguinchor, and Dakar, have a capacity of 960,000 metric tons. [Gaye April 1996, p. 2]. In recent years, these mills have been operating under capacity, and the mill in Diourbel currently processes other, non-groundnut related products. The Government of Senegal has been trying to privatize the oil mills, but has had difficulties identifying a buyer.

SONACOS only purchases groundnuts in the shell (*en coque*), and its agents purchasing groundnuts make few if any judgments as to product quality. Trucks commissioned by SONACOS still travel throughout Senegal purchasing groundnuts at specified collection points. As was observed in the current study, these collection points are often located in the villages where the producers live. Thus producers face few logistical difficulties getting their groundnuts to the point of sale.

Although SONACOS only purchases unshelled groundnuts, groundnuts are also sold in other forms and for uses other than to manufacture oil. They are also grown as confectionary nuts, as seeds for the next season, or to produce a groundnut paste used in traditional Senegalese meals. Thus on the informal market, groundnuts are sold not only in the shell, but also unshelled (*décortequé*).

The official market normally operates for four to five months—from December through April. Therefore, if a producer wishes to speculate, he can hold back his groundnuts for sale after the close of the official buying season (*après traits*). In recent years, *après traits* sales have increased. In the season 1995/1996, sixteen percent of the unshelled groundnuts and thirty-eight percent of the shelled groundnuts were sold *après traits*. In 1996/1997, these figures had practically doubled to thirty percent and seventy-one percent respectively. As can be seen in Table 6.1, producers who waited until after the close of the official season have received a higher price, most markedly in 1996/1997. The premium for waiting was much greater for those selling shelled groundnuts. In 1996/1997, those selling groundnuts in the shell received a price approximately fifteen percent higher; for those selling shelled groundnuts the price *après traits* was almost fifty percent higher. (In 1995/1996, these percentages were one percent and seventy-three percent respectively.)

Table 6.1: Average Price of Groundnuts Sold on the Parallel Market (fCFA/kg)

	1995/1996		**1996/1997**	
	During the Official Season	**After the Official Season**	**During the Official Season**	**After the Official Season**
Unshelled	128.0	129.5	139.7	160.4
Shelled	155.2	268.7	214.9	319.3
Official Price	123		131	

Historically, one way to circumvent the ban on selling groundnuts outside official channels has been to shell the groundnuts before offering them for sale. Thus according to Gaye [April 1996, p.3] most of the groundnuts sold in the parallel market are shelled. By removing the shells, producers cannot only avail themselves of more marketing opportunities, but can also add value to their product. When facing declining production, the producers' ability to increase revenue from their groundnut production by manual labor has been an attractive option. However, since the machines available to the producer for shelling the groundnuts are crude, a new category of groundnuts—broken groundnuts—has been created. Groundnut producers can also add value to their product by making groundnut paste, or peanut butter, used in cooking. They can also manufacture groundnut oil themselves for resale on the parallel market.

Besides the possibilities of receiving a higher price, producers receive other benefits. For example, on the informal market, producers receive cash for their groundnuts; on the official market there may be a delay before producers receive payment. However, the possibility of a higher price is the main attraction of the parallel market for the producers.

Gaye [September 1997] has identified several potential problems associated with the informal market. First, certain parts of Senegal may be too difficult for agents of the informal sector buyers (mostly based in Touba, center of the Mouride brotherhood) to reach. Second, producers are concerned about preserving their eligibility to receive credit available to them from official purchasers to be repaid by the guaranteed delivery of groundnuts in the coming season.

The informal market has mainly served to satisfy local demand and has been relatively stable. In recent years, the informal market has been responsible for between nine and twenty-five percent of the marketed production depending on the size of the total groundnut harvest [Gaye, interview July 2000]. As mentioned above, the size of the informal market is also affected by the GOS policy of extending credit to producers in advance of the harvest. Since similar credit is not yet available from the informal sector, producers who need credit in order to plant may feel tied to the official market.

The informal sector, by law, is limited to Senegal. Groundnuts cannot legally be traded across the border with Gambia, although trade does take place in weekly "bush" markets where there are few border patrols. The size of this market is difficult to estimate because

Senegalese buyers including representatives of SONACOS have been known to go to the Gambia to purchase groundnuts.

Just over three-quarters of the groundnuts grown in Senegal are sold either on the official or informal/parallel market; approximately ten percent is auto-consumed; and another ten percent is saved as seed.

6.3 Scenario Analysis

6.3.0 Introduction

In the analysis described below, the following assumptions or simplifications are made:

- Seventy-eight percent of the groundnuts are available for sale.
- Twenty-two percent of groundnut production is retained for seed or auto-consumption.
- Major demand points are the mills in Kaolack, Ziguinchor, and Dakar. (The mill in Diourbel is no longer processing groundnut oil.)

Several scenarios are considered.

1. Baseline scenario:
    a. Pan-territorial price is in effect.
    b. Market production goes to mills in Kaolack, Ziguinchor, and Dakar.
2. Market-based regional price differentials[2]
    a. 44 fCFA per metric ton per kilometer
    b. 71 fCFA per metric ton per kilometer

Data from the year 1996/1997 will be used as the baseline data and will consist of production data from twenty-eight departments in all ten regions of Senegal. Table 6A.1[3] lists this data and includes data by region for the 1996/1996 season. This table contains

[2] This price range was suggested by Matar Gaye, ISRA staff economist, as a possible high and low given road conditions.

data on groundnuts grown both for oil and for confectionary use. The model will only use the data on groundnuts used to produce oil. Therefore in the baseline scenario, only seventy-eight percent of the amount produced for groundnut oil is available for sale outside the department. Twenty-two percent is assumed to stay in the department.

Table 6A.2 gives the distances between supply and demand regions. The author estimated distances from a Senegalese road map[4].

6.3.1 Baseline Scenario

The initial quantities supplied and demanded in the eight regions are given in Table 6A.3[5]. The city of Dakar is a major demand area, but is not a significant supplier of groundnuts.

In the initial scenario, the following parameters are used:

Demand Elasticity[6]	-0.20
Supply Elasticity[7]	0.433
Transportation costs	44 fCFA per metric ton per kilometer

The baseline scenario replicates the situation described in Table 6A.1 where the mills were the receivers of all groundnuts not retained for seed or auto-consumed within the household. Table 6A.4 gives the results of the baseline scenario estimation, including estimations of the consumer, producer and total surpluses.

In the baseline scenario, it was assumed that the cost of transportation was borne by the parastatal organizations (*i.e.* the government) that owned and operated the mills that

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3 Source: République du Sénégal, Ministère de l'Agriculture, Direction de l'Agriculture, Projet du CILSS. *Résultats Définitifs de la Compagne Agricole 1996/1997*. May 1997, pp. 35-45.

4 *Sénégal: Carte Routière au 1:1,000,000*, L'Institut Géographique National - France, Paris 1993, 3rd edition.

5 Tables numbered "*6A*.x" are found in the appendix to Chapter 6.

6 Sullivan *et al.*, p. 40. To test the effect of the demand elasticity on the results, more inelastic estimates of –1.0 and –10.0 were used to test the sensitivity of the results to the demand elasticity.

7 The supply elasticity was provided in a private communiqué from Matar Gaye, ISRA Staff Economist.

purchased the groundnuts. Although groundnut producers throughout the country faced the same price and did not have to pay for transporting their groundnuts to the mills, the cost of transportation was still borne by society in terms of a transfer to the transporters. If we assume a cost of transportation of 44 fCFA per ton per kilometer, the total cost of transportation is 4.6×10^9 fCFA. If we assume a higher cost of 71 fCFA per ton per kilometer, the total cost of transportation would be 7.4×10^9 fCFA. In Table 6A.4, these costs are subtracted from the total surplus. Table 6A.7 gives the pattern of shipments from supply to demand regions.

6.3.2 Regional Prices

In the next two scenarios, the cost of transportation is endogenized and thus affects the pattern of groundnut shipments. Tables 6A.5 and 6A.6 give the results when the cost of transportation is 44 and then 71 fCFA per ton per kilometer and includes the cost of transportation and the consumer, producer and total surpluses. Tables 6A.8 and 6A.9 give the pattern of shipments from supply to demand regions.

In order to fully assess the changes described in these scenarios, it is useful to look at the relative importance of the various regions in the production of groundnuts. In Table 6.2, one can see that Kaolack (45.1%), Louga (12.6%), and Fatick (10.0%) produce approximately two-thirds of all groundnuts marketed in Senegal.

Table 6.2: Baseline Scenario—Quantities Supplied and Demanded by Region

Region	Quantity Supplied		Quantity Demanded	
	(100 mts)	%	(100 mts)	%
Dakar	7.26	0.1	1,179.64	24.0
Diourbel	177.33	3.6	50.02	1.0
Fatick	571.92	11.6	161.3	3.3
Kaolack	2,220.97	45.1	1,804.03	36.7
Kolda	492.21	10.0	138.83	2.8
Louga	619.74	12.6	174.79	3.6
Saint-Louis	23.54	0.5	6.64	0.1
Tambacounda	375.46	7.6	105.9	2.2
Thies	322.15	6.5	90.87	1.8
Ziguinchor	110.18	2.2	1,208.68	24.6
Senegal	**4,920.76**	**100**	**4,920.76**	**100**

Table 6.3 shows the effects of endogenizing the cost of transportation on the average price and on the quantities demanded and supplied. As would be expected, departments far from the mills show the greatest drop in price. For example, the seven departments showing the greatest fall in price—Kedougou, Bakel, Podor, Matam, Dagama, Velingara, and Tambacounda—are the most remote departments. Similarly, the departments experiencing the greatest price gain—Ziguinchor, Bignona, Dakar, and Oussouye—are either where an oil mill is located or quite close. As can be seen in Table 6.2, the regions where these departments are located are minor producers, producing just ten percent of Senegal's groundnuts. In the Groundnut Basin, price changes are much smaller. For Senegal as a whole, the average equilibrium price falls by 1.1 and 1.8 percent when the transportations costs are 44 fCFA and 71 fCFA per metric ton per kilometer respectively.

Table 6.3: Percentage Changes in Prices and Quantities Due to Endogenized Transportation Costs

Department	Percentage Changes					
	TC = 44 fCFA / mt / km			TC = 71 fCFA / mt / km		
	Quantity Supplied	Quantity Demanded	Price	Quantity Supplied	Quantity Demanded	Price
Dakar	1.7	-0.8	3.9	2.7	-1.3	6.3
Rufisque	1.3	-0.6	3.0	2.1	-1.0	4.8
Bambey	-0.2	0.1	-0.6	-0.4	0.2	-0.9
Diourbel	0.5	0.0	1.2	0.9	0.0	2.0
Mbacke	0.0	0.0	-0.1	-0.1	0.0	-0.2
Fatick	-0.6	0.3	-1.3	-0.9	0.4	-2.1
Foundiougne	-1.0	0.4	-2.2	-1.5	0.7	-3.5
Gossas	0.2	0.0	0.4	0.3	0.0	0.6
Kaolack	0.0	0.0	-0.1	-0.1	0.0	-0.1
Kaffrine	-0.9	0.4	-2.1	-1.5	0.7	-3.4
Nioro	-0.3	0.2	-0.8	-0.5	0.2	-1.2
Kolda	-0.5	0.2	-1.1	-0.7	0.3	-1.7
Sedhiou	0.7	-0.3	1.6	1.1	-0.4	2.5
Velingara	-2.2	1.0	-5.2	-3.6	1.7	-8.4
Louga	0.5	-0.2	1.2	0.9	-0.4	2.0
Kebemer	0.5	-0.2	1.2	0.9	-0.4	2.0
Linguere	0.5	-0.2	1.2	0.9	-0.4	2.0
Dagana	-2.4	1.1	-5.6	-3.9	1.8	-9.0
Matam	-2.6	1.2	-6.1	-4.2	2.0	-9.8
Podor	-3.6	1.7	-8.4	-5.9	2.7	-13.5
Bakel	-4.8	2.2	-11.1	-7.8	3.6	-18.0
Kedougou	-5.5	2.5	-12.7	-8.9	4.1	-20.5
Tambacounda	-2.2	1.0	-5.2	-3.6	1.7	-8.4
Mbour	0.3	-0.2	0.8	0.6	-0.3	1.3
Thies	0.5	-0.2	1.2	0.9	-0.4	2.0
Tivaouane	1.0	-0.4	2.2	1.6	-0.6	3.6
Bignona	1.9	-0.9	4.4	3.0	-1.4	7.0
Oussouye	1.7	-0.8	3.8	2.7	-1.2	6.2
Ziguinchor	2.3	-1.1	5.3	3.7	-1.7	8.5
Senegal	**-0.4**	**-0.4**	**-1.1**	**-0.6**	**-0.6**	**-1.7**

The effects on the quantities supplied and demanded are less dramatic, but mirror the price changes. In the Groundnut Basin, changes in quantities supplied and demanded are approximately plus or minus one percent or less regardless of the cost of transportation. In Senegal as a whole, the equilibrium quantities fell by less than one percent in both transportation cost scenarios.

Table 6.4 shows the changes in surplus by region. Given the price changes discussed above, the winners and losers in the two scenarios are not surprising. Producers in the seven departments having the largest fall in prices have changes in producer surplus ranging between –10.7 and –4.4 percent (44 fCFA per metric tom per kilometer) and between –16.9 and –7.1 percent (71 fCFA per metric tom per kilometer). Similarly, producers in the four departments having the largest percentage rise in prices have gains in producer surplus ranging between 3.3 and 4.6 percent (44 fCFA per metric tom per kilometer) and between 5.4 and 7.5 percent (71 fCFA per metric tom per kilometer).

Consumers in these departments show smaller changes (in absolute value). In the seven departments that have a fall in prices, changes in consumer surplus range between 2.1 and 5.1 percent (44 fCFA per metric tom per kilometer) and between 3.4 and 8.3 percent (71 fCFA per metric tom per kilometer).

Nationwide, the elimination of the pan-territorial price is not good for consumers or producers. Both producer and consumer surplus changes are slightly negative: -0.8 percent when the transportation cost is 44 fCFA per metric ton per kilometer and –1.2 percent when the cost increases to 71 fCFA.

When the cost of transportation is subtracted from the total surplus, the change in total surplus falls from –0.8 percent to –1.5 percent when the transportation cost is 44 fCFA per metric ton per kilometer and from –1.2 percent to –2.4 percent when the cost increases to 71 fCFA.

Table 6.4: Percentage Changes in Economic Surplus

Region	Percentage Changes in Surplus							
	Transport Cost = 44 fCFA / mt / km				Transport Cost = 71 fCFA / mt / km			
	Consumer Surplus	Producer Surplus	Total Surplus w/o TC	Total Surplus w/ TC	Consumer Surplus	Producer Surplus	Total Surplus w/o TC	Total Surplus w/ TC
Dakar	-1.6	3.4	-1.6	-2.7	-2.5	5.5	-2.5	-4.4
Rufisque	-1.2	2.6	1.2	0.4	-1.9	4.2	1.9	1.0
Bambey	0.2	-0.5	-0.2	-0.2	0.4	-0.8	-0.3	-0.3
Diourbel	0.0	1.1	0.7	0.3	0.0	1.7	1.1	0.8
Mbacke	0.0	-0.1	0.0	0.0	0.1	-0.2	-0.1	-0.1
Fatick	0.5	-1.1	-0.5	-0.6	0.8	-1.8	-0.8	-0.9
Foundiougne	0.9	-1.9	-0.8	-0.8	1.4	-3.0	-1.4	-1.4
Gossas	0.0	0.3	0.2	-0.1	-0.1	0.5	0.3	-0.2
Kaolack	0.0	-0.1	0.0	-0.5	0.1	-0.1	0.0	-0.8
Kaffrine	0.8	-1.8	-0.8	-0.8	1.4	-2.9	-1.3	-1.3
Nioro	0.3	-0.6	-0.3	-0.3	0.5	-1.0	-0.5	-0.5
Kolda	0.4	-0.9	-0.4	-0.4	0.7	-1.5	-0.7	-0.7
Sedhiou	-0.5	1.4	0.6	0.3	-0.8	2.2	1.0	0.0
Velingara	2.1	-4.4	-2.0	-2.0	3.4	-7.1	-3.1	-3.1
Louga	-0.5	1.1	0.5	0.2	-0.8	1.7	0.8	0.4
Kebemer	-0.5	1.1	0.5	0.5	-0.8	1.7	0.8	0.8
Linguere	-0.5	1.1	0.5	0.1	-0.8	1.7	0.8	0.2
Dagana	2.2	-4.8	-2.1	-2.1	3.6	-7.6	-3.4	-3.4
Matam	2.4	-5.2	-2.2	-2.2	3.9	-8.3	-3.5	-4.8
Podor	3.4	-7.1	-3.4	-3.4	5.5	-11.4	-5.4	-5.4
Bakel	4.5	-9.4	-4.1	-4.1	7.3	-14.9	-6.5	-6.5
Kedougou	5.1	-10.7	-4.7	-4.7	8.3	-16.9	-7.3	-7.3
Tambacounda	2.1	-4.4	-2.0	-2.1	3.4	-7.1	-3.1	-3.1
Mbour	-0.3	0.7	0.3	0.0	-0.5	1.1	0.5	-0.1
Thies	-0.5	1.1	0.5	0.5	-0.8	1.7	0.8	0.8
Tivaouane	-0.8	1.9	0.9	0.5	-1.3	3.2	1.5	1.3
Bignona	-1.7	3.8	1.7	1.3	-2.8	6.2	2.8	2.2
Oussouye	-1.5	3.3	1.5	1.5	-2.4	5.4	2.4	2.4
Ziguinchor	-2.1	4.6	-2.1	-4.5	-3.4	7.5	-3.3	-7.2
Senegal	**-0.8**	**-0.8**	**-0.8**	**-1.5**	**-1.2**	**-1.2**	**-1.2**	**-2.4**

However, this is not the whole picture. In the baseline scenario, the government paid all the transportation costs. When pan-territorial prices are eliminated and transportation costs are endogenized, these costs are then borne by the market. As can be seen in Tables 6A.5 and 6A.6, these costs of 1,773 million fCFA (44 fCFA per metric ton per kilometer) and 2,829 million fCFA (71 fCFA per metric ton per kilometer) are substantially less than the costs of transporting groundnuts under the baseline scenario: 4,562 million fCFA (44 fCFA per metric ton per kilometer) and 7,361 million fCFA (71 fCFA per metric ton per kilometer).

Table 6.5 summarizes the changes in total surplus when transportations costs are considered. Although the changes are small, removing pan-territorial prices results in a benefit to society no matter whether the cost of transportation is 44 or 71 fCFA per metric ton per kilometer.

Table 6.5: Changes in Total Surplus

	Baseline	TC = 44	TC = 71
Consumer Plus Producer Surplus	235,589	233,801	232,719
Minus TC = 44 / mt / km	231,027	232,028	
Minus TC = 71 / mt / km	228,228		229,890
% Change		**0.43**	**0.73**

6.3.3 Sensitivity of the Demand Elasticity to the Results

Sensitivity analysis was performed to see whether the results obtained using the initial parameters were dependent on the initial estimate of –0.20 for the demand elasticity. The model was re-examined using more inelastic demand elasticities of –1.0 and –10.0. Although there were minor differences, the overall distribution of the benefits and the size and direction of the groundnut trade were unaffected by the demand elasticity.

6.4 Conclusions

The results of this chapter suggest that eliminating the pan-territorial price supported by the government and internalizing the cost of transportation will not have a major impact on either producers or consumers on Senegal as a whole. This change, however, may have a significant effect on producers and consumers in particular regions, although not on consumers or producers in the major groundnut producing regions.

As can be seen in Tables 6A.7 through 6A.9, the pattern of shipments will be affected by the internalization of the transportation cost, but not on the overall quantities shipped from supply to demand regions.

Price changes are more dramatic. When the transportation costs are 44 fCFA per metric ton per kilometer, the equilibrium price falls by over ten percent in several of the more remote departments and rises by between four and six percent in departments close to the mills in Dakar and Ziguinchor. When the cost of transportation rises to 71 fCFA, prices changes are even greater—a drop of between ten and twenty percent in one of the more remote departments and a rise of six to eight percent and eleven in departments near Dakar and Ziguinchor. Price changes in the heart of the Groundnut Basin are modest. In Kaolack, Fatick, and Louga, prices fall by less than two percent even at the higher cost of transportation. The fact that the mill in Kaolack is so close to the major production areas may account for this result.

In the baseline scenario, the government picked up the total cost of transportation. When the system of pan-territorial pricing is eliminated, the three and seven billion fCFA cost of transportation associated with the shipment of groundnuts will have to be absorbed by the private sector. As the model suggests, the free market allocation of the groundnuts will result in a large reduction in the cost of transportation to less than three billion fCFA, even at the higher cost of transportation.

Chapter 6 Appendix: Tables

Table 6A.1: Groundnut Production from the Agricultural Campaign 1996/1997

Region / Department	Arachide huilerie			Arachide de bouche			Total Arachide		
	Area (ha)	Yield (kg/ha)	Production (mt)	Area (ha)	Yield (kg/ha)	Production (mt)	Area (ha)	Yield (kg/ha)	Production (mt)
Dakar	1,347	690	929				1,347	690	929
Rufisque	1,347	690	929				1,347	690	929
1995/1996	1,366	442	604				1,366	442	604
Diourbel	70,117	324	22,735				70,117	324	22,735
Bambey	29,601	328	9,709				29,601	328	9,709
Diourbel	14,462	308	4,454				14,462	308	4,454
Mbacke	26,054	329	8,572				26,054	329	8,572
1995/1996	72,742	737	53,645				72,742	737	53,645
Fatick	106,872	620	66,220	7,998	888	7,102	114,870	1,508	73,322
Fatick	29,619	349	10,337				29,619	349	10,337
Foundiougne	27,786	984	27,341	7,998	888	7,102	35,784	1,872	34,443
Gossas	49,467	577	28,542				49,467	577	28,542
1995/1996	154,624	1,032	159,617	6,292	837	5,266	160,916	1,869	164,883
Kaolack	316,369	808	255,664	47,628	952	45,362	363,997	1,761	301,026
Kaolack	43,981	796	35,009	12,887	461	5,941	56,868	1,257	40,950
Kaffrine	184,094	801	147,459	16,299	637	10,382	200,393	1,438	157,841
Nioro	88,294	829	73,196	18,429	692	12,753	106,723	1,521	85,949
1995/1996	292,198	1,052	307,352	33,693	928	31,252	325,891	1,979	338,604
Kolda	70,208	899	63,104				70,208	899	63,104
Kolda	27,255	855	23,303				27,255	855	23,303
Sedhiou	34,368	976	33,543				34,368	976	33,543
Velingara	8,585	729	6,258				8,585	729	6,258
1995/1996	77,378	1,044	80,798				77,378	1,044	80,798
Louga	124,810	585	72,955	8,075	712	5,749	132,885	1,296	78,704
Louga	44,492	647	28,786	4,539	947	4,298	49,031	1,594	33,084
Kebemer	44,744	305	13,647	2,500	460	1,150	47,244	765	14,797
Linguere	35,574	858	30,522	1,761	596	1,050	37,335	1,454	31,572
1995/1996	94,715	721	68,252				94,715	721	68,252
Saint-Louis	12,049	250	3,008				12,049	250	3,008
Dagana	11,928	250	2,982				11,928	250	2,982
Matam	121	215	26				121	215	26
Podor							0	0	0
1995/1996	5,697	406	2,312				5,697	406	2,312

Table 6A.1 (continued):

	Arachide huilerie			Arachide de bouche			Total Arachide		
Region /	Area	Yield	Production	Area	Yield	Production	Area	Yield	Production
Department	(ha)	(kg/ha)	(mt)	(ha)	(kg/ha)	(mt)	(ha)	(kg/ha)	(mt)
Tambacounda	47,192	1,020	48,136				47,192	1,020	48,136
Bakel	3,859	652	2,516				3,859	652	2,516
Kedougou	3,011	956	2,879				3,011	956	2,879
Tambacounda	40,322	1,060	42,741				40,322	1,060	42,741
1995/1996	52,029	950	49,410				52,029	950	49,410
Thies	91,119	453	41,302				91,119	453	41,302
Mbour	24,368	606	14,767				24,368	606	14,767
Thies	18,123	415	7,521				18,123	415	7,521
Tivaouane	48,628	391	19,014				48,628	391	19,014
1995/1996	79,242	723	57,309				79,242	723	57,309
Ziguinchor	16,031	881	14,126				16,031	881	14,126
Bignona	14,545	859	12,494				14,545	859	12,494
Oussouye	407	1,057	430				407	1,057	430
Ziguinchor	1,079	1,114	1,202				1,079	1,114	1,202
1995/1996	11,393	993	11,318				11,393	993	11,318
Senegal 1996/97	**856,114**	**687**	**588,179**	**63,701**	**914**	**58,213**	**919,815**	**1,601**	**646,392**
Senegal 1995/96	**841,384**	**940**	**790,617**	**39,985**	**913**	**36,518**	**881,369**	**1,853**	**827,135**

Table 6A.2: Distances Between Supply and Demand Areas (in kilometers)

Departments	Dakar	Rufisque	Bambey	Diourbel	Mbacke	Fatick	Foundiougne	Gossas	Kaolack	Kaffrine	Nioro	Kolda	Sedhiou	Velingara	Louga	Kebemer	Linguere	Dagana	Matam	Podor	Bakel	Kedougou	Tambacounda	Mbour	Thies	Tivaouane	Bignona	Oussouye	Ziguinchor
Dakar	0																												
Rufisque	28	0																											
Bambey	133	105	0																										
Diourbel	80	128	23	0																									
Mbacke	120	168	63	40	0																								
Fatick	155	127	61	38	78	0																							
Foundiougne	182	154	88	65	105	27	0																						
Gossas	105	153	48	25	65	41	68	0																					
Kaolack	199	171	87	64	104	44	63	39	0																				
Kaffrine	199	231	147	114	102	104	123	99	60	0																			
Nioro	199	226	142	119	159	99	118	94	55	51	0																		
Kolda	416	443	359	336	376	316	335	311	272	268	217	0																	
Sedhiou	349	376	292	269	309	249	268	244	205	201	150	70	0																
Velingara	539	566	482	459	499	439	458	434	395	391	340	123	193	0															
Louga	80	175	176	161	110	225	266	186	214	274	269	486	419	609	0														
Kebemer	80	137	138	123	72	187	228	148	176	236	231	448	381	571	38	0													
Linguere	80	290	185	162	122	200	227	187	226	276	281	498	431	621	130	168	0												
Dagana	282	377	378	363	312	427	468	388	416	476	471	688	621	811	202	240	332	0											
Matam	297	507	402	379	339	417	444	404	443	493	498	715	648	838	347	385	217	293	0										
Podor	366	461	462	447	396	511	552	472	500	560	555	772	705	895	286	324	416	84	242	0									
Bakel	655	687	603	570	558	560	579	555	516	456	507	469	592	346	498	536	368	444	151	393	0								
Kedougou	645	677	583	550	538	540	559	535	496	436	487	449	572	326	710	672	722	912	939	912	466	0							
Tambacounda	412	444	360	327	315	317	336	312	273	213	264	226	349	103	487	449	499	689	716	689	243	223	0						
Mbour	93	65	126	100	140	62	89	103	106	166	161	378	311	501	196	158	326	398	543	482	694	709	486	0					
Thies	80	52	53	76	116	114	141	101	140	200	195	412	345	535	123	85	253	325	470	409	621	636	413	73	0				
Tivaouane	50	22	75	98	138	136	163	123	162	222	217	434	367	557	101	63	231	303	448	387	599	658	435	95	22	0			
Bignona	199	378	294	271	311	251	270	246	207	203	152	215	83	338	421	383	433	623	650	650	581	561	338	297	331	63	0		
Oussouye	199	448	364	341	381	321	340	316	277	273	222	231	153	354	491	453	503	693	720	777	597	577	354	383	417	439	70	0	
Ziguinchor	415	387	321	298	338	278	297	273	234	230	179	188	110	311	448	410	460	650	677	734	554	534	311	340	374	396	27	43	0

Table 6A.3: Baseline Scenario: Initial Quantities Supplied and Demanded

Region	No.	Department	Initial Quantity (100s mt)	
			Supplied	Demanded
Dakar	1	Dakar	0.01	1,177.60
	2	Rufisque	7.25	2.04
Diourbel	3	Bambey	75.73	21.36
	4	Diourbel	34.74	9.80
	5	Mbacke	66.86	18.86
Fatick	6	Fatick	80.63	22.74
	7	Foundiougne	268.66	75.77
	8	Gossas	222.63	62.79
Kaolack	9	Kaolack	319.41	1,267.69
	10	Kaffrine	1,231.16	347.25
	11	Nioro	670.40	189.09
Kolda	12	Kolda	181.76	51.27
	13	Sedhiou	261.64	73.79
	14	Velingara	48.81	13.77
Louga	15	Louga	258.06	72.78
	16	Kebemer	115.42	32.55
	17	Linguere	246.26	69.46
Saint-Louis	18	Dagana	23.26	6.56
	19	Matam	0.20	0.06
	20	Podor	0.08	0.02
Tambacounda	21	Bakel	19.62	5.54
	22	Kedougou	22.46	6.33
	23	Tambacounda	333.38	94.03
Thies	24	Mbour	115.18	32.49
	25	Thies	58.66	16.55
	26	Tivaouane	148.31	41.83
Ziguinchor	27	Bignona	97.45	27.49
	28	Oussouye	3.35	0.95
	29	Ziguinchor	9.38	1,180.24
Senegal 1996/1997			4,920.67	4,920.67

Table 6A.4: Results of Baseline Scenario[8]

Region	Quantity Supplied	Quantity Demanded	Supply Price	Demand Price	Consumer Surplus	Producer Surplus	Total Surplus
1	0.01	1,177.60	13.1	13.1	38,566.70	0	38,567
2	7.25	2.04	13.1	13.1	66.81	110	176
3	75.73	21.36	13.1	13.1	699.55	1,146	1,845
4	34.74	9.8	13.1	13.1	320.95	526	846
5	66.86	18.86	13.1	13.1	617.67	1,011	1,629
6	80.63	22.74	13.1	13.1	744.74	1,220	1,964
7	268.66	75.77	13.1	13.1	2,481.49	4,064	6,545
8	222.63	62.79	13.1	13.1	2,056.39	3,368	5,424
9	319.41	1,267.69	13.1	13.1	41,517.17	4,832	46,349
10	1,231.15	347.25	13.1	13.1	11,372.52	18,623	29,996
11	670.39	189.09	13.1	13.1	6,192.75	10,141	16,334
12	181.76	51.27	13.1	13.1	1,679.11	2,749	4,429
13	261.64	73.79	13.1	13.1	2,416.64	3,958	6,374
14	48.81	13.77	13.1	13.1	450.97	738	1,189
15	258.06	72.78	13.1	13.1	2,383.56	3,904	6,287
16	115.42	32.55	13.1	13.1	1,066.02	1,746	2,812
17	246.26	69.46	13.1	13.1	2,274.83	3,725	6,000
18	23.26	6.56	13.1	13.1	214.84	352	567
19	0.2	0.06	13.1	13.1	1.97	3	5
20	0.08	0.02	13.1	13.1	0.66	1	2
21	19.62	5.54	13.1	13.1	181.44	297	478
22	22.46	6.33	13.1	13.1	207.31	340	547
23	333.38	94.03	13.1	13.1	3,079.51	5,043	8,122
24	115.18	32.49	13.1	13.1	1,064.06	1,742	2,806
25	58.66	16.55	13.1	13.1	542.02	887	1,429
26	148.31	41.83	13.1	13.1	1,369.94	2,243	3,613
27	97.45	27.49	13.1	13.1	900.30	1,474	2,374
28	3.35	0.95	13.1	13.1	31.11	51	82
29	9.38	1,180.24	13.1	13.1	38,653.16	142	38,795
Total	**4,920.72**	**4,920.72**			**161,154.17**	**74,435**	**235,589**
Total Transport Costs (44 fCFA / mt / km) =					4,562		**231,027**
Total Transport Costs (71 fCFA / mt / km) =					7,361		**228,228**

8 In Tables 6A.4 – 6A.6, a*ll quantities are in 100s of metric tons. All prices are on millions of fCFA.*

Table 6A.5: Scenario—Transport Cost = 44 fCFA per metric ton per kilometer

Region	Quantity Supplied	Quantity Demanded	Supply Price	Demand Price	Consumer Surplus	Producer Surplus	Transport Cost	Total Surplus
1	0.01	1,168.38	13.6	13.6	37,965	0	456	37,965
2	7.34	2.03	13.5	13.5	66	113	1	179
3	75.55	21.38	13.0	13.0	701	1,140	0	1,841
4	34.92	9.80	13.3	13.1	321	531	3	852
5	66.83	18.86	13.1	13.1	618	1,010	0	1,628
6	80.18	22.80	12.9	12.9	749	1,206	3	1,955
7	266.10	76.10	12.8	12.8	2,503	3,987	0	6,490
8	223.00	62.78	13.2	13.1	2,056	3,379	19	5,435
9	319.30	1,267.90	13.1	13.1	41,530	4,828	251	46,359
10	1,219.98	348.71	12.8	12.8	11,468	18,287	0	29,755
11	668.21	189.37	13.0	13.0	6,211	10,075	0	16,286
12	180.93	51.38	13.0	13.0	1,686	2,724	0	4,411
13	263.41	73.60	13.3	13.3	2,404	4,012	23	6,416
14	47.71	13.91	12.4	12.4	460	706	0	1,166
15	259.43	72.60	13.3	13.3	2,372	3,945	14	6,317
16	116.03	32.47	13.3	13.3	1,061	1,765	0	2,825
17	247.57	69.29	13.3	13.3	2,264	3,765	21	6,029
18	22.70	6.63	12.4	12.4	220	335	0	555
19	0.19	0.06	12.3	12.3	2	3	0	5
20	0.08	0.02	12.0	12.0	1	1	0	2
21	18.67	5.66	11.6	11.6	190	269	0	458
22	21.23	6.49	11.4	11.4	218	303	0	521
23	325.89	95.01	12.4	12.4	3,144	4,819	14	7,963
24	115.57	32.44	13.2	13.2	1,061	1,754	9	2,815
25	58.97	16.51	13.3	13.3	539	897	0	1,436
26	149.75	41.67	13.4	13.4	1,359	2,287	14	3,646
27	99.29	27.25	13.7	13.7	885	1,530	9	2,415
28	3.41	0.94	13.6	13.6	31	52	0	83
29	9.59	1,167.83	13.8	13.8	37,844	148	936	37,992
Total	**4,901.87**	**4,901.87**			**159,927**	**73,873**	**1,773**	**233,801**

Table 6A.6: Scenario—Transport Cost = 71 fCFA per metric ton per kilometer

Region	Quantity Supplied	Quantity Demanded	Supply Price	Demand Price	Consumer Surplus	Producer Surplus	Transport Cost	Total Surplus
1	0.01	1,162.72	13.9	13.9	37,598	0	747	37,598
2	7.40	2.02	13.7	13.7	66	114	2	180
3	75.44	21.40	13.0	13.0	702	1,137	0	1,839
4	35.04	9.80	13.4	13.1	321	535	3	856
5	66.81	18.87	13.1	13.1	618	1,010	0	1,628
6	79.90	22.83	12.8	12.8	751	1,198	1	1,949
7	264.54	76.31	12.6	12.6	2,517	3,940	0	6,457
8	223.24	62.77	13.2	13.1	2,055	3,386	27	5,441
9	319.23	1,268.02	13.1	13.1	41,539	4,826	406	46,365
10	1,213.13	349.60	12.7	12.7	11,527	18,082	0	29,609
11	666.87	189.55	12.9	12.9	6,223	10,035	0	16,258
12	180.42	51.44	12.9	12.9	1,691	2,709	0	4,400
13	264.50	73.48	13.4	13.4	2,396	4,045	65	6,441
14	47.04	14.00	12.0	12.0	466	686	0	1,152
15	260.28	72.49	13.4	13.4	2,365	3,971	23	6,336
16	116.41	32.42	13.4	13.4	1,058	1,776	0	2,834
17	248.37	69.18	13.4	13.4	2,257	3,789	32	6,046
18	22.36	6.68	11.9	11.9	223	325	0	548
19	0.19	0.06	11.8	11.8	2	3	0	5
20	0.08	0.02	11.3	11.3	1	1	0	2
21	18.09	5.74	10.7	10.7	195	252	0	447
22	20.47	6.59	10.4	10.4	225	282	0	507
23	321.30	95.60	12.0	12.0	3,183	4,684	0	7,868
24	115.82	32.41	13.3	13.3	1,059	1,762	16	2,820
25	59.16	16.48	13.4	13.4	538	903	0	1,440
26	150.63	41.56	13.6	13.5	1,353	2,314	6	3,667
27	100.41	27.10	14.0	14.0	875	1,565	15	2,440
28	3.44	0.94	13.9	13.9	30	53	0	84
29	9.72	1,160.21	14.2	14.2	37,352	153	1,486	37,504
Total	**4,890.30**	**4,890.30**	**373.38**	**372.94**	**159,182**	**73,537**	**2,829**	**232,719**

Table 6A.7: Shipments from Supply Regions S1…S29 to Demand Regions D1…D29 (100s of metric tons) TC = 0

Region	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15
S1	0.01														
S2	7.25														
S3										75.73					
S4	34.74														
S5							38.12	28.74							
S6									38.80						
S7	245.55														
S8		2.04		9.80					91.42			51.27			
S9			3.17		2.48	22.74			87.17		5.46		5.46	5.46	5.46
S10	870.12									33.45	183.63		68.33	8.31	67.32
S11									670.39						
S12							5.30	5.30	144.11						
S13	16.38								235.81						
S14					5.71		21.55	21.55							
S15			18.19		3.56		3.60	3.60		71.58					
S16					3.56		3.60	3.60		71.58					
S17					3.56		3.60			71.58					
S18										23.26					
S19	0.20														
S20										0.08					
S21															
S22															
S23															
S24															
S25															
S26															
S27															
S28	3.35														
S29															
Total	**1,177.60**	**2.04**	**21.36**	**9.80**	**18.86**	**22.74**	**75.77**	**62.79**	**1,267.69**	**347.25**	**189.09**	**51.27**	**73.79**	**13.77**	**72.78**

Table 6A.7 (con't):Shipments from Supply Regions S1…S29 to Demand Regions D1…D29 (100s of metric tons) TC=0

	D16	D17	D18	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	Total
S1															**0.01**
S2															**7.25**
S3															**75.73**
S4															**34.74**
S5															**66.86**
S6											41.83				**80.63**
S7	23.10														**268.66**
S8									23.11	16.55		27.49	0.95		**222.63**
S9		69.46	6.56	0.06	0.02	5.54	6.33	94.03							**319.41**
S10															**1,231.15**
S11															**670.39**
S12														27.05	**181.76**
S13	9.45														**261.64**
S14															**48.81**
S15														157.53	**258.06**
S16														33.09	**115.42**
S17														167.53	**246.26**
S18															**23.26**
S19															**0.20**
S20															**0.08**
S21														19.62	**19.62**
S22														22.46	**22.46**
S23														333.38	**333.38**
S24														115.18	**115.18**
S25														58.66	**58.66**
S26														148.31	**148.31**
S27														97.45	**97.45**
S28															**3.35**
S29									9.38						**9.38**
Total	**32.55**	**69.46**	**6.56**	**0.06**	**0.02**	**5.54**	**6.33**	**94.03**	**32.49**	**16.55**	**41.83**	**27.49**	**0.95**	**1,180.24**	**4,920.72**

Table 6A.8: Shipments from Supply Regions S1…S29 to Demand Regions D1…D29 (100s of metric tons) TC=44

Region	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15
1	0.01														
2	7.32														
3	30.77		21.42												
4	34.86														
5	47.84				18.89										
6	25.51			7.51		11.00		36.07							
7	60.54	2.02		2.30		11.86	76.39	26.77	81.40						
8	222.65														
9									318.85						
10									869.25	349.97					
11											189.76				
12												51.50	73.57		
13															
14														14.01	
15	202.45														56.49
16	83.35														
17	190.95														
18															16.03
19															
20															0.06
21															
22															
23															
24	87.59														
25	24.00														
26	146.45														
27															
28															
29															
Total	**1,164.30**	**2.02**	**21.42**	**9.81**	**18.89**	**22.86**	**76.39**	**62.85**	**1,269.50**	**349.97**	**189.76**	**51.50**	**73.57**	**14.01**	**72.58**

Table 6A.8 (con't): Shipments from Supply Regions S1…S29 to Demand Regions D1…D29 (100s of metric tons) TC=44

Region	D16	D17	D18	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	Total
1															0.01
2															7.32
3											23.26				75.46
4															34.86
5															66.73
6															80.10
7									4.66						265.95
8															222.65
9															318.85
10															1,219.22
11														477.68	667.44
12														55.67	180.74
13												24.19		238.68	262.87
14														33.73	47.74
15															258.94
16	32.46														115.81
17		56.15													247.10
18			6.68												22.72
19		0.13		0.06											0.19
20					0.02										0.08
21		12.99				5.74									18.73
22							6.59							14.71	21.31
23								95.69						230.40	326.09
24									27.78						115.37
25										16.50	18.35				58.86
26												2.95			149.40
27														98.98	98.98
28													0.94	2.46	3.40
29														9.56	9.56
Total	**32.46**	**69.27**	**6.68**	**0.06**	**0.02**	**5.74**	**6.59**	**95.69**	**32.45**	**16.50**	**41.62**	**27.14**	**0.94**	**1,161.87**	**4,896.48**

Table 6A.9: Shipments from Supply Regions S1…S29 to Demand Regions D1…D29 (100s of metric tons) TC=71

Region	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15
1	0.01														
2	7.40														
3	52.22	1.83	21.40												
4	35.04														
5	47.94				18.87										
6	16.15			9.80		15.34		16.40							
7	38.71	0.20				7.49	76.31	46.37	85.26						
8	223.24														
9									319.23						
10									863.53	349.60					
11											189.55				
12												51.44	40.44		
13															
14													33.04	14.00	
15	203.52														56.76
16	83.99														
17	191.68														
18															15.73
19															
20															
21															
22															
23															
24	115.82														
25	1.12														
26	145.90														
27															
28															
29															
Total	**1,162.72**	**2.02**	**21.40**	**9.80**	**18.87**	**22.83**	**76.31**	**62.77**	**1,268.02**	**349.60**	**189.55**	**51.44**	**73.48**	**14.00**	**72.49**

Table 6A.9 (con't): Shipments from Supply Regions S1…S29 to Demand Regions D1…D29 (100s of metric tons) TC = 71

Region	D16	D17	D18	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	Total
1															**0.01**
2															**7.40**
3															**75.44**
4															**35.04**
5															**66.81**
6									22.21						**79.90**
7									10.20						**264.54**
8															**223.24**
9															**319.23**
10															**1,213.13**
11												7.46		469.87	**666.87**
12														88.54	**180.42**
13												7.46		257.04	**264.50**
14															**47.04**
15															**260.28**
16	32.42														**116.41**
17		56.70													**248.37**
18			6.62												**22.36**
19		0.19													**0.19**
20			0.05		0.02										**0.08**
21		12.29		0.06		5.74									**18.09**
22							6.59							13.88	**20.47**
23								95.60						225.70	**321.30**
24															**115.82**
25										16.48	41.56				**59.16**
26												4.73			**150.63**
27												7.46		92.96	**100.41**
28													0.94	2.50	**3.44**
29														9.72	**9.72**
Total	**32.42**	**69.18**	**6.68**	**0.06**	**0.02**	**5.74**	**6.59**	**95.60**	**32.41**	**16.48**	**41.56**	**27.10**	**0.94**	**1,160.21**	**4,890.30**

Chapter 7: Conclusions

7.0 Introduction

This dissertation was motivated by a desire to determine how small-scale farmers in Senegal's Groundnut Basin would react to price and policy changes. In an attempt to shed light on this question, a survey of 228 households was conducted. Data from the survey were then used in an economic model of the farmers' production behavior. In a second part of the dissertation, a model was used to analyze the effects of eliminating the current system of pan-territorial pricing and to determine how shipping costs and tariffs might affect the production of groundnuts and their sales destination. This chapter reviews the conclusions arrived at from these analyses in reference to the initial objectives and hypotheses from Chapter 1.

7.1 The Objectives of the Study

7.1.0 Introduction

This study had three objectives:

1) To examine the effects on Senegalese small-scale groundnut farmers of changes in the producer price of groundnuts and in prices of inputs.
2) To determine differences within the household in the Kaolack and Fatick regions of Senegal as to the production and commercialization of groundnuts and the availability and access to agricultural inputs.
3) To examine what would happen if the pan territorial price on the producer price of groundnuts were removed.

With each objective, several hypotheses were formed. The next three sub-sections will examine each objective and the attendant hypotheses.

7.1.1 Objective 1: Conclusions

To examine the effect changes in prices had on the behavior of small-scale groundnut farmers of changes, two hypotheses were posed:

a) *The supply of groundnuts and the supply of cereals are inelastic with respect to producer prices.*
b) *The quantity of agricultural inputs is price elastic.*

As discussed in Chapter 5, the survey data were unfortunately unable to shed light on either the supply elasticity of groundnuts and cereals or the demand elasticities of agricultural inputs and, as a result, could not fulfill the first objective of this study.

Attempts to answer questions about the farmers' responses to price changes proved impossible because the model formed to analyze the survey dataset was statistically inadequate for the assumptions underlying the analysis. When the assumptions behind the analysis are violated, any conclusion drawn from the data would be open to question. Problems with the data and what could have been done to achieve better results are address below.

Even if we were to ignore the statistical adequacy of the model, most equations being estimated either had very few significant coefficients, or many of the coefficients that were significant had signs running counter to basic economic theory.

With a statistically inadequate model and so few significant coefficients, nothing meaningful could be said about the price elasticity of either the output supply or the input demand curves. Thus neither of the two hypotheses associated with the first objective of this study could be confirmed or refuted.

7.1.2 Objective 2: Conclusions

To determine differences within the household in the Kaolack and Fatick regions of Senegal as to the production and commercialization of groundnuts and the availability and access to agricultural inputs, three hypotheses were considered:

a) *There are no differences between men and women and between the household head and other adult males in the price they receive for groundnuts.*

As shown in Chapter 3, the data showed that there was no significant difference between the average price women and men received for their groundnuts, regardless of whether they sold them on the official or on the open market. Women did receive significantly less money on average than the men, reflecting the fact that they sold fewer groundnuts than men. Thus, women earned less money from the sale of the household's major cash crop.

Although women controlled fewer groundnuts fields than did the household head and men in general, they controlled essentially the same number of fields (on average, one field) as the *navetanes* and *sourgas*.

Women in the survey region participate in all aspects of agricultural activity within the households. They control and market groundnuts, the major cash crop in the region. The fact that women control fewer groundnut fields and sell fewer groundnuts may reflect the fact that women have primary responsibility for raising children, cooking meals, and general care of the household. Also, women control a higher percentage of the "other" crop fields, often vegetable gardens close to the house. Although the survey did not concentrate on eliciting gender-specific differences, there is no compelling evidence that the problems faced by women in the survey are appreciably different from those faced by other household members.

b) Access to agricultural equipment and other inputs affects the production and sale of groundnuts among the various groups who comprise the household.

Whether there was any difference between household members, especially between the CE and the CMD, in their access to equipment and other inputs, their own perceptions, as described in Chapter 3, do not support this conclusion. For example, just over forty-four percent of the CEs felt a lack of seed was the main reason for any decline in groundnut production. Forty-seven percent of the CMDs felt the same way. For fertilizer, the percentages were nineteen for CEs and twenty-five for CMDs. For material or equipment the percentages reversed, as eighteen percent of CEs felt that the lack of material or equipment was the main reason for any decline in groundnut production, while only sixteen percent of the CMDs felt that way. At least by their own perceptions, the differences in access to equipment and other inputs was not very different for these two different household members.

Certainly, more CEs than CMDs own agricultural equipment. More than three-quarters of the CEs own a seeder or a hoe or both. In contrast only twenty-nine percent of the CMDs own a seeded and only thirty-five percent own a hoe. Sixty-eight percent of the CEs own a cart versus only twenty-three percent of the CMDs.

CEs also own more animals than do CMDs. Eighty-seven percent of the CEs own a horse, and over half own more than one. For CMDs, these percentages are thirty-five and seven.

The differences in access to equipment and animals led to differences in the time of planting. Whereas seventy-one percent of the CEs planted immediately after the first significant rain, only fifty percent of the CMDs did so. By the end of a week (excluding those farmers who did not answer), ninety-two percent of the CEs and eighty-nine percent of the CMDs had begun planting.

Interestingly, again among the farmers who responded, almost three times as many CMDs than CEs had finished seeding in three days. After six days over three quarters of the CMDs had finished versus only forty-six percent of the CEs.

7.1.3 Objective 3: Conclusions

To examine what would happen if the pan territorial price on the producer price of groundnuts were removed, two hypotheses were considered:

a) *If the groundnut market is liberalized and farmers are allowed to sell their product on the open market, farmers in places distant from the oil mills or major population centers will receive less for their groundnuts.*
b) *Eliminating pan-territorial pricing will have a net positive benefit to society as a whole.*

As described in Chapter 6, the model examining the liberalization of the groundnut market indicates that farmers in locales far from the oil mills or commercial markets will receive less for their groundnuts than will farmers living close to the mills or markets. Thus, comparatively, farmers in remote areas will be less well off than their less remote fellow citizens. Although this is not a surprising result, decision makers need to consider these negative effects on some of the farmers.

The differences in prices paid to the farmer are caused by the fact that transportation costs will no longer be borne by the parastatal buyers. Because of these transportation costs, in general, groundnuts will be shipped from producing regions to more near-by markets.

Although the elimination of the policy of pan-territorial pricing will affect different regions differently, the benefits to society of allowing the market to operate will be positive. This result is due mainly to the large reduction in the cost of transportation due to the more efficient movement of groundnuts.

The model, however, does not tell the whole story. The analysis is at the region level and does not consider the impact on a particular farm. As this author personally observed, some villages are a considerable distance from the main roads. These villages may receive far fewer visits from potential buyers than the more accessible villages. Thus farmers in these villages may not be able to take advantage of the competition envisioned in the liberalization of the groundnut market. Unable to transport their groundnuts to a central market and uncertain about the number of potential buyers who come to the village, as in the old official price systems, they may face a single buyer, but at a lower price than before.

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Appendix 1: Survey Questionnaire

ENQUETE SUR LA PRODUCTION ET LA COMMERCIALISATION
QUESTIONNAIRE ADRESSE AU CHEF DU MÉNAGE

N°. d'identification de l'exploitation:________

Date:______________________________

Enquêteur:________________________

Département:________________ Arrondissement:__________________

Communauté Rurale: __________________ Village:__________________

Répondant:____

Ethnie : __________
1 = Wolof
2 = Sérére
3 = Poular
4 = Autre (à préciser) __________

Statut: (1 = CE, 2 = CMD) _______________

Questions générales:

Combien de ménages existent dans l'exploitation? ______________

Comment appréciez-vous la pluviométrie de l'hivernage passé?

(1 = bonne 2 = mauvais 3 = moyenne)

Quantité ______________

Répartition dans le temps ______________

N°. d'identification de l'exploitation:________
N°. d'identification du ménage:________

La colonne *"nombre de parcelles"* est le nombre de parcelles contrôlé directement par le personne indiquée à gauche pour l'hivernage passé.

Adultes du ménage qui allaient aux champs l'hivernage passé	**Nbre.**	**Nombre de Parcelles**		
		Arachides	**Céréales**	**Autres**
Chef du Ménage				
Femmes adultes (plus de 15 ans et dépendant directement du CM)				
Navétanes				
Sourgas (plus de 15 ans et dépendant directement du CM)				
Mbindanes		XXX	XXX	XXX

	Hommes	**Femmes**
Adultes du ménage qui n'allaient pas aux champs l'hivernage passé		
Enfants jusqu à 15 ans et directement à la charge du CM		

N°. identification d'exploitation:________

N°. identification du ménage:________

Intrants Agricoles Utilisés en 1997 dans le Ménage

Culture	Type de Sol*	Semences						Fongicide		Fumier	Engrais Chimique	
		N1		N2		Ordinaires						
		Qté kg	Valeur fCFA	Qté kg	Valeur fCFA	Qté kg	Valeur fCFA	Qté g	Valeur fCFA	Nbr. de Charrettes	Qté kg	Valeur fCFA
Arachide de bouche												
Arachide huilerie												
Arachide semence												
Mil												
Sorgho												
Maïs												
Niébé												
Coton												
Légumes												
Pastèques												
Autres (spécifier)												

* Type de Sol: 1 = Deck 2 = Dior 3 = Deck-dior 4 = Champ de case 5 = Bas fond

Nombre de jours entre la première pluie utile et votre premier semis d'arachide en 1997 ____________

Si il y a décalage, quelle en est la raison? ____

Nombre de jours entre votre premier semis et votre dernier semis d'arachide en 1997 ____________

N°. d'identification de l'exploitation:________
N°. d'identification du ménage:________

Productions agricoles et vente des récoltes du ménage

Culture	Production Totale en kg	Pour la Consommation	Réservée pour semences	Remboursement en nature	Déjà Vendue Qté	Déjà Vendu Valeur	À vendre	Autres
Arachide de bouche								
Arachide huilerie								
Arachide semence								
Mil								
Sorgho								
Maïs								
Niébé								
Coton								
Légumes								
Pastèques								
Fanes arachide								
Autres (spécifier)								

N°. d'identification de l'exploitation:________

N°. d'identification du ménage:________

Commercialisation de la récolte du Ménage dans le Marché Libre

	Culture	Statut	Qté	Valeur	Distance point de vente	Coût de transport	Autres Coûts*
A	Coque sèche	CM					
		HD					
		F					
r	Décortiquée et triée	CM					
		HD					
		F					
a	Décortiqués mais non triée	CM					
		HD					
		F					
c	Vert	CM					
		HD					
		F					
h	Sax-sax	CM					
		HD					
		F					
i	Kg sax-sax triturés	CM					
		HD					
		F					
d	Kg sax-sax transformés en dégué	CM					
		HD					
		F					
e	Kg graines triturés	CM					
		HD					
		F					
	Kg graines transformés en dégué	CM					
		HD					
		F					

*** Spécifiez les autres coûts de commercialisation**

____

____

Principal mode de transport utilisé: ______________

1 = Charrette personnelle ou empruntée
2 = Charrette louée
3 = À pied
4 = Transport en commun (automobile)
5 = Autres (à préciser) ______________________

N°. d'identification de l'exploitation:________
N°. d'identification du ménage:________

Commercialisation des Arachides et du Coton du Ménage dans le Circuit Officiel

Culture		Statut	Qté	Valeur	Distance point de vente	Coût de transport	Autres Coûts*
Arachide	de bouche	CM					
		HD					
		F					
	Huilerie	CM					
		HD					
		F					
	Semences	CM					
		HD					
		F					
COTON		CM					
		HD					
		F					

Spécifiez les autres coûts de commercialisation

____
____
____
____

Principal mode de transport utilisé: ______________

1 = Charrette personnelle ou empruntée
2. = Charrette louée
3 = À pied
4 = Transport en commun (automobile)
5 = Autres (à préciser) ____________________

N°. d'identification de l'exploitation:________
N°. d'identification du ménage:________

Dépenses du Ménage au cours des 30 deniers jours

Date: ______________________

Produits agricoles		
Poste de dépense	**Qté (avec unités)**	**Dépense**
I. Céréales		
riz		
maïs		
mil /sorgho		
II. Autres denrées Alimentaires		
poisson frais		
poisson fumé		
condiments		
Produits non agricoles		
III. Habillement		
IV. Habitation		
V. Savon plus effets de toilette		
VI. Energie		
bois de chauffe /charbon		
gaz		
pétrole		
VII. Transport		
VIII. Education, scolarité		
IX. Frais médicaux		
X. Cérémonies familiales		
baptêmes		
mariages		
funérailles		

N°. d'identification de l'exploitation:________
N°. d'identification du ménage:________

Postes de dépense	**Qté (avec unités)**	**Dépense**
XI. Stockage et traitement des stocks de produits		
XII. Taxes		
impôts		
diouty		
XIII. Dons en argent		
XIV. Achat animaux de trait et équipements agri		
XV. Achat autres animaux		
XVI. Divers (spécifier)		
Montant de votre épargne liquide actuelle →		

N°. d'identification de l'exploitation:________
N°. d'identification du ménage:________

Autres Sources de Revenus du ménage au cours des 30 derniers jours

Source	Qté vendu	Unités	Valeur
Vente Ovins/caprins			
Vente Bovins			
Vente Équins			
Vente Asins			
Vente Volaille			
Vente Oeufs:			
Vente Lait:			
Artisanat:			
Pêche			
Cueillette			
Vente fruits sauvage			
Vente fruits domestique			
Bois de chauffe			
Bois de service			
Chasse			
Autres:			

N°. d'identification d'exploitation:________
N°. d'identification du ménage:________

Equipement et animaux de traction appartenant au ménage

Equipement	**Nombre**
Semoirs	_______
Houes	_______
Araras	_______
Charrues	_______
Charrettes	_______
Tracteurs	_______
Chevaux	_______
Anes	_______
Bovins	_______

Si votre production d'arachide a baissé les derniers trois années, quels sont par ordre les principaux facteurs explicatifs autres que la pluie ?

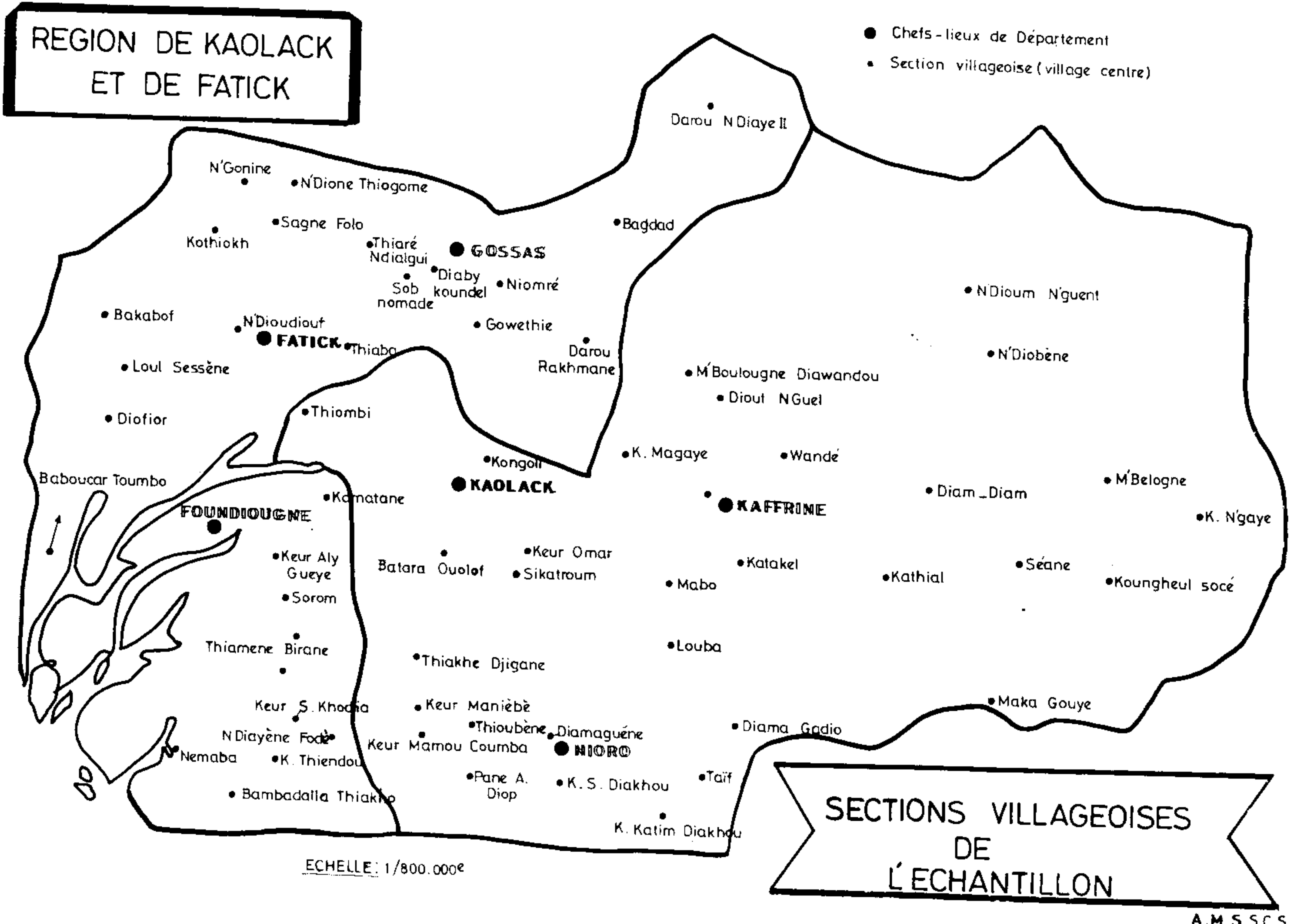
Premier __________ Deuxième __________ Troisième __________

1. Manque de semence
2. Manque d'engrais
3. Manque de matériel
4. Manque de main d'oeuvre
5. Epuisement des sols
6. Problèmes phytosanitaires
7. Préférence pour d'autres cultures ou activités (lesquelles)
8. Autre (à préciser)

Combien de membres du ménage résident actuellement ailleurs ?

au Sénégal __________
dans d'autres pays __________

Appendix 2: Map of Regions of Kaolack and Fatick


REGION DE KAOLACK ET DE FATICK
Chefs-lieux de Département
Section villageoise (village centre)
Darou N Diaye II
N'Gonine
N'Dione Thiogome
Sagne Folo
Kothiokh
Bagdad
Thiaré Ndialgui
GOSSAS
Diaby koundel
Sob nomade
Niomré
N'Dioum N'guent
Bakabof
N'Dioudiouf
FATICK
Thiaba
Gowethie
Darou Rakhmane
N'Diobène
Loul Sessène
M'Boulougne Diawandou
Diout N Guel
Diofior
Thiombi
K. Magaye
Wandé
Kongoli
Baboucar Toumbo
KAOLACK
KAFFRINE
Diam_Diam
M'Belogne
Kamatane
FOUNDIOUGNE
K. N'gaye
Keur Aly Gueye
Batara Ouolof
Keur Omar
Sikatroum
Katakel
Mabo
Kathial
Séane
Koungheul socé
Sorom
Thiamene Birane
Louba
Thiakhe Djigane
Keur S. Khodia
Keur Maniébè
Maka Gouye
N Diayène Fodé
Thioubène
Diamaguéne
Diama Gadio
Nemaba
K. Thiendou
Keur Mamou Coumba
NIORO
Pane A. Diop
K.S. Diakhou
Taïf
Bambadalla Thiakho
K. Katim Diakhou
ECHELLE: 1/800.000e
SECTIONS VILLAGEOISES DE L'ECHANTILLON
A.M.S.S.C.S

VITA

James Katon Gray (Jim), son of Ruth Simpson Hart Gray and the late Corbelle Katon Gray, was born September 28, 1945 in Norfolk County, Virginia. He is married to Linda Lee Howell Gray (Lyn), and they have a son, Rafael Antonio.

Mr. Gray graduated from Thomas Jefferson High School in Richmond, Virginia in 1963. He was awarded a Bachelor of Science degree in Mathematics (1967) from Randolph-Macon College in Ashland, Virginia and a Master of Arts degree in Economics (1978) from Georgetown University in Washington, DC.

Mr. Gray was a Peace Corps Volunteer in Liberia from November 1972 until April 1976. He has also worked long-term in Zaïre, Niger, and Somalia. Liberia remains a special interest. Mr. Gray has served as an officer in the non-governmental organization, Friends of Liberia (FOL) <*www.FOL.org*>. In 1997, he returned to Liberia to observe the Special Election held after almost eight years of civil war.