Farm-Household Analysis of Policies Affecting Groundnut Production in Senegal

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(ABSTRACT)

Since Senegal's independence in 1960, groundnuts (peanuts) have been the dominant agricultural export crop. Currently, groundnut output levels are on the decline and no clear reason for the downward trend has been found. Privatization efforts are underway as the government explores ways to breathe some life into the ailing sector, particularly as it relates to groundnut production. The 50 percent currency devaluation of 1994 constituted a major exogenous shock to the sector.

Much research has been done about the macro-level impact of the changes that are taking place. However, little work has been done recently (i.e. since the devaluation) at the micro-level. This work addressed this lack by studying the micro-level dynamics of groundnut production. Elasticities were generated and used in the analysis of policy impacts on production. The own-price elasticity of supply groundnut indicated that supply response should be positive following an increase in producer price. The increase in producer prices following the devaluation did not occasion the expected supply response. Possible reasons for this failure were explored.

It is hoped that the information revealed will complement the store of information on production in the Groundnut Basin that is already available. Thus, the present work will prove useful to public and private researchers and policy makers seeking to increase their understanding of the sector.

DEDICATION

I dedicate this thesis to Thierno Ly, Ahmadou Sall, and Cheikh Diouf, the three ISRA-Kaolack agents who worked tirelessly to collect the data for this research. Without their dedication to the project, this study could not have been completed.

From participating as much as I did in the data collection process, I have come to have much respect for the work that these agents do. The conditions in which they work are often physically taxing and sometimes frustrating due to resource constraints, yet they continue on with the work.

This study is dedicated as well to all whom are engaged in this important, yet often thankless job of data collection in Sub-Saharan Africa. They are the key to a better understanding of, and the development of better solutions to the unique problems faced by farmers in the sub-region.

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ACRONYMS

FCFA	Communauté Financière Africaine Franc (African Financial Community Franc)
CNCAS	Caisse Nationale de Crédit Agricole du Sénégal (Senegalese National Bank for Agricultural Credit)
ISRA	Insitut Sénégalais de la Recherche Agricole (Senegalese Institute of Agricultural Research)
NOVASEN	Nouvelles Arachides de Sénégal (New Groundnut of Senegal)
NPA	Nouvelle Politique Agricole (New Agricultural Policy)
ONCAD	Office National de Commercialisation et d'Assistance pour le Développement (National Service for Commercialization, Support and Development
SONACOS	Société Nationale de Commercialisation des Oléagineux du Sénégal (National Company for the Commercialization of Oil Products of Senegal)
SONAGRAINES	Société Nationale d'Approvisionnement en Graines (National Grain Supply Company)
SONAR	Société Nationale d'Approvisionnement du Monde Rural (National Supply Company for the Rural Sector)
USAID	United States Agency for International Development

Chapter One : Introduction

1.1 Problem Statement

All countries are subject to exogenous economic shocks. Some countries adapt well to these shocks while others experience periods of adjustment and readjustment. Developing countries often fall into the latter category due to the financial difficulty of absorbing the shocks. Since gaining independence in 1960, Senegal's economy has been relatively unstable. The economy has been heavily dependent on one export crop, groundnuts, for foreign exchange earnings (Economist Intelligence Unit, (EIU), 1994). This dependence has maintained the economy's vulnerability to external shocks to the agricultural sector when groundnut oil prices have declined or adverse weather conditions have been experienced. Efforts are now being made to diversify and so increase the economy's ability to absorb these shocks. Nonetheless, groundnuts remain the major cash crop for the country (Pison et al., 1995).

Currently, groundnuts are the second-ranked export commodity behind fish products (EIU, 1996). Forty percent of cultivated land is used to produce groundnuts, with as many as one million people involved in the process (EIU, 1996). "The level of groundnut output has an impact throughout the economy as groundnut processing is one of the leading industries" (EIU, 1996). The government is involved in all major aspects of groundnut production from input supply, to marketing, to producer price received (EIU, 1994). Recent policies to liberalize markets and reduce government intervention have not been rigorously applied to the groundnut sector where producer prices are still controlled by the government (Pison et al., 1995). The impact of pricing policies, including the removal of input subsidies, and of the 1994 50 percent devaluation of the Communauté Financière Africaine franc (FCFA) on groundnut production is important to Senegal as the industry remains one of its important sources of foreign exchange earnings. However, these impacts cannot be reliably assessed without dependable data on the agricultural sector.

A literature review of Senegal's economic and political situation shows that the government agencies lack reliable statistics on the groundnut industry in Senegal. Plagued with increasingly adverse terms of trade and financial problems, the government has historically devoted few resources to gathering aggregate price and quantity data for the agricultural sector. This renders impossible attempts to analyze policies affecting groundnuts in Senegal using time series data, limiting the researcher to the use of cross-sectional data. However, review of the literature also indicates that there exists no reliable source of primary, cross-sectional input and output data. Therefore, there is a need to gather information on production and inputs at the farm-level if modeling of policy impacts is to be completed.

In the last five years, there has been a concerted effort by the government to increase and improve statistical data collection, but it will be some time before enough reliable time-series data are available for econometric analysis. Because data have been lacking, there is little information on input demand and on output supply response for the groundnut industry in Senegal. Consequently, little information is available to policy makers trying to assess the impacts of government policies on groundnut production. This is a crucial lack given the government's goal of increased agricultural production, in part to generate increased export earnings (FAO Étude Législative, 1992).

There is a need to determine price elasticities of output supply and input demand in the agricultural sector. This information can guide policy makers in formulating appropriate agricultural policies regarding marketing, input supply, and producer prices.

1.2 Objective

The primary objective of this thesis is to generate output supply elasticities for groundnuts and associated crops in rotation and to generate input demand elasticities for inputs into farm-level production in Senegal's Groundnut Basin. A secondary objective is to illustrate how these elasticities can be used to estimate the production impacts of exogenous shocks such as the 1994 currency devaluation as well as to facilitate government policy decisions.

1.3 Hypotheses:

1.3.1 Maintained Hypotheses

I) Producers are profit maximizers

II) Homogeneity and symmetry conditions hold for the input demand and output supply functions.

1.3.2 Testable Hypotheses

I) Demand for cash purchases of fertilizer inputs is elastic with respect to price.

II) Demand for purchased labor inputs is highly inelastic with respect to price.

III) Supply of groundnut is inelastic with respect to producer price.

IV) Supply of millet is inelastic with respect to producer price.

The results of the tests of the above hypotheses had implications for pricing policies, taxes, and other methods of government intervention that seek to increase production and increase self-sufficiency in foods. The results also helped to more reliably quantify the impact that exogenous shocks such as the 1994 devaluation have had on production in the Groundnut Basin.

1.4 Methods

A farm-level survey of households in Senegal's Groundnut Basin was conducted in order to estimate output supply functions/elasticities for the groundnut and associated crops in rotation and input demand functions/elasticities for labor, seeds, and fertilizer inputs.

The research proceeded in four steps.

Step 1:

Key agricultural inputs and outputs in the Groundnut Basin were identified and a profit function model of farm households was developed. The input demand and output supply functions were derived from the profit function. This step helped to identify the variables for which data needed to be collected during the farm-level survey.

Step 2:

A representative survey of farm households in the central region of the Groundnut Basin was conducted in order to obtain data to estimate the model and to determine the input demand and output structure of the farms. Among the information gathered at the farm level were data on: the types of crops planted, the acreage devoted to each crop, and the output for each crop; the prices that farmers received for the crops that were sold; the quantity of inputs used in production and the prices that farmers paid for purchased inputs; wages rates paid; and information on environmental factors (e.g. soil type). Aggregate information on the corresponding official prices of the inputs and outputs as well as information on relevant pricing policies constituted the secondary data used in this study.

Step 3:

A system of input demand and output supply functions was estimated using Seemingly Unrelated Regressions. Output supply and input demand elasticities were then derived using the coefficients from the estimated system.

Step 4:

Hypotheses were tested. The targeted audience of this research are policy analysts and policymakers in Senegal. Farmers should ultimately benefit from the improved agricultural policies that result when the formulation of these latter is based on a clearer understanding of the dynamics of groundnut production.

Chapter Two : Literature Review

2.1 The Production Environment

2.1.1 General characteristics of the Groundnut Basin

The Groundnut Basin (GB) of Senegal is a vast area of rainfed production of groundnut and millet that stretches across five administrative zones, or *départements*. The GB covers about a third of Senegal's total land area and about three-fourths of its cultivated area.[1] Roughly two-thirds of Senegal's active population is found in the GB; they are responsible for producing 80 percent of the country's exportable groundnut crop and 70 percent of the country's total cereal crop. Currently, annual groundnut production is approximately 600-800,000 tons and national cereal production is holding steady at 1,000,000 tons.

The southwest, central, and southeast parts of the GB are generally thought to be the most productive areas. The data for the present work were collected in the central part of the GB, in the administrative regions of Kaolack and Fatick.[2] Twenty-seven percent of the population live in these two administrative regions which together cover approximately 12 percent of the country's total land area and are responsible for more than half of the country's total groundnut and millet production.[3]

In the southwest region of the GB, rainfall ranges from 500 to 700mm per year and the rainy season lasts about four months, from July to October.[4] This south-west region is considered to be among the better-developed areas in terms of infrastructure and not surprisingly, the population density is one of the highest in the GB. The soils are sandy, ferric, and leached. The vegetation is mostly wooded savanna.

According to the survey (Kelly et. al. 1996) from which this section draws heavily, the average family size is 8.15 adult equivalents. Neither manure nor fertilizer are used by farmers on the majority of their fields. This is especially true of groundnut fields: manure is not typically

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[1] Kelly et. al. (1996), Diagana et. al. (1996), and Claasen and Salin (1991).
[2] See Appendix A for a map of Senegal
[3] Personal communication from Matar Gaye, Researcher at ISRA-Kaolack.
[4] Kelly et. al. 1996.

used on groundnut fields as it aggravates pest problems and as will be seen later, the price of fertilizer is prohibitively high so that farmers do not use as much as they would like. Manure is used on cereal fields, though in insignificant amounts. Very little hired labor is used as most of the labor is supplied by the household. Seeding densities are higher than levels recommended by the *Institut Sénégalais de la Recherche Agricole* (ISRA) because farmers are attempting to compensate for the lack of fertilizer and the decline in soil quality while trying to maintain groundnut production levels.

2.1.2 Changes since the devaluation

In January 1994, as part of a policy move that affected the entire CFA franc zone, the CFA franc was devalued by half. Numerous studies have been conducted since the devaluation to determine the impact it has had on the households in the GB. The inflation that followed the devaluation posed the biggest challenge to households and according to some studies has lessened the positive effect that the devaluation was expected to have had on farmers' incomes.

A study conducted in 1994/1995 summarized the changes that have taken place in the production systems in the GB:[5] farmers surveyed indicated that following the devaluation, they reduced the area planted in millet because the devaluation provided an incentive to increase their groundnut output. The study found that from the 1993/94 season to the 1994/95 season, the area planted in groundnut had increased by 78 percent while the area planted in millet fell by 23 percent.[6] This increase in the area planted further deepens the mystery surrounding the downward trend in annual groundnut yield. The observed decline in groundnut yields cannot then be due to a decrease in the area planted but must be due to other, more subtle reasons. This important issue is discussed further in Chapters Four and Five.

2.1.3 Current production constraints

The environmental changes that are occurring in the GB are increasing the challenges that farmers have to deal with in the production of groundnut and millet. Farmers faced with erratic rainfall, decreasing soil fertility, and inadequate supply of inputs have to be ever more creative in making the most of their limited resources.

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[5] Diagana et. al. 1996 (I).

[6] Diagana et. al. 1996 (I).

A study conducted in the GB last year asked farmers to list the major constraints to production that they currently face.[7] Following are some of the constraints that were identified:

1) soil degradation due to wind erosion;
2) pests (i.e. nematodes and termites);
3) decreasing yields;
4) lack of availability of key inputs: seeds, fertilizer, agricultural equipment;
5) no food security;
6) lack of a Cereal Bank and of stock houses.

The constraints are interrelated and as complex as the possible solutions discussed. These solutions included:

1) increasing access to key inputs (organic and chemical fertilizer, seeds, equipment);
2) creation of cereal banks.

The farmers alone cannot solve these problems; nor can the public officials, working independently of the farmers, arrive at a feasible solution. A cooperative effort on the part of farmers, research and extension agents, public officials, and urban consumers (i.e. by agreeing to higher grain prices) will be required in order to arrive at an equitable and mutually beneficial solution to the production constraints enumerated above. Stepping back from the abstract, much can be accomplished under the present institutional setup by increasing public officials' understanding of the dynamics of income generation in the GB. The more accurate quantitative information that is available to policy makers, the more realistic the agricultural policies will be. The relevance and applicability of the policies will also increase the rate of adoption of the measures that are implemented to meet the policy goals.

The present-day policy environment has been influenced by past agricultural policies in the Groundnut Basin. In the next section the agricultural policy environment will be examined, from the colonial period to the present day.

[7] Plan d'amenagement et de gestion des terroirs de la communauté rurale de Diaoule. PGCRN. Septembre 1996.

2.2 The Policy Environment

2.2.1 The Colonial Legacy

Agricultural policy in Senegal during the colonial era was focused on increasing groundnut production and improving the technical aspects thereof. In the early 1800s, Governor Roger envisioned the government's role in agriculture as one of heavy involvement in the agricultural sector: the government was to conduct agricultural research, provide monetary advances for equipment, distribute seeds, provide economic incentives to farmers to increase productivity, and so forth.[8]

A policy of heavy government involvement in the agricultural sector made sense within the context of France's goal of essentially turning Senegal into a groundnut producing machine. Indeed, in 1850, Colonial Governor Protet claimed that groundnut production would "save the country".[9] Not surprisingly, with such a clear, narrow purpose in mind, the strategy of heavy government involvement was successful. Senegal became a major exporter of groundnuts. And even today Senegal remains the largest producer and exporter of groundnuts in West Africa.[10] Indeed, Senegal represents a "success story for the rapid transformation of a subsistence economy into an export-oriented, cash crop economy" (Kelly et. al. 1996: 12).

French colonial rule left the Senegalese economy heavily dependent on the revenue from groundnut exports. During colonial rule, there was little opportunity for the diversification of exports. However, in the post-colonial period, the government has not focused on diversifying export commodities, thus continuing the reliance on groundnut export revenue to finance the public sector. For a long time, Senegal's food strategy differed little from the pattern established during the colonial period: "1) specialization in producing and exporting groundnut products to finance cereal imports,... 2) heavy state involvement in agricultural production and marketing" (Martin and Crawford. *In* Delgado and Jammeh, 1991: 85). In the area of research and development, the government largely followed the historical pattern of favoring research on groundnuts. Consequently, the limited resources that the public sector invested into agricultural

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[8] Kelly et. al. (1996).

[9] Bonnefond and Couty. *In* The Political Economy of Senegal Under Structural Adjustment. Eds. Christopher L. Delgado and Sidi Jammeh.

[10] Claasen and Salin. (1991).

production were focused on increasing groundnut output, to the detriment of millet and rice production.

A comparison of the amount that is invested back into the agricultural sector with the revenue that accrues to the government from the export of agricultural commodities reveals that the government under-invests in the agricultural sector. One study has shown that the government has continued to extract heavily from the groundnut producers in the form of a low producer price received compared to the export price.[11] According to the study, the producer price received by groundnut producers from 1970-1985 typically varied between one-fourth to one-half of the export price. This low producer price could reflect high marketing costs, such as transportation costs. These costs are real costs and thus would lower the producer price received in relation to the export price of the good. If marketing costs are low, then the low producer price could reflect a transfer of resources in some way from the groundnut sector to the public sector as suggested by Claasen and Salin.

To aggravate the situation, the development of the industrial sector became a dominant concern while the development of the agricultural sector was considered to be of secondary importance. Thus, when funds were available for investment, the industrial sector was targeted as a recipient of these funds more often than the agricultural sector. Not surprisingly then, when record crops were realized and the terms of trade shifted in favor of groundnut production in the mid-1970s, the vast investment programs instituted by the Senegalese government were focused on industrialization projects:

> Factories were built in order to transform cotton into textiles, sugar cane into refined sugar, phosphates into fertilizer, fish into fishmeal, and groundnuts into oil products and feed cake. ... Given the record crops of groundnuts in 1974-1976, and the high international price of groundnut oil, Senegal expanded the refining capacity of its oil mills... (Claasen and Salin. 1991: 118).

However, the economic boom of 1974 was only short-lived and only two years later, the price of groundnuts returned to levels that were only slightly higher than their pre-1974 levels.[12] The purpose here is not to pass any value judgments on the actions taken by the government, but

[11] Claasen and Salin (1991).
[12] Claasen and Salin. (1991).

rather to illustrate how the development of the agricultural sector has historically been of secondary importance to the industrialization of the country.

2.2.2 The Period of Structural Adjustment

The 1980s witnessed an onslaught of agricultural policies designed to help the agricultural sector to regain its former vitality and economic robustness. One of the legacies of colonialism was the heavy government involvement in the agricultural sector. As noted in the first chapter, this policy involved the government in all major aspects of groundnut production: from input supply, to marketing, to the establishment of producer prices. The continuation of the pattern of centralized decision-making implicitly assumed the existence in the rural communities of “a sort of primitive mentality unable to make economic decisions”(Claasen and Salin. 1991: 59).

The agricultural polices of the 1980s attempted to correct for these mistaken views and curtail government involvement in the agricultural sector. Thus, the structural reforms of the 1980s were ideological as well as practical. As some authors have noted, the guiding principles of these reforms were to:

> 1) curtail direct government intervention in the agricultural sector while encouraging private sector actors (both commercial and cooperative) to fill the gap; and
> 2) eliminate government subsidies and taxes to the greatest extent possible (Kelly et. al. 1996: 18)

With this newfound ideology, the adjustments and readjustments began: the *Programme Agricole* was overhauled in 1980, the government introduced the New Agricultural Policy in 1984, and in 1986 came the Cereals Policy.[13] The reform of the *Programme Agricole*, the government’s vehicle for providing input credit to the farmers since 1960, involved the discontinuation of the supply of all equipment and fertilizer credit with the eventual elimination by the middle of the decade of the entire program.

The New Agricultural Policy (NAP) announced by the government redefined Senegal’s food strategy. No longer were groundnut production and heavy government involvement to be characteristic of the agricultural sector. These former objectives were replaced by the following objectives: an increase in the cereals self-sufficiency rate and the transfer of input and product marketing responsibilities from the public to the private sector.[14] Thus began a gradual phasing out of the government supply of inputs to farmers. As an example, government distribution of groundnut seed was significantly reduced in the 1985/1986 planting season and discontinued completely with subsequent seasons.[15] Such changes had impacts on the use of various production inputs. These impacts are discussed in the following section.

One of the main goals of the newly-revised agricultural policy was to reduce cereal imports and increase the production and consumption of local cereals such as millet and sorghum. The Cereals Plan was the government's vehicle for attaining a cereals self-sufficiency rate of 80% by the year 2000.[16] The government wanted to reduce the imports of rice from Asia as the cost of importing rice was on the rise. It encouraged the increased production and consumption of cereals by liberalizing cereal marketing for locally produced coarse grains.[17] In an attempt to make locally produced grains more attractive to consumers, the government invested in research to develop ways of reducing processing costs and consumer prices.

2.2.3 Evolution and Impact of Pricing Policies on production in the Groundnut Basin

The centralized nature of decision-making in the formulation and implementation of agricultural policy has been discussed above. This top-down approach was evidenced in the formulation of price policies in particular. As one author notes, "farmers cannot freely decide their cost structure and choices of techniques. Nor can they freely determine the diversification of their products according to relative prices" (Claasen and Salin 1991: 57). The government fixed the producer prices of various crops, from cash crops (groundnuts and cotton) to food crops (millet).

However, a major change occurred in 1980 with the new agricultural policy of increased liberalization. The government was still involved, though to a lesser extent, in setting the prices (or ceilings and floors for the prices) of various crops. The most significant changes were seen in the policies concerning the supply of major inputs into production in the GB. Fertilizer, agricultural equipment, seeds, and credit were all subjected to different rules governing their

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[13] Kelly et al. 1996.
[14] Martin and Crawford. In Delgado and Jammeh. 1991.
[15] Kelly and Delgado. In Delgado and Jammeh. 1991.
[16] Kelly and Delgado. In Delgado and Jammeh. 1991.
[17] Kelly et. al. 1996.

supply and accessibility to farmers. Input supply policy became as variable as the weather while the government sought the magic combination of policies that would increase cereal production and involve the private sector in the input and product marketing activities of the agricultural sector.

For instance, from 1980 to 1985, the *Société Nationale d'Approvisionnement du Monde Rural* (SONAR) which was created in 1980 to oversee the distribution of inputs to farmers, implemented a different set of credit, subsidy, and input distribution policies for each of the three major categories of inputs: seed, fertilizer, animal traction equipment.[18] Several authors have noted that the rules changed "with little warning... 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: 21).

The lack of stability of the policies pertaining to these key inputs are likely to have substantial impacts on input use and hence on output. The frequent changes in the input and producer price policies discourage the adoption of improved technology, be it agricultural equipment, improved seeds (i.e. certified) or fertilizer.[19] Indeed, since the policy changes of the 1980s, usage of these key inputs has been highly variable. Currently, credit is the least-employed method of procurement of inputs: for example, in the case of seed inputs, credit is used by thirty-one percent of the households, and only twelve percent of the seed used by farmers is acquired through credit.[20] In the following paragraphs, the impact of the unstable policy climate on the use of each of the three inputs is examined more closely.

Since the elimination of the *Programme Agricole* credit program, the price of agricultural equipment has become prohibitively high. A program, begun in 1987 by the *Caisse Nationale de Crédit Agricole du Sénégal* (CNCAS), was not able to resurrect the demand for agricultural equipment.[21] Presently, animal traction equipment is available on credit to only a limited number of farmers who have contracts with *sociétés d'encadrement*.[22] Most farmers have turned to reconditioned equipment which costs considerably less than factory-made equipment and the

[18] Ibid. p. 21
[19] Diagana et. al. 1996 (II). p. 1
[20] Kelly et. al. 1995.
[21] Kelly et. al. 1996.

increased demand has provided much employment for local blacksmiths.[23] In the short-run, using reconditioned equipment seems to provide a way to avoid the purchase of factory-made equipment which is generally too expensive to procure. Farmers earning an average of 30-50,000 CFA francs annually per adult equivalent are unlikely to spend 60,000 CFA francs to purchase factory-made equipment when the reconditioned equipment sells for 10-15,000 CFA.[24]

However, reconditioned equipment cannot be reconditioned indefinitely. Eventually, the farmers are going to need new equipment. "At some point local blacksmiths will have to learn how to manufacture traction equipment from scratch at lower costs than the factories, or there will have to be some 'new blood' pumped into the system from factory production to maintain the flow of reconditioned equipment" (Kelly et. al. 1996: 21). Indeed new survey evidence indicates that farmers are already feeling the need for new and better equipment. A survey different from the survey discussed at the beginning of section 2.1.3 also asked farmers to rank their production constraints in the order of decreasing importance.[25] In this survey, farmers cited inadequate animal traction equipment as second in importance only to the lack of groundnut seed. The impact of a recent reduction in the price of agricultural equipment has not significantly increased the sale of agricultural equipment. Farmers are still of the opinion that the price of factory-made agricultural equipment will always be prohibitively high.

Chemical fertilizer use in the GB also dropped drastically with the policy reforms of the 1980s. These policy reforms were intended to reduce the high rate of default on loans.[26] The reforms went from a temporary suspension of credit-supply programs, to a *retenue* tax system and to the eventual elimination of the fertilizer subsidy.[27] With the elimination of the subsidy, the price of fertilizer increased, as expected. During this period, the government attempted to privatize the supply of fertilizer. From 1986 through 1989, USAID/Senegal funded a

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[22] Diagana et al. 1996 (II). *Sociétés d'encadrement* can loosely be described as regional extension agencies. They provide extension and support services to farmers. [Personal discussion with Matar Gaye, Researcher at ISRA]
[23] Kelly et. al. 1996.
[24] Kelly et. al. 1996.
[25] Kelly et. al. (1996).
[26] Kelly et. al. (1996).
[27] Diagana et. al. 1996 (II). The *retenue* tax system was instituted when the government-run distribution of seeds was eliminated. Under the *retenue* system, the government would withhold a given percentage of the proceeds from farmers' groundnut sales. The revenue from the tax would then be used to finance the distribution of seeds

progressively declining fertilizer subsidy for the cash sale of fertilizer by the private sector to farmers.[28] This policy failed to reverse the downward trend of fertilizer sales because farmers faced liquidity constraints that made them unable to purchase fertilizer with cash.

Following the currency devaluation of 1994, the price of fertilizer increased again. Studies have suggested that the reason why farmers are not using fertilizer may have more to do with demand than with liquidity constraints. The relative profits associated with using fertilizer versus not using fertilizer may not be perceived to be high enough to warrant the investment in fertilizer.[29] Another reason that has been advanced for the low level of fertilizer use is that it makes better economic sense to buy groundnut seed than to buy fertilizer. Recent surveys have shown that farmers preferred to purchase groundnut seed rather than fertilizer, given the cost/return ratios they faced in the 1980s and 1990s.[30]

This tendency may have its advantage in that the environmental dangers related to the overuse of fertilizer will be averted. However, the sacrifice may be dear in terms of foregone output and revenue as there is evidence to suggest that "fertilizer has a positive contribution to make in zones with adequate rainfall, *if it is used regularly every year*" (Kelly et. al. 1996: 25).

Groundnut seed, as the major input into a commodity that is very important to the Senegalese economy, was the last input to have its distribution system wrested from the control of the public sector.[31] The most significant change in the new agricultural policy was that farmers were encouraged to build up their personal reserves of groundnut seeds and rely less on government supplies of certified seeds.[32] These higher quality certified seeds are supplied by the government through the *Société Nationale d'Approvisionnement en Graines* (SONAGRAINES). During the 1985/86 season, the government supplied seeds to farmers for the last time because the groundnut seed program could no longer be maintained with the proceeds from the retenue tax.[33] Seed storage therefore has become the most common mode of procuring seed for the next season: 84 percent of households have seed stocks that account for 63 percent of the seeds

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during the following season. This system was a sort of intermediate step as the government moved towards a complete phase-out of the public distribution of groundnut seeds.

28 Kelly et. al. 1996.

29 Diagana et. al. 1996 (I).

30 Kelly et. al. 1996.

31 Kelly et.al. (1996).

32 Diagana et. al. 1996 (II)

33 Kelly et. al. 1996.

planted during the season.[34] However, the storage of seed is not without its difficulties. Farmers have found it difficult to stock adequate quantities of seed as they have had to deal with the temptation to eat or sell the seeds when emergencies arise; they are also faced with the problem of protecting their stocks against insects.[35]

Most studies estimate that about a third of the farmer's stock of seed should be replaced with the higher quality certified seed every year in order for the farmer to maintain the quality of the seed stocks. A recent study revealed that the replacement rate did not exceeded 11 percent in the last cropping seasons and that 70 percent of farmers interviewed blamed their poor groundnut yields on the low replacement rate (i.e. poor quality) of their seed stocks.[36] According to the farmers, the main constraints to achieving an acceptable replacement rate are that there is a limited availability of credit to procure certified seeds and the prices of certified seeds that are supplied by SONAGRAINES are prohibitively high.[37]

On the other hand, the seed supply for millet is not problematic. Millet and sorghum seeds are usually stored by the farmers themselves. They reserve the best seeds from each harvest for storage.[38] The cost of production and the seeding densities are low when compared with groundnut production. Therefore farmers are not as constrained in millet/sorghum production.[39] The timely and regular procurement of quality inputs, especially groundnut seeds, plays a vital role in ensuring that farmers are able to maintain profitable levels of output.

Policy has played and will continue to play a role in shaping and defining the rural environment. It is therefore imperative that policymakers are able to rightly determine the impact of their policies on the economic indicators in the GB: producer price of groundnuts, producer price of millet, and the price of key inputs. Quantitative information on the GB facilitates efforts to gain a better understanding of the impact of policy on the economic indicators. The present work will add to the store of information that is available through the generation of input demand and output supply elasticities for groundnut and associated crops based on a farm-level survey of 150 households in villages throughout the GB. It is hoped that such information will be of use to

[34] Kelly et. al. 1995.
[35] Kelly et. al. 1996.
[36] Diagana et. al. 1996 (II).
[37] Kelly et. al. 1996.
[38] Kelly et. al. 1996.
[39] Kelly et. al. 1996.

policymakers as they search for the right mix of policies that will increase the viability of the agricultural sector.

Chapter Three : Methodology

3.1 Conceptual Framework

Duality theory provides an appropriate conceptual framework for analyzing output supply and input demand response. Output supply and input demand functions are derived from the solution of the unconstrained profit maximization problem. The dual profit function is a function of input and output prices and other fixed and environmental factors. The derived input demand and supply functions depend only on prices and on these factors. The dual profit function can thus be estimated directly from price and output data. This dual profit function in turn provides much needed information about supply and demand elasticities (Young *et al*).

Theory clearly indicates that input demand functions should slope downward; an increase in input price resulting in a decrease in the quantity demanded of the input. The magnitude of the fall in quantity demanded is quantified using information on the elasticity of input demand; thus, there is a need to generate these elasticities in order to get a clearer picture of the impacts of pricing policies on demands for inputs and ultimately on production.

Output supply functions have a nonnegative slope with respect to output price. An increase in the price of a good, such as has been observed with the devaluation of the FCFA, would thus suggest an increase in the supply of the good. The magnitude of the increase in supply will depend on the elasticity of the supply function, such as will be estimated here. The supply function is inversely related to the price of inputs. Pricing policies that inflate input prices can thus be expected to adversely impact on the supply of the affected crops. The elasticity of the supply function is a crucial tool for determining the size of such impacts on quantity produced.

Both input demand and output supply functions are homogeneous of degree zero in input and output prices so an increase of equal proportion in all input and output prices will affect neither function. Thus, if the increase in producer prices and any observed increase in input prices brought on by the devaluation or by other pricing policies are of equal proportion, the effect on supply will be negligible and the pricing policy would have had little effect on increasing production.

The 1994 devaluation of the FCFA will be analyzed later. As one author has observed, “various studies have attempted to measure the macroeconomic impact of the CFA devaluation, but the micro-level still remains underinvestigated" (Diagana 1995: 2). An analysis of the impact of the devaluation will thus attempt to fill this void. The conceptual framework for analyzing the impacts of devaluation are provided by Dione et al. (cited in Diagana, 1995) and in Diagana et al. 1996 (I).

Devaluation usually favors a rise in a country's exports because its goods are now cheaper for other countries to procure. Import-substitution is also encouraged in the country whose currency has been devalued as imports are now more expensive due to the decreased purchasing power. In addition, domestic prices are expected to increase in response to the decreased purchasing power of the currency. In Senegal, this has largely been the experience. Consumer prices shot up in the period immediately following the devaluation. Imports of rice also fell, to the benefit of locally grown grains such as millet. The competitiveness of the groundnut crop was expected to rise in the wake of the devaluation.

The hope was that the increase in groundnut exports would allow for an increase in the producer price received. Added to this, the import-substitution that would increase the competitiveness of indigenous cereals, and the devaluation should have increased the incomes of rural households. The increase in incomes was in turn expected to encourage households to invest in improved technologies that would increase production.

The task of quantifying the impact that pricing policies (as well as the devaluation) have on input demand and output supply is made much easier when information on elasticities of output supply and input demand are available. In the next section, the methods to be used in estimating the input demand and output supply functions will be discussed.

3.2 Methods

3.2.1 Model

Input demand and output supply elasticities will be calculated from coefficients of the estimated input demand and output supply equations. Each will be a function of the *same* set of independent variables, P_i's and Z's. The price variables are normalized variables: they are all normalized on the price of millet seed. The output supply and input demand equations will be of the form:

$$Y_i = f\,(P_1, P_2, P_3, \ldots P_n, Z),$$

$X_i = f\,(P_1, P_2, P_3, \ldots P_n, Z)$,

where,

Y_i's are the output quantities;

X_i's represent the input quantities used;

P_n's represent the normalized prices of the outputs as well as of the inputs used; and

Z's stand for the fixed environmental variables: land, family labor, insecticide dummy, index of soil quality, and the expenditure on procuring or maintaining capital. These variables will be discussed in detail in section 3.2.4.

These functions will be generated from the optimization of the quadratic variable profit function:[40]

$$\Pi = \sum_{i=1}^{8} \alpha_i P_i + \tfrac{1}{2} \sum_{i=1}^{8} \sum_{k=1}^{8} \varphi_{ik} P_i P_k + \sum_{i=1}^{4} \beta_j Z_j$$

$$+ \tfrac{1}{2} \sum_{j=1}^{4} \sum_{t=1}^{4} \gamma_{ik} Z_j Z_t + \sum_{i=1}^{8} \sum_{j=1}^{4} \rho_{jk} P_j Z_i$$

In the estimation of the system of input demand and output supply equations above, the possibility cannot be ruled out that the disturbances in the different equations are correlated. That is,

$E[\varepsilon_i \varepsilon_j] = \sigma_{ij} I$,

where i = j = (1, 2, … 8) and I is the n x n identity matrix.

3.2.2 Theory

Least squares estimators are unbiased and efficient estimators of the regression coefficients when the assumptions of the classical normal linear regression model hold. However, in the case where there is extra information relating to the regression equation and the variables that is not included in the model specification, these estimators lose their robust properties.

An example of the "extra information" would be the case where there is a correlation between the disturbance in the regression equation under consideration and the disturbance in another regression equation. More specifically, a shock to the demand for groundnut seed input could occur and the change in demand for groundnut seed would in turn affect the supply of groundnut. Thus, the error terms in the equation for groundnut seed input demand and groundnut output supply are correlated.

Here, the method of choice in the estimation of the parameters is an iterative procedure such as the Seemingly Unrelated Regression. Seemingly Unrelated Regressions give the best estimates of the coefficients because the input demand and output supply functions are related through their disturbances. It is true that ordinary least squares estimation could be used separately on each equation to estimate the coefficients. However, "by estimating each equation separately and independently, we are disregarding the information about the mutual correlation of the disturbances, and the efficiency of the estimators becomes questionable" (Kmenta 1986: 637).

3.2.3 Data collection

The data collection involved a farm-level survey of approximately 150 households in the central region of the groundnut basin. This region includes the administrative regions of Kaolack and Fatick.[41] Information was collected on the yield in kilograms of groundnuts, millet, and other associated crops. Information was also collected on the quantities of labor, agricultural equipment, seeds, and organic / inorganic fertilizer used. The following tables define the variables of the model.

The producer prices recorded are the prices received by the farmer in the 1996-96 season. The present survey was conducted in the middle of the 1996-97 commercialization period therefore farmers were asked about the prices that they received on average for the commercialization of last year's crop.

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[40] See Appendix D for a full specification of the profit function model as well as the derived input demand and output supply equations for groundnut

[41] See Appendix A for a map of Senegal.

Table 3-1: Input and Output quantity variables

Y_1	Groundnuts produced	Kilograms (kg)
Y_2	Millet produced	Kg
Y_3	Aggregated variable of "other crops" produced	Kg
X_1	Groundnut seeds purchased	Kg
X_2	Millet seeds purchased	Kg
X_3	OC seeds purchased	Kg
X_4	Chemical fertilizer purchased	Kg
X_5	Fungicide purchased	Grams
X_6	Labor (hired and exchange)	Number of person-days

Table 3-2: Input and Output price variables

Y_1	Producer price received for groundnuts	FCFA / kg
Y_2	Producer price received for millet	FCFA / kg
Y_3	Producer price received for OC (weighted by quantities)	FCFA / kg
P_1	Price of groundnut seeds	FCFA / kg
P_2	Price of millet seeds	FCFA / kg
P_3	Price of OC seeds (weighted by quantities)	FCFA / kg
P_4	Price of chemical fertilizer	FCFA / kg
P_5	Price of fungicide	FCFA / g
P_6	Price of labor (hired and exchange)	FCFA / person-day of labor

Table 3-3: Fixed, environmental, and dummy variables

Z_1	Land: quantity of land farmed by family	Hectares
Z_2	Capital: service flow from capital stock	FCFA
Z_3	Soil: three (3) different soil types possible	-
Z_4	Labor: family labor	Person-days
Z_5	Insecticide use on crops (dummy variable)	Liters

3.2.4 Variable Definition

Before looking at the way in which the variables were constructed, a brief description of the production environment as it relates specifically to the variables listed above is desirable.

The production and marketing channels of the groundnut crop remains the most complicated of all channels for one reason: groundnut is a cash as well as a food crop therefore the uses of the groundnut output are varied. The output side of groundnut production will be examined first as it will help to explain what happens on the input side. Figure 3-1 gives a graphical picture of the production and marketing channels of the groundnut crop.

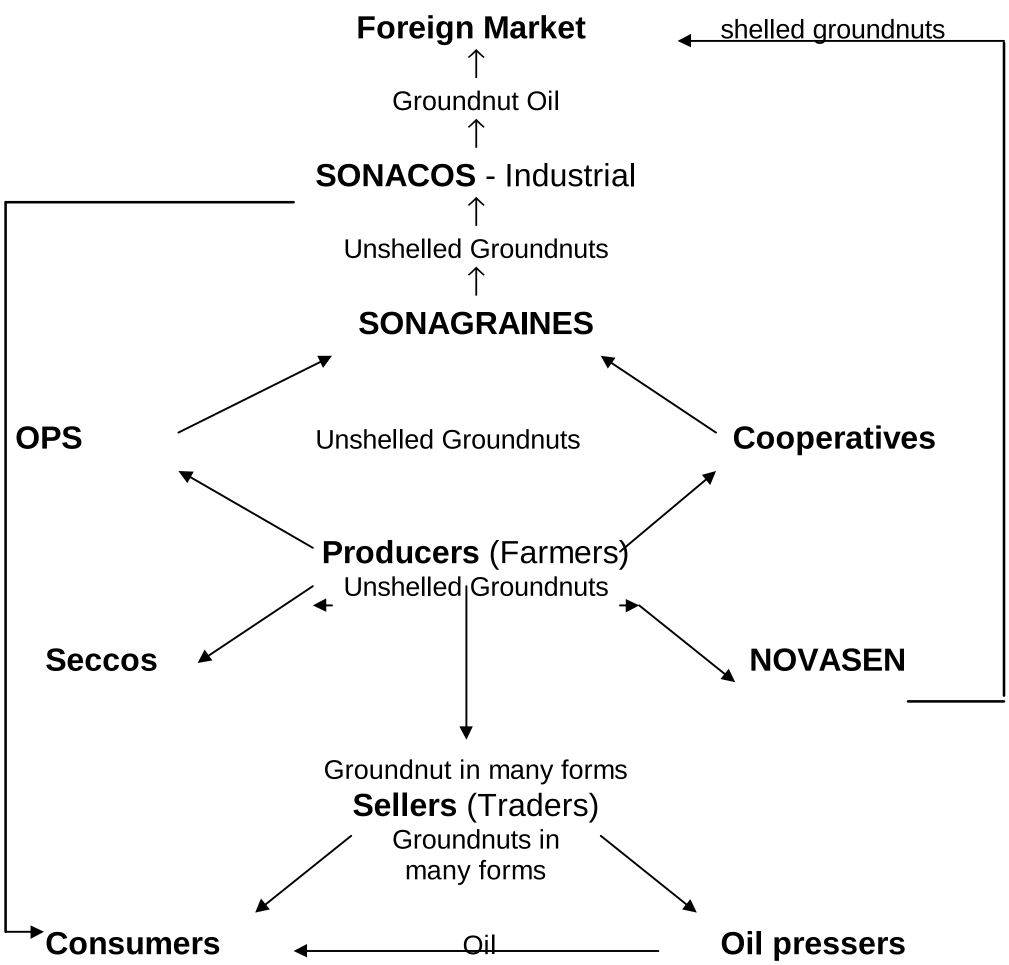

Figure 3-1

Figure from Gaye, M. 1996. (I).

Three distinct markets have developed around groundnut production which lead to three different "types" of groundnuts. The first type is *arachide huilerie* which is, loosely translated, "oil groundnuts." When sold on the official market, the groundnuts are purchased by OPS (*Organismes Privés Stockeurs*) which are private sector agents or by SONAGRAINES, a subsidiary of SONACOS. Both the OPS and SONAGRAINES then sell the groundnut to SONACOS (*Société Nationale de Commercialisation des Oléagineux du Sénégal*) where they are processed for making groundnut oil. As Figure 3-1 shows, the oil is either exported or sold on the domestic market.

The second type of groundnut is *arachide de bouche*, which are "confectionery groundnuts." All of the farmers who produce confectionery groundnuts are under contract with *Nouvelles Arachides de Senegal*, NOVASEN[42]. NOVASEN is a private company that has managed to corner the confectionery groundnut market. They provide the seed, fertilizer and fungicide to contract farmers at a discount. These inputs are provided to the farmers on credit with the condition that the farmers follow strict production practices and sell their output to NOVASEN. During the season, NOVASEN agents typically visit contract farms to make sure that production practices meet the prescribed standards. As shown in Figure 3-1 these groundnuts are then shelled and exported by NOVASEN for use in making peanut butter and other processed foods.

The third type of groundnut is *arachide semences*, or "seed groundnuts." Unlike oil groundnuts and confectionery groundnuts, these groundnuts are not immediately destined for consumption. The seed groundnut output is sold to the government-owned Seccos, as illustrated in Figure 3-1. The government then supplies those who desire it with government-certified quality seed. These seed groundnuts are of a higher grade than those destined for consumption.

The farmers who produce seed groundnuts are farmers under contract with either SONACOS or private sector agents. They must meet certain requirements to receive the contract to produce seed: [43] willingness to follow the recommended farming practices; ownership of sufficient land and capital; willingness to supply a given amount of seeds themselves as a condition for receiving fertilizer and seed inputs; willingness to build up "savings" in the form of

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[42] Gaye, M. April 1996 (II).
[43] Discussion of the contract conditions and benefits from Gaye, M. April 1996 (II).

seed stocks against the next growing season. There are benefits to being a contractual farmer that make farmers willing to meet these often stringent conditions. These benefits include: favored access to fertilizer, which as discussed in the Literature Review, has become prohibitively expensive; and access to the best quality seeds available for distribution. These are very tangible benefits and provide the incentive for farmers to become contractual farmers.

On the input side, there are three different types of groundnut seed available. Seeds range from Ordinary to N1, with N1 being the purest breed available on the market. N1 seeds cost around 182cfa per kilogram while ordinary seeds cost around 120cfa per kilogram. In between Ordinary seeds and N1 seeds are N2 seeds. The N1 seeds are bought by farmers who are contracted to produce seed groundnuts. Being that the output seeds will be one level lower in quality than the seed input, the farmers engaged in the production of seed groundnuts will buy N1 seeds and sell the resulting N2 seeds back to the government.

The most common groundnuts produced are oil groundnuts while the least common are the seed groundnuts. Very rarely does one see a farmer engaged in the production of all three different types of groundnut. However, a significant number of farmers interviewed engaged in the production of two types of groundnut. Therefore, the groundnut seed input variable as well as the groundnut seed output variable are weighted sums of the relevant quantities in the numerous cases where at least two types of groundnut were produced.

Millet is mainly a food crop and therefore definition and interpretation of the variable is more straightforward than that of groundnuts. The millet (or *mil-souna*) variable here is a combination of data on millet and sorghum production. Millet and sorghum were not separated because in most national data in Senegal, the separation is not made even though they are two distinct crops. On occasion, millet is sold but this occurs when the family has met its own food needs and it seeking to commercialize the remaining millet crop. The OC, or "other crops" variable is an aggregate of the many different types of crops planted in the area. These include okra, bissap, watermelon, tomato, rice, corn, cowpea, cassava. An aggregation was necessary here because the crops planted are so varied that there is not a significant number of farmers producing a given combination of the crops.

The fertilizer and fungicide variables are measured in kilograms and grams, respectively. The labor variable is defined as man-days of work. Adult female labor input is assumed to be 75 percent of that of an adult male as women typically have other demands on their time, such as food preparation, with all the wood gathering, buying food at the market and other such activities that are involved therein. Children's labor is valued at a maximum of 50 percent of that of an adult male. No differentiation is made between the labor input of male and female children. The reasoning is that female children (anyone less than 15 years of age) do not have competing activities that would cause them to contribute significantly less than their male counterparts.

These different scales are used only in computing total family labor input. Hired labor is usually of adult males (only one case of female hired labor was encountered) therefore no further modification was necessary for this variable.

Land is listed as a fixed variable because the amount of land that the farm family disposes of once the growing season begins is generally fixed. Moreover, decisions about how much seed to buy or use from last year's stock, and how much fertilizer and labor to allocate are made assuming a fixed quantity of land.

The hectares of land are calculated indirectly as the farmers cannot tell exactly how many hectares they farm. The *tremis* is a local unit of weight measurement used primarily in the harvest of groundnuts. Since the survey was restricted to the heart of the groundnut basin, the assumption is that most farmers would be quite familiar with the unit and thus be able to estimate how many tremis their land would yield. Each tremis weighs approximately five kilograms. More significantly, several studies conducted at ISRA have led researchers there to conclude that one hectare of land yields approximately 84 tremis of groundnut.[44] Thus, the size of the land can be calculated given the farmers'estimate of the size of their yield, based on the yield in tremis.

The capital variable captures the use or service flow from the capital stock toward production during the growing season. This service flow is calculated using the farmers' estimate of the market value of their capital (machinery and traction animals), estimates of repair or upkeep costs, and any rental costs incurred. Taking into account the discussion in the previous chapter about the near full depreciation of capital stock in the region, the market value of the capital was divided by five under the assumption that the capital was only good for another five years.

The market value was also multiplied by 0.05, which was assumed to be the interest rate, or the opportunity cost of not selling the equipment today. However, given the wide variations in

[44] From discussions with Matar Gaye, Agricultural Economist at ISRA-Kaolack. March 1997.

the inflation rate[45], particularly since the devaluation, the interest rate used may have over-estimated the opportunity cost of not selling the equipment. In addition, the near full depreciation of the capital stock in many cases would also mean that the opportunity cost of not selling the equipment could not be very high. The potential for an over-valuation of the service flow from the capital stock is more likely in view of the significance of its parameter estimate as discussed in the following chapter.

The two results above were summed together with any rental, repair, or maintenance costs in order to get a value for the capital variable. The capital variable therefore is not used as a wealth proxy here but rather as a service flow estimate.

The third 'Z' variable is an environmental variable that represents the soil type of most of the parcels farmed by each household. By far, Dior was the most common soil type. Dior soil is dry, sandy soil. It is increasingly found further and further south in the groundnut basin as annual rainfall levels trend downward, within and across regions of the basin. Deck soil is a heavy clay soil found in the southern regions of the groundnut basin. Deck-dior, as the name would suggest, is soil that is drier than Deck soil but heavier than Dior soil. Deck-dior is also very common in the groundnut basin.

A final type of soil encountered is the *champ de case* or garden soil type. This garden soil is not technically different from Dior or Deck-dior. However, it was separated from the others based on the reasoning that soil that is located around the household's "backyard" will be richer than soil out in the fields because the garden soil is fertilized regularly with human and animal waste.[46]

Family labor is listed in the table of 'Z' variables because it is considered to be a fixed cost. There is no opportunity cost to working on the farm because the typical household member has no employment alternatives to working on the farm and is therefore not missing any opportunity for wage employment. This is particularly true during the growing season (the season for which data was collected here) because the family must assure its food needs by locking in family labor for the season.

The fifth 'Z' variable is a dummy variable for insecticide use. It simply indicates whether

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[45] In 1994, the inflation rate was 32.1%, in 1995, it fell to 8.1% and in 1996, it was 2.8%. Situation Economique et Sociale du Senegal. 1996 and 1997 editions.

or not insecticides were used on the crops during the growing season. Insecticide use only concerned the aggregate "other crop" variable because farmers never use insecticides in the production of groundnut or millet but they use insecticides on watermelon, cotton, and a few other cash crops.

Having looked at the variables of the model, the data collection process will now be described. In total, 150 households were sampled in the administrative regions of Fatick and Kaolack. The "sections villageoises" or rural communities were picked at random from a list of communities in Fatick and Kaolack that was kept at the ISRA-Kaolack station. Some villages selected were not surveyed because they were inaccessible by road. That was the only condition for rejecting a village.

The goal was to visit two villages per day and interview six households in each village. There were three enumerators conducting the interviews so it amounted to two households per enumerator per village. Twenty-five villages were visited over the course of the two and a half week data collection period.

The typical household in the groundnut-producing region is composed of 2 or 3 family units all living in a cluster. The head of the group of households is typically the man who owns all the land being farmed by the members of the households living together. For convenience, he is simply referred to as the "head of the household" (HOH) where "household" refers to the group of households living in a compound.

Households are of a compound nature with several individual producers. Therefore the survey had to be designed with this in mind. Interviewing only the HOH about his farms would leave out other key producers such as unmarried and married dependents. Time and resource constraints did not allow us to interview all individual producers in each household. Therefore, three categories were developed and one household member per category was to be interviewed. These respondents would be the HOH, the dependent head of household (these are heads of households in their own right but are dependent in the sense that they are farming land that does not belong to them), and a married woman of the household. Each was to be asked about crops planted, input use, and yield on his / her individual farms.

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[46] From discussions with Matar Gaye and Cheikh Diouf, ISRA-Kaolack. March 1997.

Interviewing these three members was assumed to yield qualitative responses that were representative of the entire household. Naturally, in questions relating to the quantitative measures for the entire household, the preceding assumption would not be valid as these three producers could not be assumed to be the only producers in all cases. So, when quantitative measures were sought for the entire household, the HOH was asked to give the estimates.

Unfortunately, interviewing these three members for each household was not so easily put into practice. It was often the case that the HOH chose to answer on behalf of the other two, in addition to answering the questions that concerned him directly. It would not have been proper or acceptable for the enumerators to take the woman aside and interview her since all three were men. Typically, the women and the dependent heads of households would defer to the HOH, preferring rather to supplement and occasionally correct the information supplied by the HOH concerning plots belonging to them.

Regarding the accuracy of the HOH's responses, confidence can be placed in them because he usually consulted the other family members whenever he was not sure of the figures regarding input use and yield, for example. Indeed, in most cases, the interviews were conducted with the HOH surrounded by female and dependent male members of the household. So that all the HOH needed to do was ask when he was not sure of the answer.

To recapitulate, this chapter outlined the profit function model that will form the basis of this analysis, discussed the form of the input demand and output supply equations, presented theoretical justifications for using Seemingly Unrelated Regression, and concluded with a brief look at all the variables used in estimating the system as well as a description of the data collection process.

The following chapter will discuss general properties of the typical farm family in the groundnut basin and the estimation of the model. The results of the estimation will be presented as well as an interpretation of the results.

Chapter Four : Estimation and Results

4.1 General characteristics of the production environment

In this section, specific observations relating to household characteristics, farming practices, and input use patterns will be discussed. This discussion will provide a primary context for the presentation of the estimation results and their interpretation.

At the beginning of the growing season, the head of the household (HOH) allocates land to dependent heads of households, to unmarried dependents such as the son of the HOH, and to women. The recipients typically “pay” the HOH for the land by working on the HOH’s fields every morning before moving on to work on their own fields. The HOH may give them seeds to sow if he wishes. Otherwise, they are responsible for buying their own seeds. The proceeds from any sale of output from each person’s fields belongs to him or her alone, especially, if it is a groundnut (or other cash crop) field.

Owing perhaps to its great importance to the household, groundnut fields are planted right after the first useful rain, on average five days after the first rain. Millet fields are planted “dry”, that is, about a month before the arrival of the first rains. In most cases, this practice is a labor-saving device because the household wants to focus exclusively on sowing the groundnut fields soon after the first rain. On average, most crops in the “other crops” aggregate variable are sown one month after the first useful rain.

A closer inspection reveals that the planting schedule follows a loose hierarchy. The fields belonging to the HOH as well as to the household in general are planted before fields belonging to any other individual members of the household are planted. Other members include dependent heads of household and women. Accordingly, the allocation of labor input seems to follow this hierarchy, with the common fields and head of household’s fields receiving the lion’s share of labor input.

The millet fields are usually fertilized with manure. The farmers “park” their animals on the fields for some hours so that they can leave their droppings on the fields. Fields planted in watermelon are also fertilized in the same way. However, peanut fields tend to receive chemical fertilizer.

With this context of the household structure and farming practices laid out, the following sections will look at the results of the estimation procedure.

4.2 Estimation results

4.2.1 Functional Form

The appropriateness of the functional form was tested to determine which functional form provided a better fit to the data. The Translog variable profit function model was compared to the normalized quadratic variable profit function model. The estimation results indicated that the Translog profit function model was not an adequate representation of the dynamics of profit generation. This conclusion was reached by considering the significance of the estimated parameters in both the OLS and Seemingly Unrelated Regression. The results of the regression run with the normalized quadratic variable profit function resulted in more significant parameter estimates in both cases. Therefore, the normalized quadratic variable profit function was adopted as the model used in the analysis.

4.2.2 Estimation of the groundnut input demand equation

Having estimated the systems of input demand and output supply equations based on a normalized quadratic profit function model, the elasticities are easy to calculate. Tables listing the estimation results for all inputs and all outputs are located in Appendix E. The variables included in the tables for the equations that will be discussed are listed and defined below. The prices are all normalized on the price of millet seed.

NPIPEA=normalized price of groundnut seed
NPIOC=normalized price of ‘other crops’ seed
NPIFERT=normalized price of fertilizer
NPIFUNG=normalized price of fungicide
NPLAB=normalized price of labor
NPPEA=normalized price of groundnut

NPMILL=normalized price of millet
NPOC=normalized price of 'other crops'
LAND=total area planted in all crops
CAP=capital
QLABF=quantity of family labor
DIOR=sandy soil
DEDIOR=mixture of sandy "Dior" soil and clay "Deck" soil
CHCAS=garden soil

Although the tables that follow will list results for all the above variables, the discussion itself will be limited to variables that are significant. Here, a variable is said to be significant if the p-value associated with the parameter estimate is less than or equal to 0.10.

The results of the estimation of the groundnut seed input demand equation are provided in table 4.1. The dependent variable is IPEA, the quantity of groundnut seed input. The independent variables are listed in the far-left column of the table. Also included in the table are the parameter estimates, the t-statistics and the p-values. In all cases, the null hypothesis is that the parameter has no explanatory power, in other words, H_0: α_n=0.

Table 4-1: Estimation of groundnut seed input demand equation

Variable	Parameter Estimate	T-statistic	Prob > |T|
NPIPEA	-232.91	-1.06	.29
NPIOC	0.72	0.92	.36
NPIFERT	-98.48	-1.44	.15
NPIFUNG	43.21	0.25	.8
NPLAB	10.62	0.78	.44
NPPEA	694.93	1.64	.10
NPMILL	579.71	1.84	.07
NPOC	0.84	0.01	.99
LAND	251.89	6.23	.00
CAP	.00	2.42	.03
QLABF	-0.17	-1.19	.24
DIOR	-218.03	-0.89	.38
DEDIOR	-20.62	-0.08	.93
CHCAS	-310.40	-0.86	.39

Using a p-value of 0.10 as the maximum cut-off point, only two price variables are significant: the normalized prices of peanut and millet. The input demand function is downward-sloping. However, for the parameter estimate of the groundnut seed input price, NPIPEA, the size of the rejection region is too large to render any conclusion about the parameter estimate. A test of the null hypothesis is only rejected at levels of significance greater than 0.29.

The groundnut producer price variable, NPPEA, is significant (p-value = 0.10). It has a positive impact on the demand for groundnut seed. This result is reasonable because it is expected that if the producer price of groundnuts were to rise, then farmers eager to benefit from the price increase will produce more groundnut and thus increase their demand for groundnut seeds.

The normalized millet producer price also has a significant and positive effect on the demand for groundnut seed. This result may seem a bit odd at first glance. One might have expected that an increase in the producer price of millet would lead to a fall, rather than an increase in the demand for groundnut seed, as farmers increased millet production.

It will be shown later that millet and groundnuts are production complements. As such, they are not competing for resources. Therefore, if the price of millet were to increase, the complementary relationship implies that farmers would not reduce groundnut production. The results show that farmers increase the demand for groundnut seed (or seek to increase groundnut production) when the producer price of millet increases. Therefore, the existence of a complementary production relationship between the two crops seems to offer an adequate explanation of the result that the producer price of millet has a significant and positive impact on the demand for groundnut seed input.

The variable 'LAND' has a significant and positive impact on the demand for groundnut seed judging from the t-statistic and the p-value. This variable represents the number of hectares that are available to the household. The farmer would demand more groundnut seed if the total land area available to him were to increase.

Compared to the land variable, the capital variable has a less significant impact on the demand for groundnut seed, but remains significant nonetheless (p-value = 0.03). However, the estimate of the parameter (at 0.00) is negligible. Very little can be said with certainty concerning the impact of family labor and soil type on the demand for groundnut seed input given the size of the rejection regions.

4.2.3 Estimation of the groundnut output supply equation

The next table will look at the estimation results of the output supply equation for groundnuts. The dependent variable in Table 4-2 is QPEA, the quantity of groundnuts produced. The independent variables are listed in the far-left column of the table.

Table 4-2: Estimation of groundnut output supply equation

Variable	Parameter Estimate	T-statistic	Prob > |T|
NPIPEA	-694.92	-1.64	.10
NPIOC	-2.05	-0.84	.40
NPIFERT	310.15	1.42	.15
NPIFUNG	-110.19	-0.23	.82
NPLAB	91.59	2.26	.03
NPPEA	2568.55	1.49	.14
NPMILL	1973.67	2.02	.04
NPOC	-547.11	-1.88	.06
LAND	684.46	4.73	.00
CAP	.01	5.12	.00
QLABF	-.94	-1.86	.06
DIOR	-237.26	-0.27	.79
DEDIOR	-527.98	-0.59	.56
CHCAS	-886.2	-0.69	.49

The input price of groundnut seed has a negative impact on QPEA as expected. The groundnut seed variable is also significant (p-value = 0.10). Judging from the parameter estimate of NPIPEA, the normalized price of groundnut seed input, changes in the price of groundnut seed have a large impact on the supply of groundnut.

Hired labor has a significant impact on groundnut output (p-value = 0.03). However, contrary to expectations, the sign on the parameter estimate is positive. One reason for this result may be that the labor market in the region is not highly developed and wage rates may not fully capture the cost of labor. This could render inaccurate any analysis based on the wage rate.

From observations made during the data collection, contract workers received cash, in-kind, or a mixture of cash and in-kind payments in exchange for their labor. When the latter cases were encountered, the respondent was asked to monetarize the in-kind payment. These differences in hiring conditions led to large variations in the wage rate[47] which may not be due to differences in opportunity or transactions costs, but may in fact be the result of a poorly functioning labor market where workers are rarely paid on the margin.

The variable, QLABF, the amount of family labor, is significant (p-value = 0.06), but like the NPLAB variable, has the wrong sign. One would expect that the supply of groundnut is positively related to the quantity of family labor.

Econometric theory may provide some guidance here in trying to find a reason for the wrong signs on these two parameter estimates. These wrong signs may indicate a misspecification of the labor variable. Labor in the region under study is a compound activity. It involves land clearing, seeding, weeding, and harvest. Workers may be hired for one particular activity or for all activities. Family members themselves may not all engage in all activities. In developing the variable, the implicit assumption that all workers (hired and family) were engaged in all activities throughout the growing season may be an over-simplification of the labor environment. If there was indeed an over-simplification of the labor environment, then a case could be made for the presence of misspecification bias in the parameter estimates.

In the case of hired labor, the wage recorded was assumed to be paid to the workers for performing all of the above tasks. Since the average wage rate may differ for each activity,

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[47] See Appendix F for a list of variable means, standard deviations, maxima, and minima.

assuming that all workers were hired to perform all the tasks may undervalue the wage paid for each individual activity. It is possible, therefore, that the NPLAB variable was not measured correctly.

Another problem discussed above concerns the lack of a well-functioning labor market. This lack of a labor market complicates the task of calculating the opportunity cost of labor. In this study, the opportunity cost of the family labor was zero because it was assumed that they had little or no opportunities for outside employment. However, in a region where cattle-breeding is becoming more and more important as a secondary, revenue-generating activity (particularly in the northern parts), it is possible that there is a positive opportunity cost of family labor on the farm. There could be other revenue-generating opportunities for family members (i.e. hiring themselves out to farmers in other villages or working in nearby towns) that were not recorded. It is possible therefore, that the opportunity cost of family labor was underestimated and that by assuming a zero opportunity cost of family labor, the QLABF variable was not measured correctly.

Misspecification of any variable leads to biased parameter estimates. This error may be the cause of the wrong signs on both variables. Developing a labor variable is often tricky and, especially when working with cross-sectional data, misspecifying or not measuring correctly such an important variable can compromise the accuracy of the estimation results.

The coefficient of the normalized price of groundnut is positive, indicating an upward sloping supply curve for groundnut. However, the price of groundnut is not very significant in the output supply of groundnut equation having a p-value of 0.14. Reasons for this will be examined in the following section.

Millet is significant in the groundnut output supply equation, having a p-value of .04. Output price of millet has a positive impact on the groundnut equation. As in the case of the groundnut input demand equation, this result can also be explained by the complementary relationship that exists between the two crops. If the producer price of millet were to increase, farmers would increase the supply of groundnut, rather than decrease the supply of groundnut, as they would do if the two crops were competitive.

The response of the levels of groundnut output to changes in the price of millet is inelastic at 0.55. A one percent increase in the price of millet will result in a 0.55 percent increase in the supply of groundnuts. The response is even as high as it is because of the complementary relationship that exists between the two crops, as will be discussed in the following section on hypothesis testing.

The aggregate variable of "other crops" has a negative and significant impact on groundnut output (p-value = 0.06). The elasticity of supply of groundnut with respect to the price of the "other crops" variable is -0.11. This indicates that the 'other crops' and groundnuts are competitive, that is they compete for land. This makes sense because the main 'other crop' observed during the data collection is watermelon which is increasingly planted as a cash crop and thus would compete with groundnuts for land and labor inputs. This competitive relationship does not exist between millet and groundnut because one is a food crop and will always be allocated some land, while the other is the dominant cash crop and will always be allocated land as well.

Concerning the impact of the environmental variables in the groundnut supply equation, the land variable, as in the case of the groundnut seed input demand equation above, has a significant and positive impact on the function (p-value = .00 in both equations). This significance would indicate that an increase in total land available to the farmer would result in an increase in groundnut output. The parameter estimate of the capital variable is significant with a p-value of .00. However, the parameter estimate here, as in the groundnut input supply equation, is negligible. In both these equations, the significance of the capital variable and the negligible parameter estimate, may be due to the over-valuation of the capital stock discussed in the previous chapter.

The next tables will look at the estimation results for the output supply equation for millet as well as the estimation results for the output supply equation for "other crops." The dependent variable in Table 4-3 is QMILL, the quantity of millet produced. The dependent variable in Table 4-4 is QOC, the quantity of the aggregate variable, "other crops" produced. In each case, the independent variables are listed in the far left column of the table.

Table 4-3: Estimation of millet output supply equation

Variable	Parameter Estimate	T-statistic	Prob > |T|
NPIPEA	-579.71	-1.84	.07
NPIOC	-0.43	-0.23	.82
NPIFERT	-12.33	-0.08	.94
NPIFUNG	-129.68	-0.39	.70
NPLAB	42.98	1.46	.15
NPPEA	1973.67	2.02	.05
NPMILL	1331.58	1.48	.14
NPOC	-132.72	-0.63	.53
LAND	470.16	4.46	.00
CAP	0.003	3.24	.00
QLABF	-0.15	-0.41	.68
DIOR	-1788.96	-2.79	.01
DEDIOR	-1850.25	-2.82	.01
CHCAS	-1799.47	-1.91	.06

Table 4-4: Estimation of output supply equation for "other crops"

Variable	Parameter Estimate	T-statistic	Prob > |T|
NPIPEA	-0.84	-0.01	.99
NPIOC	-4.66	-5.12	.00
NPIFERT	96.55	1.80	.07
NPIFUNG	34.54	0.54	.59
NPLAB	-2.92	-0.25	.80
NPPEA	-547.11	-1.88	.06
NPMILL	-132.72	-0.63	.53
NPOC	-198.50	-0.78	.44
LAND	550.83	4.43	.00
CAP	-0.002	-2.25	.03
QLABF	-0.09	-0.21	.83
INSDUM[48]	2560.29	6.37	.00
DIOR	237.75	0.32	.75
DEDIOR	156.37	0.20	.84
CHCAS	-479.98	-0.43	.67

48 Not surprisingly, INSDUM, the dummy variable for insecticides, is positive and significant in this equation as insecticide use was almost entirely limited to application on watermelons, which in turn made up a significant part of this aggregate variable.

Tables 4-3 and 4-4 show that the parameter estimates of the land variable in the output supply of millet and in the output supply of "other crops" equations are 470.17 and 550.83 respectively. That the parameter estimate of the land variable in the output supply of groundnut equation is higher (at 684.16) than both of these values means that an increase in land will lead to a proportionately larger increase in groundnut output than in millet or "other crops" output. This makes sense in a region where groundnuts remain by far the dominant cash crop.

In the following section the hypotheses listed in the first chapter will be formally tested and conclusions drawn. The section that follows will then expand on the brief interpretations in this section. Reasons for the estimation results will be suggested in an attempt to interpret what is going on in the region.

4.3 Hypothesis Testing

Formal tests of the hypotheses in Chapter 1 will use information from the tables that follow. Table 4-5 lists the parameter estimates and p-values (in parentheses) for the systems of input demand and output supply equations. Table 4-6 presents the short-run elasticities associated with the derived input demand and output supply equations.

Table 4-5: Parameter estimates of the system of input demand and output supply equations with associated p-values

Dependent Variables	Independent Variables								
	IPEA	**IMILL**[49]	**IOC**	**IFERT**	**IFUNG**	**QLAB**	**QPEA**	**QMILL**	**QOC**
Constant	-682.8	n/a	3.7	-366.2	-431.9	138.6	-2884.03	-239.2	356.1
NPIPEA	-232.9 (.29)	-914.2 (n/a)	0.72 (.36)	98.4 (.15)	43.2 (.80)	10.2 (.44)	-694.9 (.10)	-579.7 (.07)	-0.84 (.99)
NPIMILL	-914.2 (n/a)	-6091.1 (n/a)	-5.92 (n/a)	36.62 (n/a)	-123.9 (n/a)	92.32 (n/a)	5482.3 (n/a)	2453.5 (n/a)	-848.8 (n/a)
NPIOC	0.71 (.36)	-5.92 (n/a)	-0.02 (.0034)	-0.35 (.45)	-0.07 (.91)	-0.04 (.64)	-2.05 (.40)	-0.42 (.82)	-4.6 (.0001)
NPIFERT	-98.4 (.15)	36.62 (n/a)	0.35 (.45)	353.8 (.0001)	25.3 (.72)	16.1 (.04)	3100.1 (.16)	-12.3 (.94)	96.5 (.07)
NPIFUNG	43.2 (.80)	-123.9 (n/a)	-0.07 (.91)	25.3 (.72)	-1794.7 (.10)	-2.4 (.83)	-110.1 (.82)	-129.6 (.70)	34.5 (.59)
NPLAB	10 (.44)	92.32 (n/a)	-0.04 (.64)	16.1 (.04)	-2.4 (.83)	5.3 (.01)	91.5 (.03)	42.9 (.15)	-2.9 (.80)
NPPEA	694.9 (.10)	5482.3 (n/a)	2.05 (.40)	-310.7 (.16)	110.1 (.82)	-91.5 (.03)	2568.5 (.14)	1973.6 (.05)	-547.1 (.06)
NPMILL	579.7 (.06)	2453.5 (n/a)	0.42 (.82)	12.3 (.94)	129.6 (.70)	42.9 (.15)	1973.6 (.05)	1331.5 (.14)	-132.7 (.53)
NPOC	0.8 (.99)	-848.8 (n/a)	4.65 (.0001)	-96.5 (.07)	-34.5 (.59)	2.9 (.80)	-547.1 (.06)	-132.7 (.53)	-198.4 (.44)

[49] Derived using homogeneity and symmetry properties.

Table 4-6: Estimated short-run elasticities

Dependent Variables	Independent Variables								
	IPEA	**IMILL**	**IOC**	**IFERT**	**IFUNG**	**QLAB**	**QPEA**	**QMILL**	**QOC**
NPIPEA	-0.31	-53.3	.18	.36	.09	.25	-.26	-.29	-.001
NPIMILL	-1.04	-293.4	-1.2	.11	-.20	1.83	1.67	.99	-.94
NPIOC	0.02	-7.4	-0.15	-.02	-.003	-.02	-.02	-.005	-.13
NPIFERT	-0.08	1.23	.05	.74	.03	.23	.07	-.004	.07
NPIFUNG	.004	-.48	-.001	.006	-.23	-.004	-.003	-.004	.003
NPLAB	.03	10.94	-.02	.12	-.01	.26	.07	.04	-.008
NPPEA	.78	261.4	.41	-.91	.18	-1.81	.77	.79	-.60
NPMILL	.60	107.5	.08	.03	.19	-.78	.55	.49	-.13
NPOC	.0006	-26.6	.61	-.19	-.04	.04	-.11	-.04	-.14

Hypothesis #1:

Demand for cash purchases of fertilizer inputs is elastic with respect to price.

Table 4-7: Estimation of fertilizer input demand equation

Variable	Parameter Estimate	T-statistic	Prob > |T|
NPIPEA	98.48	1.44	.15
NPIOC	-0.35	-0.76	.45
NPIFERT	353.88	6.40	.00
NPIFUNG	25.38	0.36	.72
NPLAB	16.18	2.11	.04
NPPEA	-310.15	-1.42	.16
NPMILL	12.3	0.08	.94
NPOC	-96.55	-1.80	.07
LAND	41.19	1.55	.12
CAP	0.00	3.07	.00
QLABF	0.04	0.45	.65
DIOR	384.79	2.37	.02
DEDIOR	301.56	1.83	.07
CHCAS	225.99	0.96	.34

The sign of the own price parameter estimate (NPIFERT) indicates an upward-sloping demand curve. The above hypothesis cannot be tested since an elasticity cannot be derived under the condition of an upward-sloping demand. However, possible causes for the upward-sloping demand curve will be explored in the paragraphs that follow.

Farmers make their decisions about the amount of inputs to buy at the beginning of the planting season. Thus, based on previous years' harvest, rains, producer prices, and input prices, they form expectations about the current year's farming conditions and based on that, decide how much of each input to procure. At least, theoretically, this is how the decision-making process works.

In the real and very uncertain world in which farmers operate however, few exogenous conditions remain stable enough to form a reliable basis for decision-making. Prices of fertilizer inputs are an example of an exogenous parameter that has changed enough over the years to be considered variable. Discussions in the Literature Review highlighted the erratic fertilizer price trends particularly since the 1980 reforms.

The upward-sloping demand curve may reflect the fact that the price signals have become distorted as a result of the price policies that at first subsidized fertilizer, then provided it on credit, and then finally stopped all public fertilizer supply programs.[50] This lack of a consistent policy may cause farmers to respond abnormally or minimally to price signals. Indeed, some researchers have argued that there is no significant demand for fertilizer on the part of farmers.[51] In such a situation, attempting to derive an input demand curve for fertilizer may not be appropriate given the minimal demand caused by the prohibitive price of the input.

As in the case of the labor variables in the discussion of the estimation results of the groundnut output supply equation, econometric problems may be the cause of the wrong sign on the parameter estimate. The input demand function for fertilizer may be misspecified due to a measurement error. There may an important variable related to the demand for fertilizer inputs that is missing from the model. Such an omission would cause the parameter estimates to be biased.

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[50] See discussion on fertilizer use in section 2.2.3

[51] Kelly et al. 1996 and Gaye, M. (II) 1996.

Hypothesis #2:

Demand for purchased labor inputs is highly inelastic with respect to price.

Table 4-8: Estimation of labor input demand equation

Variable	Parameter Estimate	T-statistic	Prob > |T|
NPIPEA	10.26	0.78	.44
NPIOC	-0.05	-0.46	.64
NPIFERT	16.18	2.11	.04
NPIFUNG	-2.41	-0.21	.83
NPLAB	5.31	2.52	.01
NPPEA	-91.59	-2.26	.03
NPMILL	-42.98	-1.46	.15
NPOC	2.92	0.25	.80
LAND	4.05	0.69	.49
CAP	0.00	2.74	.01
QLABF	-0.03	-1.56	.12
DIOR	-27.83	-0.78	.44
DEDIOR	-18.30	-0.50	.61
CHCAS	-39.81	-0.76	.45

As in the previous case with fertilizer input, the demand curve for labor input is upward-sloping therefore the hypothesis cannot be formally tested.

As suggested in the preceding section on the results of estimating the groundnut output supply equation, econometric problems may be the cause of the positive sign on the labor input. In other words, misspecification and / or inaccurate measurement of the some variables, (i.e. NPLAB, QLABF) could lead to biased parameter estimates. Correlation between NPLAB and another independent variable in the model may also cause the sign on NPLAB to be "contrary to logic" (Mendenhall et al., 636).[52]

[52] Mendenhall et al. 1989

Hypothesis #3:

Supply of groundnuts is inelastic with respect to producer price.

The own-price elasticity of supply for groundnuts is 0.77. According to the definition used here, the variable is not significant (p-value = .14). However, the p-value is close enough to the cutoff and the variable important enough to warrant some discussion of the implications of the result.

Given the elasticity calculated above, supply of groundnuts is inelastic with respect to producer price. Therefore we fail to reject the above hypothesis. A 1 percent decrease in the price of groundnuts would result in a 0.77 decrease in the supply of groundnuts. Supply of groundnuts is inelastic because whether producer prices are favorable or not, farmers will plant groundnuts. There are historical reasons for this dependence on groundnut that were discussed in the Literature Review. Farmers simply have not diversified enough to reduce their dependence on revenue from the sale of groundnuts.

However, there is some diversification occurring in the region. Data collection in the region revealed that there are other crops that farmers can plant and sell for cash. Ninety-eight out of 150 households surveyed, or 65.3 percent, planted crops apart from groundnut and millet during the 1996-1997 growing season. Watermelon, vegetable farming, and maize were common ‘other crops’ planted. The presence of these cash crop options would reduce the dependency on groundnuts as the only cash crop. This would cause the own-price elasticity of demand for groundnuts to be “moderately inelastic.” The own-price elasticity is “moderately inelastic” in the sense that within the range of an inelastic response, the response is relatively elastic. The presence of other cash crops planted would prevent farmers from reacting more to the increase in the price of groundnuts. Thus, the existence of cash crop options may explain why the groundnut supply response is not highly inelastic (i.e. does not have an own-price elasticity of 0.20 for example).

This effect of cash crop options on the own-price groundnut supply response further implies that the more farmers diversify their crops, the more elastic the groundnut supply response will be to changes in the price of groundnuts. However, the overall supply response remains inelastic mainly because groundnuts are still the dominant cash crop and the most reliable in terms of revenue-generation.

With an elasticity of output supply of groundnuts calculated, one can look at the effect of an increase in groundnut producer prices on the supply of groundnut. The devaluation of 1994 occasioned a 50 percent reduction in the value of the CFA franc. Official groundnut price during the 1994/1995 growing season was 120fcfa / kg[53] while during the 1996/1997 season it was 125fcfa / kg.[54] Using the producer price after a two-year lag is reasonable because farmers need time to adjust their farming strategies to the new price signals.

The percentage increase in prices from 1994 to 1996 is 4.2 percent. Given the own-price elasticity of supply of 0.77, we would expect groundnut output to have increased by 3.2 percent from 1994 to 1996. The elasticity calculated is based on data collected in the Groundnut Basin while the yield data refer to national levels of output.

The national groundnut output is estimated at 735,000 tons for the 1994/1995 growing season.[55] For the 1996/1997 growing season, national output is estimated at 646,394 tons.[56] This represents a decrease in groundnut output of 88,606 tons or a 12 percent relative fall in groundnut output. The percentage change in groundnut output from the year in which the devaluation occurred to the present year is negative. It is not only less than the calculated increase, it is even a decrease.

In these two years since the devaluation, farmers must have had time to adjust to the higher groundnut output price. Still, output levels are on the decline. Within the context of the devaluation, the response might be weak because the increase in producer price was marginal at 4.2 percent. Farmers may feel that this is not enough of an incentive to increase production given the high cost of groundnut seed and fertilizer inputs that they still face. Therefore, rather than being seen as weak, their response to the higher price may be appropriate given the changes in input prices.

Indeed, the increase in producer prices would not have provided enough incentive to increase groundnut yield when the inflation rate is considered. Following the devaluation, inflation rates took a downward plunge from 32.1 percent in 1994 to 8.1 percent in 1995[57]. The government is credited with controlling the hike in consumer prices that usually follows a

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53 Kelly et al. 1996
54 Diaper III. Projet du CILSS. 1997.
55 EIU 1996-1997
56 DIAPER III - Projet du CILSS. 1997.

currency devaluation. In 1996, the inflation rate was 2.8 percent.[58] Therefore, from 1994 to 1996, the average inflation rate was 14.3 percent. With an average inflation rate of 14.3 percent over the two-year period under consideration, a 4.2 percent increase in producer price will have a limited or even zero supply response. One could argue whether farmers even benefited from the increase in producer prices, given the variability in the prices of consumer goods.

Such a high inflation rate erodes farmers' real purchasing power so that increases in producer prices will not result in higher income levels. Economic theory states that demand functions are homogeneous of degree zero in prices and income. Thus demand is only affected when there has been a real, as opposed to nominal change in purchasing power. If income rises, but prices also rise by the same magnitude, real purchasing power remains unaffected. Assuming that homogeneity conditions hold, something can be said in general about the effect of the expected increase in income and the increase in prices on demand.

Within this context of the devaluation, farmers' incomes were expected to have risen following the increase in producer prices. However, prices also rose following the devaluation. Indeed, prices rose more than incomes could have risen as a result of the increase in producer price. This would translate into a real decline in purchasing power because goods are more expensive but income has not risen to balance out the increase in consumer prices.

With a lower real purchasing power, farmers may not even feel a positive income effect. In this case, demand will be adversely effected. Farmers will not purchase more inputs than they were purchasing before the devaluation. They may even use fewer yield-enhancing inputs such as fertilizer, purchased labor, high-quality seeds as these inputs become more expensive and the farmers' buying power erodes. Within this context, the observed fall in groundnut output becomes more sensible. The policy to increase producer prices had a limited effect on income and yield. A plausible reason for this would be that inflation rates remained high enough to dominate the effect that higher producer prices was to have had on farmers' income and on yield.

Thus, it has been illustrated how a price policy may have little effect on output, as discussed in Chapter 3. Producer price of groundnut in this case has increased, but apparently not enough to cancel out the increase in input prices during the same 2-year period. Price policies

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[57] Situation Economique et Sociale du Senegal. Nov. 1996.
[58] Note de Conjoncture. April 1997.

that target the output side must set complementary goals on the input side if the policies are to have a net positive effect on production.

Hypothesis #4:

Supply of millet is inelastic with respect to producer price

The own-price elasticity of supply for millet is 0.49 with a p-value of 0.14. Again, given the proximity of the p-value to the cutoff and the importance of the variable, the results will be discussed. The supply response is inelastic and we fail to reject the hypothesis. A 1 percent increase in the price of millet would lead to a 0.49 percent increase in the supply of millet. This weak response is not surprising since so little of the millet crop is commercialized anyway. Indeed, there has been no reliable proof of a solid millet supply response to changes in the producer price of millet.[59]

For example, farmers faced with a declining producer price of millet will react in a more inelastic fashion than farmers faced with a falling producer price of groundnut. This may be because millet is a staple food crop and is therefore a necessity for the household. Groundnut being a cash crop, farmers may continue to produce it anyway or produce more of another cash crop in response to the declining groundnut price.

The result of a positive, rather than a negative relationship between the price of millet and the supply of groundnut (as observed in the preceding section) may be due to the fact that farmers do not consider millet and groundnut to be production substitutes, in the sense that they compete for inputs. Millet is a food crop, but groundnut is a cash crop so both will almost always be planted. However, if the household needs millet, revenue from groundnut sales can be used to buy millet, though the converse may not be true since millet is not a cash crop. The option of using the revenue from the sale of groundnut output to buy millet has given rise to the often-heard statement by farmers that *"l'arachide c'est aussi du mil"* [groundnut is also millet] (Gaye, 1994).

4.4 A Closer Look at the Results

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[59] Gaye, M. 1994.

One of the maintained hypotheses of the study was that symmetry conditions hold for the system of input demand and output supply equations. The estimation results discussed above were calculated with these symmetry conditions imposed. In this section, the validity of the symmetry conditions is discussed bases on the results of tests of the symmetry conditions.

The null hypothesis in each case was that the symmetry conditions held, i.e., $\beta_{12} = \beta_{21}$. The null hypothesis was tested against the alternative hypothesis that the parameter estimates were not equal. Using an α-level of .10 as a loose cut-off point, in four out of 28 cases, the null was rejected; that is, the symmetry condition did not hold for the given equation. In two of these latter four cases, the α-level could go as low as .00, meaning that the null hypothesis relating to the equation could be rejected with near certainty. Table 4-9 lists the individual results of the tests.

Table 4-9: Tests of Symmetry Conditions

Symmetry Condition	F-Value	Prob > F
1.idp.npioc-idc.npipea=0	.787	.375
2.idp.npifert-idf.npipea=0	.010	.918
3.idp.npifung-idu.npipea=0	.463	.49
4.idp.nplab-idl.npipea=0	.357	.550
5.idp.nppea+osp.npipea=0	.416	.519
6.idp.npmill+osm.npipea=0	.103	.748
7.idp.npoc+oso.npoc=0	.284	.594
8.idc.npifert+idf.npioc=0	2.465	.117
9.idc.npifung+idu.npioc=0	.281	.596
10.idc.nplab-idl.npioc=0	1.254	.263
11.idc.nppea+osp.npioc=0	2.545	.111
12.idc.npmill+osm.npico=0	7.554	.006
13.idc.npoc+oso.npioc=0	109.659	.000
14.idf.npifung-idu.npifert=0	.221	.638
15 idf.nplab-idl.npifert=0	2.408	.121
16.idf.nppea+osp.npifert=0	2.711	.100
17.idf.npmill+osm.npifert=0	1.256	.263
18.idf.npoc+oso.npifert=0	.209	.648
19.idu.nplab-idl.npifung=0	.167	.683
20.idu.nppea+osp.npifung=0	.572	.450
21.idu.npmill+osm.npifung=0	.026	.872
22.idu.npco+oso.npifung=0	.528	.468
23.idl.nppea+osp.nplab=0	1.919	.166
24.idl.npmill+osm.nplab=0	.976	.323
25.idl.npoc+oso.nplab=0	.2.002	.157
26.osp.npmill-osm.nppea=0	.121	.729
27.osp.npoc-oso.nppea=0	.869	.351
28.osm.npoc-oso.npmill=0	.675	.412

A global test of the symmetry conditions imposed on the original estimation was conducted. The F-value of the test was 5.72 with a p-value of 0.0001. This result suggests that the null hypothesis be rejected; in other words, that all symmetry conditions do not hold across the system of input demand and output supply equations.

Given the results of the tests of individual symmetry conditions, equations 11-13, and 16 were removed and the global test was conducted on the remaining symmetry conditions. The resulting F-value was .71 with a p-value of .830. This result suggests that we fail to reject the null hypothesis that the symmetry conditions hold across the remaining system of input demand and output supply equations. Restrictions 11, 16, and particularly, 12 and 13 were inaccurate restrictions to impose. They therefore could not be assumed to hold and could not serve as maintained hypotheses.

The system of input demand and output supply equations was then estimated under this smaller set of restrictions. The estimation results for the groundnut output supply equation is compared to the estimation results of the same equation when all the symmetry conditions were imposed. Table 4-10 is just a duplication of Table 4-2. Table 4-11 lists the estimation results for the groundnut supply equation under the smaller set of restrictions.

Table 4-10: Estimation of groundnut output supply equation

Variable	Parameter Estimate	T-statistic	Prob > |T|
NPIPEA	-694.92	-1.64	.10
NPIOC	-2.05	-0.84	.40
NPIFERT	310.15	1.42	.15
NPIFUNG	-110.19	-0.23	.82
NPLAB	91.59	2.26	.03
NPPEA	2568.55	1.49	.14
NPMILL	1973.67	2.02	.04
NPOC	-547.11	-1.88	.06
LAND	684.46	4.73	.00
CAP	.01	5.12	.00
QLABF	-.94	-1.86	.06
DIOR	-237.26	-0.27	.79
DEDIOR	-527.98	-0.59	.56
CHCAS	-886.2	-0.69	.49

Table 4-11: Estimation of groundnut output supply equation under smaller set of restrictions

Variable	Parameter Estimates	T-statistic	Prob>|T|
NPIPEA	-775.95	-1.8	.07
NPIOC	-1.689	-0.91	.37
NPIFERT	817.19	2.65	.01
NPIFUNG	-320.67	-0.67	.51
NPLAB	72.96	1.74	.08
NPPEA	3012.00	1.72	.09
NPMILL	1464.93	1.45	.15
NPOC	-630.27	-2.25	.03
LAND	616.10	4.54	.00
CAP	0.006	5.49	.00
QLABF	-0.91	-2.38	.02
DIOR	13.05	0.01	.99
DEDIOR	-413.53	-0.45	.65
CHCAS	-1798.16	-1.36	.18

One significant difference between the two results is that the normalized output price of groundnut is more significant in the second regression with a p-value of .09. In the first regression, the parameter estimate of the NPPEA variable was not as significant with a p-value of 0.14. In the second regression, the parameter estimate of the normalized price of millet no longer has significant explanatory power in the groundnut output supply equation. The estimates of the normalized price of "other crops" variable, NPOC, and the normalized price of groundnut seed input, NPIPEA, remain significant in the second regression, as they were in the first regression.

These results suggest that the output price of groundnut may have more explanatory power in the output supply of groundnut than indicated by the results of the first regression. Therefore, there was no real loss of accuracy in discussing the parameter estimate as a significant variable, as was done in earlier sections of this chapter. On the other hand, the normalized price of millet may not have as significant an explanatory power as the first regression suggested. The NPOC and NPIPEA parameter estimates became more significant in the second regression than they were in the first, suggesting that the estimation results in the first regression were largely accurate relating to the explanatory power of these two variables in the groundnut output supply equation.

In conclusion, the overall symmetry conditions hold as maintained hypotheses when certain specific symmetry conditions are omitted. The rest of this section discusses the implications of the observed lack of price variation and the possibility of specification error.

The first observation made as early as the data collection stage concerns the lack of variation in groundnut prices. The standard deviation for the groundnut price variable is only 8.6 (with a mean of 127.2).[60] The lack of variation in groundnut prices is due to two major factors. The more obvious reason is that groundnuts remain the only crop in the groundnut basin whose output price is fixed by the government. The price is the same regardless of the zone and even of the quality of the crop.[61] Farmers selling their groundnut crop (i.e. oil peanuts) to the government warehouses or to the *Organismes Privés Stockeurs* which are private sector agents, are guaranteed a price of 120fcfa / kg (1995-96 season). This fixed price protects the farmers when

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[60] See Appendix F.
[61] Gaye, M. April 1996. (I).

there is a flood of produce on the market due for instance to a season of exceptionally good rains. In such a situation, they are assured at least the price of 120fcfa / kg.

However, they pay a price for this protection in the sense that they cannot get a higher price for their crop, even when the market is signaling it. As long as they sell through official public and private sector channels, they are locked into the one price. They do not have opportunities for value-adding as the official channels only accept unshelled groundnuts which typically go for a lower price than shelled groundnuts.

The limitations of selling through the official channels alone become significant because, for most farmers, that is the only option they have. Survey results indicated that only about 25 percent of respondents sold part or all of their crop on the parallel market therefore the majority of farmers sold their crop through official channels. They do not have the resources to speculate and wait until prices on the parallel market become attractive. Neither do they have the time to shell the groundnut and sell it on the parallel market for a higher price. Furthermore, the Seccos and the OPS are more accessible to the farmers than the parallel markets. In their competitive rush to secure a larger share of farmers' output, the public and private sector agents are locating themselves strategically near the farmers. Some agents even go out to meet the farmers armed with the weighing equipment and all![62]

This leads to the second reason why almost no variation was observed in the groundnut price. It has been mentioned that the official channels are often more convenient than the parallel market. A more compelling reason for the lack of speculation is that most farmers do not have the financial resources to speculate on the parallel market. To be able to speculate, the farmer cannot be dependent on revenue from the groundnut crop to meet his needs.[63] He must have income from other sources in order to be able to wait out the official period until less groundnut is available on the market and the price increases.

With few farmers exercising this option, the reported producer price of all three types of groundnut in the survey hovers around 125fcfa / kg. The situation is very similar for millet. The standard deviation in the input and output price of millet was a mere 13.8 and 13.6 respectively.

[62] From discussions with Matar Gaye. March 1997.
[63] Gaye, M. April 1996. (I).

For the millet crop, this lack of variation is due more to the limitations of cross-sectional data than to any overt price fixing by the government.

So with little variation occurring in the groundnut price, there is not much information in the data, hence the lack of significance in most variables in the input demand and output supply equations for groundnut. Lack of variation in prices is one of the problems often associated with cross-sectional data. In this situation, the problem is aggravated by the price fixing that exists for the groundnut crop.

As has been seen in the discussions above of parameter estimates with the wrong signs, another challenge of using cross-sectional data is that the estimation results are often vulnerable to estimation bias resulting from misspecification errors. In particular, omitting important variables from the model will result in biased parameter estimates. In order to avoid this problem, it is important that, particularly in the collection of data in developing countries, the researcher spends as much time in the study area as is necessary to better understand the dynamics of production and profit generation in the region. This will ensure that the profit function or production function model he or she will develop will include a high percentage of the explanatory variables.

Relating to the data collection process, as mentioned in the previous chapter, all the enumerators were male. This may have had consequences for gathering accurate production data on female producers. Future surveys may strive to include both male and female enumerators in order to minimize any inaccuracy that may arise, for example from having the head of household answer for the woman.

Furthermore, the more the researcher understands the dynamics of profit generation in the region, the lower his risk of inaccurately measuring explanatory variables. The researcher will thus be able to avoid some of the problems that plague models developed using cross-sectional data.

Chapter Five : Conclusion

5.1 Summary of estimation results

The estimation results revealed interesting relationships between key inputs and outputs in the Groundnut Basin. The estimation of input demand for groundnut seed revealed that both the producer price of groundnut and millet have a significant (both statistically and quantitatively) impact on the demand for groundnut seed.

The positive relationship between the producer price of millet and the demand for groundnut seed implied that there exists a complementary relationship between groundnut and millet. This relationship was implied again when the cross-price elasticity of supply of groundnut with respect to the producer price of millet was calculated.

Estimation of the groundnut output supply equation showed that the price of groundnut seed has a significantly negative impact on the supply of groundnut. The producer price of millet was shown to have a positive relationship to the supply of groundnuts. And the producer price of the "other crops" was shown to have a negative impact on the supply of groundnuts. This negative relationship followed from the competitive relationship that exists between the crops. Furthermore, farmers were shown to react in an inelastic fashion to changes in the producer price of groundnut concerning the supply of groundnut.

Symmetry conditions were found to hold under certain conditions. However, tests of the symmetry conditions imply that little accuracy was lost in interpretation of the results by imposing symmetry across all equations.

5.2 Policy Implications

The Senegalese government has set a top-priority goal for the agricultural sector as the millennium approaches: to move closer towards attaining self-sufficiency in foods by increasing the production of groundnuts and millet.[64] To attain this objective, the production of "oil groundnuts" must reach 1,200,000 tons.[65] Millet production must also increase, though not at the expense of groundnut production in order for the population's food needs to be met.[66]

The government has been encouraging import substitution of millet for rice by drastically reducing rice imports and encouraging farmers to produce millet. The devaluation of 1994 was intended to increase groundnut production but not at the expense of millet, by raising the producer price of groundnut.

Estimation results suggest a complementary relationship between millet and groundnut. In this sense, the government's approach of setting a dual-objective that targets both crops is appropriate. Developing policies that allow variation in the prices of both millet and groundnut seems appropriate, based on the results of the current study.

There have been reports highlighting the advantages of increasing the price of groundnut as a way of counteracting the downward trend in the volume of groundnuts produced.[67] The current price of 125fcfa / kg is not considered to be competitive. The authors of a recent report[68] on the groundnut sector in Senegal suggest increasing the producer price of groundnut to 140fcfa / kg. According to them, this will provide an incentive to farmers to increase groundnut production but not at the expense of millet production. Their argument is that any price higher than this will cause an increase in groundnut production with a resulting decline in millet production, thereby compromising the government's goal of increased food self-sufficiency.

While no recommendation will be made here for any particular price policy, statements can be made based on the estimation results about the groundnut supply response to changes in certain prices. The estimation results indicate that the supply response of groundnut to changes in the producer price of groundnut is inelastic. This may partly explain the mediocre groundnut supply response to the 1994 devaluation. High inflation rates also contribute to diminishing the positive effect of the producer price increase on incomes and on groundnut supply. The results

[64] Freud et al. 1997
[65] Freud et al. 1997
[66] Freud et al. 1997
[67] Freud et al. 1997

suggest that policies that seek to increase groundnut supply mainly through an increase in the producer price of groundnut are not going to be very effective.

Based on the results, a more effective way to reach the same goal of increasing groundnut supply would be to explore policies that reduce the constraints surrounding the acquisition of groundnut seed or encourage a more competitive producer price of millet.[69] Perhaps, a policy that maintains the competitiveness of the producer price of groundnut in combination with either of the two results above will be even more effective. It seems logical that facing a higher groundnut producer price *and* either a lower groundnut seed price or a higher millet producer price, farmers will tend to increase groundnut production.

The estimation results of the current study did not allow conclusions to be drawn about the own-price elasticity of demand for fertilizer. Thus, based on the results, a statement cannot be made here about the role that policies that affect fertilizer supply / availability could play in increasing groundnut production.

Nonetheless, the results do provide guidance on what to expect from groundnut farmers when prices vary in a given direction. Policies that allow for variation in the producer price of millet and groundnut seed will have a predictable impact on the supply of groundnut. This impact can then be quantified using the elasticities generated in this study. The key to the usefulness of the elasticities calculated here is market-driven variation in the input and output prices. Lack of exogenous variation in prices will complicate the efforts of policy-makers to isolate and to predict the impact of agricultural policies on prices in the region.

However, when policy makers can isolate the effects of agricultural policies on prices, then they can exploit opportunities to develop agricultural policies that allow for changes in prices that will have a desirable effect on groundnut production. As stated in the Problem Statement, the lack of statistical data to aid in quantifying policy impacts is a major drawback and this is a void that the current study has attempted to address through the generation of input demand and output supply elasticities.

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[68] Freud et al. 1997

[69] An argument can reasonably be made for including high inflation rates as a constraint, but the effects of interest rates on production is beyond the scope of this study and was only discussed in general terms as it contributed to explaining the weak supply response of groundnut output to the increase in producer prices.

5.3 Declining groundnut production: causes and effects

A recent report has noted that groundnut output levels are on the decline.[70] Indeed, researchers at Senegal's agricultural institutes are very interested in finding out what is causing the fall in groundnut output.[71] It must be noted that the decrease observed is in the volume of groundnuts moving through the official channels. So the question arises whether the observed fall is an absolute decline in groundnut production nationwide or whether it represents a growing tendency to sell output on the parallel market rather than on the official market.

This survey has shown that there may be many reasons for this decline in groundnut production.

i. The "moderately inelastic" response of producers to changes in the price of groundnut may cause them to explore other cash crops such as watermelon if the price of groundnut is no longer competitive.

ii. There were some cases (about 25 percent) where households sold on the parallel market and received a price that was, on average, 20 percent higher than what they would have received selling their output on the official market.

iii. Farmers feel a need for value-adding in order to increase their revenue from sale of their output. Being that the official channels only accept unshelled groundnuts, farmers seeking to value-add must sell on the parallel market, thereby further reducing the volume that moves through official channels.

Other reasons that have been advanced for the fall in national output levels of groundnut include: natural resource degradation; desertification; higher auto-consumption levels; declining seed quality leading to lower yields; illegal exports to neighboring countries.

Regardless of the reason, there must be an impact on farmer incomes. Is it positive or negative? Are farmers shifting out of groundnut to more profitable crops or are they simply producing less groundnut because their economic situations so dictate? These are questions that

[70] Freud et al. 1997

are outside the scope of this survey but which are important enough to justify the collection of time-series data in order to find reliable answers to the questions.

With the current survey being cross-sectional, it was not be possible to determine how incomes have evolved over the past few years. However, statements can be made regarding the observed level of profits for this past year. Economic theory states that as long as variable costs are covered, farmers will continue to produce even if total profits are negative. The information on profits in this work relates to variable costs so that one would not expect to see many cases where variable profits are negative as this would lead to questions about how these households are surviving.

Of all the households surveyed, only 5 had negative profits.[72] And in these cases, the profits were not large negative profits. The smallest profit observed was a case of negative profits of -828.73fcfa while the other four cases were larger than -250fcfa. The largest profit observed was 19,480fcfa with a mean of 44,16fcfa.[73] Therefore, it is safe to conclude that most households are covering their variable costs by a fair margin. Based on this cross-sectional result, there is no reason to think that farmers cannot and are not making profits by engaging in groundnut production.

5.4 Further Research Opportunities

With farmers moving into the production of other cash crops, particularly watermelon, more research is needed on the impact of pesticides on the soil and water resources in the region. Currently, little comprehensive information is available on pesticide use in agriculture. As natural resource degradation becomes more of a concern in the Sahel, information on agriculture's contribution to the state of natural resources in Senegal will become more important.

Due to the lack of time, this study could not look at the production environment in which women operate. Data on inputs, areas planted, and prices received were collected specifically for women's plots but could not be analyzed because they were not comprehensive within and across female producers. In addition, as mentioned in Chapter Four, the reliability of the production data

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[71] From discussions with Matar Gaye. March 1997

[72] See Appendix G.

[73] See Appendix F.

for female producers was questionable due to the way in which the interviews of female producers were conducted.

In the future, plot-level data for women's plots and men's plots could be collected and analyzed. Special constraints faced by women may be revealed and thus targeted. Such contribution from research would help policymakers to design their policies so that they can better address the production constraints faced by farmers.

Broadening the focus from the actual data to be collected to the type of data collected, there are limitations to cross-sectional data that are further aggravated by the price-fixing of the main cash crop. Until government stops fixing groundnut prices or until real alternatives to groundnut as a the main cash crop appear, the lack of variation in the groundnut price will continue to reduce the usefulness of cross-sectional data in estimating elasticities of input demand and output supply.

Since information on elasticities of input demand and output supply is important to policy makers seeking to increase productivity in the agricultural sector, investments need to be made into collecting time-series data. Typically, such data are more expensive to collect and the data collection can only be funded by public or international agencies. However, the investment is worth the cost because time-series data will reveal trends in prices, income, soil conditions, labor markets, and input use that are very important to know when trying to design the right policies to increase productivity without compromising soil quality and other environmental factors. Policy that is formulated without a steady stream of reliable information from research will have little or no effect in actually helping to achieve stated goals.

5.5 Usefulness of this study

This study has fulfilled its stated goal of generating input demand and output supply elasticities for groundnut production in the groundnut basin. The elasticity of supply of groundnuts was also used in analyzing the output supply response to the increase in producer prices following the devaluation of 1994.

Elasticities have been shown to prove useful in pointing out the desired direction of change and thus providing a context within which to diagnose and analyze changes that move in an undesirable direction. Elasticities have also been shown to be useful in the design of policies, particularly those intended to have an impact on the supply of a crop, such as groundnut.

It is hoped that this work will prove useful to public and private researchers in their quest for a clearer understanding of production dynamics in the Groundnut Basin. Senegalese public officials may also add to their store of information about the region through a reading of this work.

BIBLIOGRAPHY

Alston J.M., G. W. Norton, P. G. Pardey. *Science under Scarcity: Principles and Practice for Agricultural Research Evaluation and Priority Setting*. Cornell University Press. Ithaca, NY. 1995.

Bouchet, F. C. *An Analysis of Sources of Growth in French Agriculture 1960-1984*. PhD Dissertation. Virginia Polytechnic Institute and State University. 1987.

Claasen, E. and P. Salin. *The impact of stabilization and structural adjustment policies on the rural sector*. Food and Agriculture Organization (FAO). 1991

Delgado, C. and Jammeh S. *The Political Economy of Senegal under Structural Adjustment.* Praeger, NewYork. 1991.

Diagana, B. N. *Will the CFA franc Devaluation Enhance Sustainable Agricultural Intensification in the Senegalese Peanut Basin?* Mimeo, December 1995. Michigan State University Policy Synthesis Paper no. 9, February 1996.

Diagana B., M. Gaye, ISRA-PASE, V. Kelly, MSU/USA. *Impact de la dévaluation du FCFA sur les revenus et la sécurité alimentaire au Sénégal.* 1996. (I)

Diagana B., V. Kelly, M. Kébé. *L'offre agricole suite à la dévaluation: pourquoi une réponse si faible?* 1996. (II)

DIAPER III - Projet du CILSS. *Résultats Définitifs de la Campagne Agricole 1996/1997*. Division des statistiques agricoles. Ministère de l'Agriculture du Sénégal. Mai, 1997.

Economist Intelligence Unit, The. *Senegal*. Country Profile. 1994-95; 1995-96; 1996-97.

FAO Etude Législative. No. 48. *Les Périmètres irrigués en droit comparé africain (Madagascar, Maroc, Niger, Sénégal, Tunisie)*. Etude realisée par Negib Bouderbala, Monique Caverivìre, Mohamed Derouiche, Daniele Mangatalle, Ramarolanto Ratiaray pour le Service droit et développement, Bureau juridique. Rome: Organisation des Nations Unies pour l'alimentation et l'agriculture, 1992.

Freud, Claude. E. Hanak Freud, J. Richard, P. Thenevin. *La Crise de l'Arachide au Sénégal: Un Bilan Diagnostic*. Ministère de l'Agriculture du Sénégal. Commision Européenne.

Centre de coopération internationale en recherche agronomique pour le développement (CIRAD). Montpellier, France. Janvier, 1997.

Gaye, M. *Les circuits commerciaux de l'arachide au Sénégal dans le contexte de la libéralisation*. Insitut Sénégalais de Recherches Agricoles/ Kaolack. Avril 1996. (I)

Gaye, M. *Les cultures céréalières dans le bassin arachidier: motivations et contraintes chez les producteurs*. Institut Sénégalais de Recherches Agricoles: Etudes et documents. Vol. 5 N^{o}. 2. 1994.

Gaye, M. *Le Marché des Intrants Agricoles au Sénégal dans le contexte du désengagement de l'Etat. Situation au niveau du bassin arachidier*. ISRA/Kaolack. Avril 1996. (II)

Kelly V., B. Diagana, T. Reardon, M. Gaye, and E. Crawford. *Cash Crop and Foodgrain Productivity in Senegal: Historical View, New Survey Evidence, and Policy Implications.* MSU International Development Paper No. 20. Michigan State University. East Lansing. 1996.

Kelly V., B. Diagana, and T. Reardon. *Nonprice determinants of Input Acquisition Behavior in Senegal*. 1995.

Kmenta J. *Elements of Econometrics*. Macmillan Publishing Company. New York. 1986.

Maddala, G.S. *Econometrics*. McGraw-Hill Book Company. New York. 1977.

Mendenhall, William., J. E. Reinmuth and R. Beaver. Statistics and Management for Economics. PWS-Kent Publishing Company. Boston. 1989.

Note de Conjoncture. Ministère de l'Economie, des Finances, et du Plan. Direction de la Prévision et de la Statistique. Avril, 1997.

Pison G., K. H. Hill, B. Cohen, and K. A. Foote (eds). *Population dynamics of Senegal*. National Academy Press, Washington DC. 1995.

Plan d'amenagement et de gestion des terroirs de la communauté rurale de Diauole. Projet de gestion communautaire des ressource naturelles. Sall Consulting Group and the Latimer Group. Management - Etudes Economiques - Finance. Dakar, Senegal. 1996.

Situation Economique et Sociale du Sénégal. Edition 1995. Ministère de l'Economie, des Finances, et du Plan. Direction de la Prévision et de la Statistique. Novembre, 1996.

Sidhu, Surjit S. And Carlos A. Baanante. *Estimating Farm-Level Input Demand and Wheat Supply in the Indian Punjab Using a Translog Profit Function*. American Journal of

Agricultural Economics. 1981

Thomas, R.L. *Introductory Econometrics Theory and Applications*. Longman. London, New York. 1985.

Young, D. L., R. C. Mittelhammer, A. Rostamizadeh, and D. Holland. *Duality Theory and Applied Production Economics Research: A Pedagogical Treatise*. Research Bulletin 0962. Agricultural Research Center, College of Agriculture and Home Economics. Washington State University. 1985.

Appendix A: Map of Senegal

Figure A- 1: Map of Senegal (GIF, 282KB)

Appendix B: Survey (French)

QUESTIONNAIRE – CHEF D'EXPLOITATION

I. Les données antécédentes

Communauté rurale ____________________ Village ____________________

1.1 N°. identification du ménage ______________

1.2 Nom du chef de ménage ________________ Age ____________

1.3 Membres du ménage

Population et main d'oeuvre agricole familiale du ménage durant l'hivernage passé

	Hommes		Femmes	
	Total	Actifs	Total	Actives
Moins de 15 ans				
15 à 59 ans				
60 et plus				

1.4 Ethnie ________ 1=Wolof 2=Sérère 3=Poular 4=Autre: (préciser) ______________

1.5 Est-ce que vous savez lire ou écrire en Français? _______ 1=Oui 2=Non

1.6 Est-ce que vous savez lire ou écrire en Arabe? _______ 1=Oui 2=Non

1.7 Savez-vous lire et écrire dans votre langue maternelle…

1.7a …en alphabet français? _______ 1=Oui 2=Non

1.7b …en alphabet arabe? _______ 1=Oui 2=Non

II. DONNEES AGRICOLES

2.1 Combien de parcelles sont exploitèes par les membres de votre ménage pendant l'hivernage de 1996? Arachide semences ________; Arachide huilerie ________;

Arachide de bouche_____ ;

Mil _______ ; Autres (préciser) _____ ; _____; _____

Equipment et animaux de traction pour l'hivernage 1996

	Nombre d'unités possédés	Valeur marchande estimeé	Cout d'entretien et du réparation	Cout de location
Sémoir				
Houe				
Arara				
Charrue				
Charrette				
Tracteur				
Chevaux				
Ane				
Bovins				

QUESTIONNAIRE – CHEF DE MENAGE DEPENDENT

I. Les données antécédentes

Communauté rurale ______________________ Village ____________________

1.1 Nom du chef de ménage dépendent _________________________

1.2 Est-ce que vous savez lire ou écrire en Français? _________ 1=Oui 2=Non

1.3 Est-ce que vous savez lire ou écrire en Arabe? __________ 1=Oui 2=Non

1.4 Savez-vous lire ou écrire dans votre langue maternelle …

1.4a …en alphabet français? ____________ 1=Oui 2=Non

1.4b …en alphabet arabe? _____________ 1=Oui 2=Non

II. DONNEES AGRICOLES

2.1 Combien de parcelles avez-vous exploité pendant l'hivernage de 1996?

Arachide semences ______ ; Arachide huilerie______ ; Arachide de bouche _______;

Mil ______ ; Autres (préciser) ________ ; _______ ; ______

QUESTIONNAIRE – FEMME

I. Les données antécédentes

1.1 Nom de la femme ____________________

1.2 Est-ce que vous savez lire ou écrire en Français? ________ 1=Oui 2=Non

1.3 Est-ce que vous savez lire ou écrire en Arabe? ________ 1=Oui 2=Non

1.4 Savez-vous lire ou écrire dans votre langue maternelle…

1.4a …en alphabet français? ____________ 1=Oui 2=Non

1.4b …en alphabet arabe? ____________ 1=Oui 2=Non

II. LES DONNEES AGRICOLES

2.1 Combien de parcelles avez-vous exploité durant l'hivernage de 1996?

Arachide semences ______ ; Arachide huilerie ________ ; Arachide de bouche ________;

Mil ________ ; Autres (préciser) ________; ______; ______

2.2 La campagne agricole de 1996

A. Caractéristiques des parcelles et données de production

Nom ____________________
Statut________ 1=chef d'exploitation 2=chef de ménage dépendent 3=Sourga (non-marié) 4=Femme

	Distance de la case (km)	Type de sol a/	Décalage semis – première pluie	Capacité en trémis	Production (en kilos)
Arachide sémences pour l'exploitation					
pour le CE					
Arachide huilerie pour l'exploitation					
pour le CE					
Arachide de bouche pour l'exploitation					
pour le CE					
Mil pour l'exploitation					
pour le CE					
Autre **(préciser)** pour l'exploitation					
pour le CE					
Autre **(préciser)** pour l'exploitation					
poue le CE					
Autre **(préciser)** pour l'exploitation					
pour le CE					

a/ 1=Dior 2=Deck-dior 3=champ de case 4=Bas fond

Autres techniques locales de protection des semences, des cultures, et des récoltes

Semences ____

Cultures ____

Récoltes ____

	Fumier – no. de charrettes	N1 Qté	N1 Prix	N2 Qté	N2 Prix	Semences Ordinaires Qté	Semences Ordinaires Prix
Arachide sémences pour l'exploitation							
pour le CE							
Arachide huilerie pour l'exploitation							
pour le CE							
Arachide de bouche pour l'exploitation							
pour le CE							
Mil pour l'exploitation							
pour le CE							
Autre (préciser) pour l'exploitation							
pour le CE							
Autre (préciser) pour l'exploitation							
pour le CE							
Autre (préciser) pour l'exploitation							
pour le CE							

*Préciser la culture

	Engrais chimique Qté	Engrais chimique Prix	Fongicide Qté	Fongicide Prix	Herbicide Qté	Herbicide Prix
Arachide semences pour l'exploitation						
pour le CE						
Arachide huilerie pour l'exploitation						
pour le CE						
Arachide de bouche pour l'exploitation						
pour le CE						
Mil pour l'exploitation						
pour le CE						
Autre* pour l'exploitation						
pour le CE						
Autre* pour l'exploitation						
pour le CE						
Autre* pour l'exploitation						
pour le CE						

Nom ________________________________
Statut_______ 1=chef de ménage dépendent 2=Sourga (non-marié) 3=Femme

	Distance de la case	Type de sol a/	Décalage semis – première pluie	Capacité en trémis	Production (en kilos)
Arachide semences					
Arachide huilerie					
Arachide de bouche					
Mil					
Autre (préciser)					
Autre (préciser)					
Autre (préciser)					

a/ 1=Dior 2=Deck-dior 3=Champ de case 4=Bas fond

Techniques locales de protection des semences, des cultures, et des récoltes

Semences ____

Cultures ____

Récoltes ____

*Préciser la culture

	N1 Qté	N1 Prix	N2 Qté	N2 Prix	Semences Ordinaires - Qté	Semences Ordinaires - Prix	Fumier – no. de charrettes
Arachide semences							
Arachide huilerie							
Arachide de bouche							
Mil							
Autre*							
Autre*							
Autre*							

*Préciser la culture

	Engrais chimique – Qté	Engrais chimique - Prix	Fongicide Qté	Fongicide Prix	Herbicide Qté	Herbicide Prix
Arachide semences						
Arachide huilerie						
Arachide de bouche						
Mil						
Autre*						
Autre*						
Autre*						

2. Intrants: main d'oeuvre

Nom ______________________________

Statut ___________ 1=chef d'exploitation 2=chef de ménage dépendent 3=sourga (non-marié) 4=femme

*Nombre de personnes

STATUT	FAMILIALE a/				SALARIE(E) a/							
	Hommes		Femmes		Nombre				Cout total			
					Hommes		Femmes		Espèces		Qté en nature	
	*No.	Jours	*No.	Jours	*No. Femmes	Jours	*No.	Jours	Hommes	Femmes	Hommes	
L'exploitation												
Le CE												
Le CMD												
La Femme												
Le Sourga												

a/ Unités: Personnes-jours

*Nombre de personnes

STATUT	ECHANGE					
	Hommes		Femmes		Qté en nature	
	*No.	Jours	*No.	Jours	Hommes	Femmes
L'exploitation (demandez au CE)						
Le CE personnellement						
Le CMD						
Le Sourga						
La Femme						

C. Commercialisation et Prix

Nom ___________________________________

Statut ——— 1=Chef d'exploitation 2=Chef de ménage dépendent 3=Sourga (non-marié) 4=Femme

Commercialisation de l'arachide

***Quantité vendue pour cette campagne et Prix reçu pour la campagne passée**

TYPE	Coopérative		OPS		*MP – Vente en coque					
	Qté	Prix	Qté	Prix	Av.O		D.O		Ap.O	
					Qté	Prix	Qté	Prix	Qté	Prix
Huilerie										
De Bouche										
Semences										
Vert arachide										

*MP=Marché parallel

*Av.O=avant la période officielle D.O=durant la période officielle Ap.O=après la période officielle

Type d'arachide	Marché parallel – Vente en grains décortiquées					
	*Av.O		*D.O		*Ap.O	
	Qté	Prix	Qté	Prix	Qté	Prix
Huilerie						
De Bouche						
Semences						

*Av.O=avant la période officielle D.O=durant la période officielle Ap.O=après la période officielle

	Quantité vendue	Prix de vente
Mil		
Autre (préciser)		
Autre (préciser)		
Autre (préciser)		

Appendix C: Survey (English translation)

QUESTIONNAIRE – HEAD OF EXTENDED FAMILY (HEF)

I. Demographic data

Rural Community ____________________ Village ____________________

1.1 Household identification number ______________

1.2 Name of the HEF __________________ Age ____________

1.3 Household members

Total and active family labor force for the 1996-1997 planting season

	Male		Female	
	Total	Active	Total	Active
Less than 15 yrs				
15 to 59 yrs				
60 and over				

1.4 Ethnic group ________ 1=Wolof 2=Sérère 3=Poular 4=Other: (specify)__________

1.5 Can you read or write in French? _______ 1=Yes 2=No

1.6 Can you read or write in Arabic? _______ 1=Yes 2=No

1.7 Can you read or write in your maternal language …

1.7a …in the Latin alphabet? _______ 1=Yes 2=No

1.7b …in Arabic characters? _______ 1=Yes 2=No

II. FARM DATA

2.1 How many parcels of land were farmed by the extended household during the cropping season of 1996? Seed peanuts __________ ; Oil peanuts _________ ;

Confectionery peanuts ______ ;

Millet _______ ; Others (specify) ______ ; ______ ; ______

Farm equipment and traction animals used for the '96-'97 season

	Number of units owned	Estimated market value	Maintenance and repair cost	Rental cost
Seeder				
Hoe				
Peanut harvester				
Plow				
Cart				
Tractor				
Horse				
Donkey				
Cattle				

2.2 The 1996 season

A. Parcel characteristics and production data

Name__________________

	Distance from home	Soil Type a/	Lag of planting - first useful rain	Size of land (in "tremis")	Yield (in kilos)
Seed peanuts for the ext. family					
for the HEF					
Oil peanuts for the ext. family					
for the HEF					
Confect. Peanuts for the ext. family					
for the HEF					
Millet for the ext. family					
for the HEF					
Other **(specify)** for the ext. family					
for the HEF					
Other **(specify)** for the ext. family					
for the HEF					
Other **(specify)** for the ext. family					
for the HEF					

a/ 1=Dior 2=Deck-dior 3=Garden soil 4=Valley

Local techniques used to protect seed stocks, crops, and harvest

Seeds ____

Crops ____

Harvest ____

	Manure - no. of carts	N1 Qty	N1 Price	N2 Qty	N2 Price	Ordinary Seeds Qty	Ordinary Seeds Price
Seed Peanuts for the ext. family							
for the HEF							
Oil Peanuts for the ext. family							
for the HEF							
Confectionery Peanuts for the ext. family							
for the HEF							
Millet for the ext. family							
for the HEF							
Other (specify) for the ext. family							
for the HEF							
Other (specify) for the ext. family							
for the HEF							
Other (specify) for the ext. family							
for the HEF							

*Specify the crop

	Chemical fertilizer -- Qty	Chemical fertilizer -- Prix	Fungicide Qty	Fungicide Price	Herbicide Qty	Herbicide Price
Seed Peanuts for the ext. family						
for the HEF						
Oil Peanuts for the ext. family						
for the HEF						
Confect. Peanuts for the ext. family						
for the HEF						
Millet for the ext. family						
for the HEF						
Other* for the ext. family						
for the HEF						
Other* for the ext. family						
for the HEF						
Other* for the ext. family						
for the HEF						

QUESTIONNAIRE – DEPENDENT HEAD OF HOUSEHOLD (DHH) OR UNMARRIED DEPENDENT (SOURGA)

I. Demographic data

Rural community ______________________ Village ___________________

1.1 Name of the dependent head of household ________________________

1.2 Can you read or write in French? _________ 1=Yes 2=No

1.3 Can you read or write in Arabic? __________ 1=Yes 2=No

1.4 Can you read or write in you maternal language…

1.4a …in the Latin alphabet? ____________ 1=Yes 2=No

1.4b …in Arabic characters? _____________ 1=Yes 2=No

II. FARM DATA

2.1 How many parcels did you farm in the '96-'97 cropping season?

Seed peanuts ______ ; Oil peanuts ______ ; Confectionery peanuts _______;

Millet ______ ; Other (specify) ________; _______ ; ______

QUESTIONNAIRE – WOMAN

I. Demographic data

1.1 Name of the woman ______________________________

1.2 Can you read or write in French? ________ 1=Yes 2=No

1.3 Can you read or write in Arabic? ________ 1=Yes 2=No

1.4 Can you read or write in your maternal language…

1.4a …in the Latin alphabet? ____________ 1=Yes 2=No

1.4b …in Arabic characters? ____________ 1=Yes 2=No

II. FARM DATA

2.1 How many parcels did you farm in the 1996-1997 cropping season?

Seed peanuts ______ ; Oil peanuts ________ ; Confectionery peanuts ________ ;

Millet ________ ; Other (specify) ________ ; ______ ; ______

Name________________________________

Statute _______ 1=DHH 2=Sourga 3=Woman

	Distance from the home	Soil Type a/	Lag in planting - first useful rain	Size of land	Yield (in kilos)
Seed Peanuts					
Oil Peanuts					
Confectionery Peanuts					
Millet					
Other (specify)					
Other (specify)					
Other (specify)					

a/ 1=Dior 2=Deck-dior 3=Garden soil 4=Valley

Local techniques used to protect seed stocks, crops, and harvest

Seeds ____

Crops ____

Harvest ____

*Specify the crop

	N1 Qty	N1 Price	N2 Qty	N2 Price	Ordinary Seeds Qty	Ordinary Seeds Price	Manure – no. of carts
Seed Peanuts							
Oil Peanuts							
ConfectioneryPeanuts							
Millet							
Other*							
Other*							
Other*							

*Specify the crop

	Chemical fertilizer - Qty	Chemical fertilizer - Price	Fungicide Qty	Fungicide Price	Herbicide Qty	Herbicide Price
Seed Peanuts						
Oil Peanuts						
ConfectioneryPeanuts						
Millet						
Other*						
Other*						
Other*						

2. Inputs: Labor

Name____________________________

Statute__________ 1=HEF 2=DHH 3=Sourga 4=Woman

*Number of people

	FAMILY a/				HIRED a/							
	Male		Female		Quantity				Total Cost			
					Male		Female		Cash		Qty in kind	
STATUTE	*No.	Days	*No.	Days	*No. Female	Days	*No.	Days	Male	Female	Male	
The ext family												
The HEF												
The DHH												
The Woman												
The Sourga												

a/ Units: Person-days

*Number of workers

	EXCHANGE					
	Male		Female		Qty in kind	
STATUTE	*No.	Days	*No.	Days	Male	Female
The ext. family (ask the HEF)						
The HEF personally						
The DHH						
The Sourga						
The Woman						

C. Commercialization and producer price received

Name___________________________________

Statute——— 1=HEF 2=DHH 3=Sourga 4=Woman

Commercialization of the peanut crop

***Quantity sold during this season and Price received during last year's season**

TYPE OF PEANUTS	Cooperative		OPS		*PM – Sale of unshelled peanuts					
	Qty	Price	Qty	Price	B.O		D.O		A.O	
					Qty	Price	Qty	Price	Qty	Price
Oil										
Confectionery										
Seed										
Green (unripe)										

*PM=Parallel Market

*B.O=Before the start of the official period D.O=During the Official period A.O=After the Official period

Type of groundnut	Parallel market – Sale of shelled peanuts					
	*B.O		*D.O		*A.O	
	Qty	Price	Qty	Price	Qty	Price
Oil						
Confectionery						
Seed						

*B.O=Before the start of the official period D.O=During the official period

A.O=After the official period

	Quantity sold	Selling Price (Fcfa / kilo)
Millet		
Other (specify)		
Other (specify)		
Other (specify)		

Appendix D: Quadratic Variable Profit Function and Derived Input Demand for Groundnut Seed and Derived Output Supply for Groundnut

$\Pi = f$ (normalized prices)

$$
\begin{aligned}
\Pi = {} & \alpha_0 + \alpha_1\, NPIPEA + \alpha_2\, NPIOC + \alpha_3\, NPIFERT + \alpha_4\, NPIFUNG + \alpha_5\, NPLAB + \alpha_6\, NPPEA \\
& + \alpha_7\, NPMILL + \alpha_8\, NPOC + \alpha_9\, LAND + \alpha_{10}\, CAP + \alpha_{11}\, DIOR + \alpha_{12}\, DEDIOR \\
& + \alpha_{13}\, CHCAS + \alpha_{14}\, QLABF \\
& + \tfrac{1}{2}\beta_1\, NPIPEA * NPIPEA + \tfrac{1}{2}\beta_2\, NPIOC * NPIOC + \tfrac{1}{2}\beta_3\, NPIFERT * NPIFERT \\
& + \tfrac{1}{2}\beta_4\, NPIFUNG * NPIFUNG + \tfrac{1}{2}\beta_5\, NPLAB * NPLAB + \tfrac{1}{2}\beta_6\, NPPEA * NPPEA \\
& + \tfrac{1}{2}\beta_7\, NPMILL * NPMILL + \tfrac{1}{2}\beta_8\, NPOC * NPOC + \tfrac{1}{2}\beta_9\, LAND * LAND \\
& + \tfrac{1}{2}\beta_{10}\, CAP * CAP + \tfrac{1}{2}\beta_{11}\, DIOR * DIOR + \tfrac{1}{2}\beta_{12}\, DEDIOR * DEDIOR \\
& + \tfrac{1}{2}\beta_{13}\, CHCAS * CHCAS + \tfrac{1}{2}\beta_{14}\, QLABF * QLABF \\
& + \gamma_1\, NPIPEA * NPIOC + \gamma_2\, NPIPEA * NPIFERT + \gamma_3\, NPIPEA * NPIFUNG \\
& + \gamma_4\, NPIPEA * NPLAB + \gamma_5\, NPIPEA * NPPEA + \gamma_6\, NPIPEA * NPMILL \\
& + \gamma_7\, NPIPEA * NPOC + \gamma_8\, NPIPEA * LAND + \gamma_9\, NPIPEA * CAP \\
& + \gamma_{10}\, NPIPEA * DIOR + \gamma_{11}\, NPIPEA * DEDIOR + \gamma_{12}\, NPIPEA * CHCAS \\
& + \gamma_{13}\, NPIPEA * QLABF \\
& + \gamma_{14}\, NPIOC * NPIFERT + \gamma_{15}\, NPIOC * NPIFUNG + \gamma_{16}\, NPIOC * NPLAB \\
& + \gamma_{17}\, NPIOC * NPPEA + \gamma_{18}\, NPIOC * NPMILL + \gamma_{19}\, NPIOC * NPOC \\
& + \gamma_{20}\, NPIOC * LAND + \gamma_{21}\, NPIOC * CAP + \gamma_{22}\, NPIOC * DIOR \\
& + \gamma_{23}\, NPIOC * DEDIOR + \gamma_{24}\, NPIOC * CHCAS + \gamma_{25}\, NPIOC * QLABF \\
& + \gamma_{26}\, NPIFERT * NPIFUNG + \gamma_{27}\, NPIFERT * NPLAB + \gamma_{28}\, NPIFERT * NPPEA \\
& + \gamma_{29}\, NPIFERT * NPMILL + \gamma_{30}\, NPIFERT * NPOC + \gamma_{31}\, NPIFERT * LAND \\
& + \gamma_{32}\, NPIFERT * CAP + \gamma_{33}\, NPIFERT * DIOR + \gamma_{34}\, NPIFERT * DEDIOR \\
& + \gamma_{35}\, NPIFERT * CHCAS + \gamma_{36}\, NPIFERT * QLABF \\
& + \gamma_{37}\, NPIFUNG * NPLAB + \gamma_{38}\, NPIFUNG * NPPEA + \gamma_{39}\, NPIFUNG * NPMILL \\
& + \gamma_{40}\, NPIFUNG * NPOC + \gamma_{41}\, NPIFUNG * LAND + \gamma_{42}\, NPIFUNG * CAP \\
& + \gamma_{43}\, NPIFUNG * DIOR + \gamma_{44}\, NPIFUNG * DEDIOR + \gamma_{45}\, NPIFUNG * CHCAS \\
& + \gamma_{46}\, NPIFUNG * QLABF \\
& + \gamma_{47}\, NPLAB * NPPEA + \gamma_{48}\, NPLAB * NPMILL + \gamma_{49}\, NPLAB * NPOC \\
& + \gamma_{50}\, NPLAB * LAND + \gamma_{51}\, NPLAB * CAP + \gamma_{52}\, NPLAB * DIOR \\
& + \gamma_{53}\, NPLAB * DEDIOR + \gamma_{54}\, NPLAB * CHCAS + \gamma_{55}\, NPLAB * QLABF \\
& + \gamma_{56}\, NPPEA * NPMILL + \gamma_{57}\, NPPEA * NPOC + \gamma_{58}\, NPPEA * LAND \\
& + \gamma_{59}\, NPPEA * CAP + \gamma_{60}\, NPPEA * DIOR + \gamma_{61}\, NPPEA * DEDIOR \\
& + \gamma_{62}\, NPPEA * CHCAS + \gamma_{63}\, NPPEA * QLABF \\
& + \gamma_{64}\, NPMILL * NPOC + \gamma_{65}\, NPMILL * LAND + \gamma_{66}\, NPMILL * CAP \\
& + \gamma_{67}\, NPMILL * DIOR + \gamma_{68}\, NPMILL * DEDIOR + \gamma_{69}\, NPMILL * CHCAS \\
& + \gamma_{70}\, NPMILL * QLABF \\
& + \gamma_{71}\, LAND * CAP + \gamma_{72}\, LAND * DIOR + \gamma_{73}\, LAND * DEDIOR \\
& + \gamma_{74}\, LAND * CHCAS + \gamma_{75}\, LAND * QLABF + \gamma_{76}\, CAP * DIOR + \gamma_{77}\, CAP * DEDIOR \\
& + \gamma_{78}\, CAP * CHCAS + \gamma_{79}\, CAP * QLABF + \gamma_{80}\, DIOR * DEDIOR + \gamma_{81}\, DIOR * CHCAS \\
& + \gamma_{82}\, DIOR * QLABF + \gamma_{83}\, DEDIOR * CHCAS + \gamma_{84}\, DEDIOR * QLABF \\
& + \gamma_{85}\, CHCAS * QLABF
\end{aligned}
$$

Input Demand for Peanut seed (IDP)
IDP:

$$IPEA = \frac{\partial \Pi}{\partial NPIPEA}$$

$$= \alpha_1 + \beta_1\, NPIPEA + \gamma_1\, NPIOC + \gamma_2\, NPIFERT + \gamma_3\, NPIFUNG + \gamma_4\, NPLAB + \gamma_5\, NPPEA + \gamma_6\, NPMILL + \gamma_7\, NPOC + \gamma_8\, LAND + \gamma_9\, CAP + \gamma_{10}\, DIOR + \gamma_{11}\, DEDIOR + \gamma_{12}\, CHCAS + \gamma_{13}\, QLABF$$

Output Supply of Peanut (OSP)
OSP:

$$QPEA = \frac{\partial \Pi}{\partial NPPEA}$$

$$= \alpha_6 + \beta_6\, NPPEA + \gamma_5\, NPIPEA + \gamma_{17}\, NPIOC + \gamma_{28}\, NPIFERT + \gamma_{38}\, NPIFUNG + \gamma_{47}\, NPLAB + \gamma_{56}\, NPMILL + \gamma_{57}\, NPOC + \gamma_{58}\, LAND + \gamma_{59}\, CAP + \gamma_{60}\, DIOR + \gamma_{61}\, DEDIOR + \gamma_{62}\, CHCAS + \gamma_{63}\, QLABF$$

Appendix E: Estimation results of input demand and output supply equations

The SAS System

SYSLIN Procedure
Seemingly Unrelated Regression Estimation

Cross Model Covariance

Sigma	IDP	IDC	IDF	IDU
IDP	328344.39867	69.683366273	44650.804285	18456.814311
IDC	69.683366273	45.075032694	-209.1338697	-123.0911076
IDF	44650.804285	-209.1338697	142053.67908	27323.950917
IDU	18456.814311	-123.0911076	27323.950917	190170.95953
IDL	-3036.609205	81.700276334	-1482.038561	-66.73168132
OSP	241399.69484	-773.76418	288442.53626	89772.504876
OSM	268841.50386	1149.2123879	130109.93272	-1700.741691
OSO	-159374.4819	669.37971472	-62711.86494	14504.05024

Sigma	IDL	OSP	OSM	OSO
IDP	-3036.609205	241399.69484	268841.50386	-159374.4819
IDC	81.700276334	-773.76418	1149.2123879	669.37971472
IDF	-1482.038561	288442.53626	130109.93272	-62711.86494
IDU	-66.73168132	89772.504876	-1700.741691	14504.05024
IDL	7046.3766788	10751.950171	1633.208143	25527.888766
OSP	10751.950171	4219721.866	1246997.7555	-116072.5469
OSM	1633.208143	1246997.7555	2243108.9724	-47722.08093
OSO	25527.888766	-116072.5469	-47722.08093	3143552.3748

Cross Model Correlation

Corr	IDP	IDC	IDF	IDU
IDP	1	0.0181132462	0.2067465338	0.0738617917
IDC	0.0181132462	1	-0.082647573	-0.042042309
IDF	0.2067465338	-0.082647573	1	0.1662436841
IDU	0.0738617917	-0.042042309	0.1662436841	1
IDL	-0.063130782	0.1449681419	-0.046843607	-0.00182296
OSP	0.2050831586	-0.056104627	0.372555646	0.1002142155
OSM	0.3132609956	0.1142896986	0.2304936806	-0.002604001
OSO	-0.156871348	0.0562333778	-0.093845429	0.0187588775

Cross Model Correlation

Corr	IDL	OSP	OSM	OSO
IDP	-0.063130782	0.2050831586	0.3132609956	-0.156871348
IDC	0.1449681419	-0.056104627	0.1142896986	0.0562333778
IDF	-0.046843607	0.372555646	0.2304936806	-0.093845429
IDU	-0.00182296	0.1002142155	-0.002604001	0.0187588775
IDL	1	0.0623537248	0.012990726	0.1715227064
OSP	0.0623537248	1	0.4053205025	-0.031869647
OSM	0.012990726	0.4053205025	1	-0.01797148
OSO	0.1715227064	-0.031869647	-0.01797148	1

Cross Model Inverse Correlation

Inv Corr	IDP	IDC	IDF	IDU
IDP	1.16744	-0.01836	-0.12069	-0.06437
IDC	-0.01836	1.05758	0.07665	0.02161
IDF	-0.12069	0.07665	1.22889	-0.15640
IDU	-0.06437	0.02161	-0.15640	1.03937
IDL	0.05142	-0.15053	0.05063	-0.00170
OSP	-0.06213	0.11253	-0.37214	-0.06627
OSM	-0.30861	-0.17691	-0.10312	0.08251
OSO	0.15770	-0.02933	0.07261	-0.04582

Inv Corr	IDL	OSP	OSM	OSO
IDP	0.05142	-0.06213	-0.30861	0.15770
IDC	-0.15053	0.11253	-0.17691	-0.02933
IDF	0.05063	-0.37214	-0.10312	0.07261
IDU	-0.00170	-0.06627	0.08251	-0.04582
IDL	1.06268	-0.11738	0.02024	-0.16433
OSP	-0.11738	1.35668	-0.45606	0.00542
OSM	0.02024	-0.45606	1.32468	-0.04389
OSO	-0.16433	0.00542	-0.04389	1.06163

Cross Model Inverse Covariance

Inv Sigma	IDP	IDC	IDF	IDU
IDP	3.5555524E-6	-4.773794E-6	-5.588325E-7	-2.576392E-7
IDC	-4.773794E-6	0.0234627056	0.0000302945	7.3821526E-6
IDF	-5.588325E-7	0.0000302945	8.6508951E-6	-9.515773E-7
IDU	-2.576392E-7	7.3821526E-6	-9.515773E-7	5.4654919E-6
IDL	1.0691466E-6	-0.000267102	1.6005226E-6	-4.667237E-8
OSP	-5.278312E-8	8.1597462E-6	-4.80671E-7	-7.398377E-8
OSM	-3.596082E-7	-0.000017594	-1.826909E-7	1.2633843E-7
OSO	1.5522891E-7	-2.464568E-6	1.0866822E-7	-5.926939E-8

Inv Sigma	IDL	OSP	OSM	OSO
IDP	1.0691466E-6	-5.278312E-8	-3.596082E-7	1.5522891E-7
IDC	-0.000267102	8.1597462E-6	-0.000017594	-2.464568E-6
IDF	1.6005226E-6	-4.80671E-7	-1.826909E-7	1.0866822E-7
IDU	-4.667237E-8	-7.398377E-8	1.2633843E-7	-5.926939E-8
IDL	0.0001508125	-6.807761E-7	1.6099389E-7	-1.104173E-6
OSP	-6.807761E-7	3.2151121E-7	-1.482378E-7	1.488196E-9
OSM	1.6099389E-7	-1.482378E-7	5.9055645E-7	-1.652844E-8
OSO	-1.104173E-6	1.488196E-9	-1.652844E-8	3.377182E-7

System Weighted MSE: 1.0233 with 1082 degrees of freedom.
System Weighted R-Square: 0.3697

Model: IDP
Dependent variable: IPEA seed input for peanut crop

SYSLIN Procedure
Seemingly Unrelated Regression Estimation

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-682.219400	480.597226	-1.420	0.1581
NPIPEA	1	-232.908009	219.714647	-1.060	0.2911
NPIOC	1	0.715511	0.781228	0.916	0.3614
NPIFERT	1	-98.480279	68.605986	-1.435	0.1535
NPIFUNG	1	43.216421	173.876506	0.249	0.8041
NPLAB	1	10.262175	13.247015	0.775	0.4399
NPPEA	1	694.928262	423.517187	1.641	0.1032
NPMILL	1	579.713319	315.918448	1.835	0.0688
NPOC	1	0.842574	82.533972	0.010	0.9919
LAND	1	251.889439	40.447887	6.228	0.0001
CAP	1	0.000731	0.000326	2.242	0.0266
QLABF	1	-0.168326	0.141451	-1.190	0.2362
DIOR	1	-218.032002	246.299077	-0.885	0.3776
DEDIOR	1	-20.624964	251.388063	-0.082	0.9347
CHCAS	1	-310.403484	359.918588	-0.862	0.3900

Variable	DF	Variable Label
INTERCEP	1	Intercept
NPIPEA	1	normalized peanut seed price
NPIOC	1	normalized seed price of other crops
NPIFERT	1	normalized price of fertilizer
NPIFUNG	1	normalized price of fungicide
NPLAB	1	normalized price of labor
NPPEA	1	normalized price of peanut
NPMILL	1	normalized price of millet
NPOC	1	normalized price of other crops
LAND	1	areas planted in all crops
CAP	1	capital
QLABF	1	quantity of family labor used
DIOR	1	sandy soil
DEDIOR	1	deck-dior soil
CHCAS	1	backyard field

Model: IDC
Dependent variable: IOC seed inputs for other crops

SYSLIN Procedure
Seemingly Unrelated Regression Estimation

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	3.722223	4.334898	0.859	0.3921
NPIPEA	1	0.715511	0.781228	0.916	0.3614
NPIOC	1	-0.029497	0.009885	-2.984	0.0034
NPIFERT	1	0.351502	0.459875	0.764	0.4460
NPIFUNG	1	-0.071700	0.639147	-0.112	0.9109
NPLAB	1	-0.045407	0.098030	-0.463	0.6440
NPPEA	1	2.053680	2.436757	0.843	0.4009
NPMILL	1	0.425093	1.828856	0.232	0.8166
NPOC	1	4.656279	0.908832	5.123	0.0001
LAND	1	-0.148721	0.472111	-0.315	0.7533
CAP	1	0.000005201	0.000003761	1.383	0.1690
QLABF	1	0.003101	0.001645	1.885	0.0616
INSDUM	1	7.672315	1.592368	4.818	0.0001
DIOR	1	-8.536074	2.870383	-2.974	0.0035
DEDIOR	1	-9.610186	2.943063	-3.265	0.0014
CHCAS	1	-11.201870	4.206449	-2.663	0.0087

Variable	DF	Variable Label
INTERCEP	1	Intercept
NPIPEA	1	normalized peanut seed price
NPIOC	1	normalized seed price of other crops
NPIFERT	1	normalized price of fertilizer
NPIFUNG	1	normalized price of fungicide
NPLAB	1	normalized price of labor
NPPEA	1	normalized price of peanut
NPMILL	1	normalized price of millet
NPOC	1	normalized price of other crops
LAND	1	areas planted in all crops
CAP	1	capital
QLABF	1	quantity of family labor used
INSDUM	1	Dummy variable for insecticide use
DIOR	1	sandy soil
DEDIOR	1	deck-dior soil
CHCAS	1	backyard field

Model: IDF
Dependent variable: IFERT fertilizer input in kilos

SYSLIN Procedure
Seemingly Unrelated Regression Estimation

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-366.267393	300.269604	-1.220	0.2247
NPIPEA	1	98.480279	68.605986	1.435	0.1535
NPIOC	1	-0.351502	0.459875	-0.764	0.4460
NPIFERT	1	353.882551	55.335428	6.395	0.0001
NPIFUNG	1	25.381073	70.168747	0.362	0.7181
NPLAB	1	16.183522	7.665169	2.111	0.0366
NPPEA	1	-310.150332	218.896249	-1.417	0.1589
NPMILL	1	12.326425	152.082414	0.081	0.9355
NPOC	1	-96.548466	53.604122	-1.801	0.0740
LAND	1	41.191465	26.548388	1.552	0.1232
CAP	1	0.000653	0.000212	3.074	0.0026
QLABF	1	0.041888	0.092268	0.454	0.6506
DIOR	1	384.785641	162.067919	2.374	0.0190
DEDIOR	1	301.554997	165.198957	1.825	0.0702
CHCAS	1	225.985941	236.472447	0.956	0.3410

Variable	DF	Variable Label
INTERCEP	1	Intercept
NPIPEA	1	normalized peanut seed price
NPIOC	1	normalized seed price of other crops
NPIFERT	1	normalized price of fertilizer
NPIFUNG	1	normalized price of fungicide
NPLAB	1	normalized price of labor
NPPEA	1	normalized price of peanut
NPMILL	1	normalized price of millet
NPOC	1	normalized price of other crops
LAND	1	areas planted in all crops
CAP	1	capital
QLABF	1	quantity of family labor used
DIOR	1	sandy soil
DEDIOR	1	deck-dior soil
CHCAS	1	backyard field

Model: IDU
Dependent variable: IFUNG fungicide input in grams

SYSLIN Procedure
Seemingly Unrelated Regression Estimation

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-431.931448	407.020094	-1.061	0.2905
NPIPEA	1	43.216421	173.876506	0.249	0.8041
NPIOC	1	-0.071700	0.639147	-0.112	0.9109
NPIFERT	1	25.381073	70.168747	0.362	0.7181
NPIFUNG	1	-1794.792271	1090.624519	-1.646	0.1022
NPLAB	1	-2.405710	11.402036	-0.211	0.8332
NPPEA	1	110.190298	472.628487	0.233	0.8160
NPMILL	1	129.681746	332.654677	0.390	0.6973
NPOC	1	-34.537998	64.260556	-0.537	0.5918
LAND	1	105.706638	30.819176	3.430	0.0008
CAP	1	0.000347	0.000250	1.388	0.1675
QLABF	1	0.466652	0.109257	4.271	0.0001
DIOR	1	201.348689	189.583526	1.062	0.2901
DEDIOR	1	340.316901	192.439767	1.768	0.0793
CHCAS	1	148.669998	276.206567	0.538	0.5913

Variable	DF	Variable Label
INTERCEP	1	Intercept
NPIPEA	1	normalized peanut seed price
NPIOC	1	normalized seed price of other crops
NPIFERT	1	normalized price of fertilizer
NPIFUNG	1	normalized price of fungicide
NPLAB	1	normalized price of labor
NPPEA	1	normalized price of peanut
NPMILL	1	normalized price of millet
NPOC	1	normalized price of other crops
LAND	1	areas planted in all crops
CAP	1	capital
QLABF	1	quantity of family labor used
DIOR	1	sandy soil
DEDIOR	1	deck-dior soil
CHCAS	1	backyard field

Model: IDL
Dependent variable: QLAB quantity of hired labor

SYSLIN Procedure
Seemingly Unrelated Regression Estimation

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	138.641025	59.700996	2.322	0.0217
NPIPEA	1	10.262175	13.247015	0.775	0.4399
NPIOC	1	-0.045407	0.098030	-0.463	0.6440
NPIFERT	1	16.183522	7.665169	2.111	0.0366
NPIFUNG	1	-2.405710	11.402036	-0.211	0.8332
NPLAB	1	5.314243	2.113221	2.515	0.0131
NPPEA	1	-91.587133	40.532217	-2.260	0.0255
NPMILL	1	-42.984509	29.527246	-1.456	0.1478
NPOC	1	2.922651	11.716332	0.249	0.8034
LAND	1	4.056227	5.917895	0.685	0.4943
CAP	1	0.000130	0.000047363	2.742	0.0070
QLABF	1	-0.032083	0.020568	-1.560	0.1212
DIOR	1	-27.828924	35.844724	-0.776	0.4389
DEDIOR	1	-18.299507	36.744470	-0.498	0.6193
CHCAS	1	-39.805401	52.518935	-0.758	0.4498

Variable	DF	Variable Label
INTERCEP	1	Intercept
NPIPEA	1	normalized peanut seed price
NPIOC	1	normalized seed price of other crops
NPIFERT	1	normalized price of fertilizer
NPIFUNG	1	normalized price of fungicide
NPLAB	1	normalized price of labor
NPPEA	1	normalized price of peanut
NPMILL	1	normalized price of millet
NPOC	1	normalized price of other crops
LAND	1	areas planted in all crops
CAP	1	capital
QLABF	1	quantity of family labor used
DIOR	1	sandy soil
DEDIOR	1	deck-dior soil
CHCAS	1	backyard field

Model: OSP
Dependent variable: QPEA quantity of peanuts produced

SYSLIN Procedure
Seemingly Unrelated Regression Estimation

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-2884.033848	1852.310519	-1.557	0.1219
NPIPEA	1	-694.928262	423.517187	-1.641	0.1032
NPIOC	1	-2.053680	2.436757	-0.843	0.4009
NPIFERT	1	310.150332	218.896249	1.417	0.1589
NPIFUNG	1	-110.190298	472.628487	-0.233	0.8160
NPLAB	1	91.587133	40.532217	2.260	0.0255
NPPEA	1	2568.525626	1727.843295	1.487	0.1395
NPMILL	1	1973.668407	979.163302	2.016	0.0459
NPOC	1	-547.108813	290.370105	-1.884	0.0617
LAND	1	684.464073	144.684030	4.731	0.0001
CAP	1	0.005917	0.001155	5.123	0.0001
QLABF	1	-0.936505	0.503163	-1.861	0.0649
DIOR	1	-237.260502	879.423220	-0.270	0.7877
DEDIOR	1	-527.979457	900.247385	-0.586	0.5586
CHCAS	1	-886.198834	1290.784173	-0.687	0.4936

Variable	DF	Variable Label
INTERCEP	1	Intercept
NPIPEA	1	normalized peanut seed price
NPIOC	1	normalized seed price of other crops
NPIFERT	1	normalized price of fertilizer
NPIFUNG	1	normalized price of fungicide
NPLAB	1	normalized price of labor
NPPEA	1	normalized price of peanut
NPMILL	1	normalized price of millet
NPOC	1	normalized price of other crops
LAND	1	areas planted in all crops
CAP	1	capital
QLABF	1	quantity of family labor used
DIOR	1	sandy soil
DEDIOR	1	deck-dior soil
CHCAS	1	backyard field

Model: OSM
Dependent variable: QMILL quantity of millet produced

SYSLIN Procedure
Seemingly Unrelated Regression Estimation

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-239.205937	1240.293063	-0.193	0.8474
NPIPEA	1	-579.713319	315.918448	-1.835	0.0688
NPIOC	1	-0.425093	1.828856	-0.232	0.8166
NPIFERT	1	-12.326425	152.082414	-0.081	0.9355
NPIFUNG	1	-129.681746	332.654677	-0.390	0.6973
NPLAB	1	42.984509	29.527246	1.456	0.1478
NPPEA	1	1973.668407	979.163302	2.016	0.0459
NPMILL	1	1331.578134	901.587166	1.477	0.1421
NPOC	1	-132.719273	211.192707	-0.628	0.5308
LAND	1	470.156050	105.494159	4.457	0.0001
CAP	1	0.002733	0.000844	3.237	0.0015
QLABF	1	-0.150325	0.368623	-0.408	0.6841
DIOR	1	-1788.957824	641.643469	-2.788	0.0061
DEDIOR	1	-1850.245592	656.957685	-2.816	0.0056
CHCAS	1	-1799.472294	943.045065	-1.908	0.0585

Variable	DF	Variable Label
INTERCEP	1	Intercept
NPIPEA	1	normalized peanut seed price
NPIOC	1	normalized seed price of other crops
NPIFERT	1	normalized price of fertilizer
NPIFUNG	1	normalized price of fungicide
NPLAB	1	normalized price of labor
NPPEA	1	normalized price of peanut
NPMILL	1	normalized price of millet
NPOC	1	normalized price of other crops
LAND	1	areas planted in all crops
CAP	1	capital
QLABF	1	quantity of family labor used
DIOR	1	sandy soil
DEDIOR	1	deck-dior soil
CHCAS	1	backyard field

Model: OSO
Dependent variable: QOC quantity of other crops produced

SYSLIN Procedure
Seemingly Unrelated Regression Estimation
Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	356.144541	894.964154	0.398	0.6913
NPIPEA	1	-0.842574	82.533972	-0.010	0.9919
NPIOC	1	-4.656279	0.908832	-5.123	0.0001
NPIFERT	1	96.548466	53.604122	1.801	0.0740
NPIFUNG	1	34.537998	64.260556	0.537	0.5919
NPLAB	1	-2.922651	11.716332	-0.249	0.8034
NPPEA	1	-547.108813	290.370105	-1.884	0.0618
NPMILL	1	-132.719273	211.192707	-0.628	0.5308
NPOC	1	-198.495768	254.099355	-0.781	0.4361
LAND	1	550.830510	124.474391	4.425	0.0001
CAP	1	-0.002190	0.000975	-2.245	0.0264
QLABF	1	-0.087913	0.429463	-0.205	0.8381
INSDUM	1	2560.293814	401.961941	6.369	0.0001
DIOR	1	237.746187	755.494946	0.315	0.7535
DEDIOR	1	156.370101	776.307173	0.201	0.8407
CHCAS	1	-479.982950	1106.877391	-0.434	0.6653

Variable	DF	Variable Label
INTERCEP	1	Intercept
NPIPEA	1	normalized peanut seed price
NPIOC	1	normalized seed price of other crops
NPIFERT	1	normalized price of fertilizer
NPIFUNG	1	normalized price of fungicide
NPLAB	1	normalized price of labor
NPPEA	1	normalized price of peanut
NPMILL	1	normalized price of millet
NPOC	1	normalized price of other crops
LAND	1	areas planted in all crops
CAP	1	capital
QLABF	1	quantity of family labor used
INSDUM	1	Dummy variable for insecticide use
DIOR	1	sandy soil
DEDIOR	1	deck-dior soil
CHCAS	1	backyard field

SYSLIN Procedure
Seemingly Unrelated Regression Estimation

Cross Model Restrictions:

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
RESTRICT	-1	0.284322	0.385855	0.737	0.4633
RESTRICT	-1	0.002345	0.006003	0.391	0.6977
RESTRICT	-1	0.000464	0.000746	0.622	0.5358
RESTRICT	-1	-0.054207	0.029656	-1.828	0.0674
RESTRICT	-1	-0.000913	0.001037	-0.881	0.3806
RESTRICT	-1	-0.000060235	0.001435	-0.042	0.9667
RESTRICT	-1	0.002270	0.001548	1.466	0.1432
RESTRICT	-1	0.668623	0.858826	0.779	0.4384
RESTRICT	-1	0.074628	0.063803	1.170	0.2436
RESTRICT	-1	0.623248	4.780871	0.130	0.8969
RESTRICT	-1	0.050809	0.148826	0.341	0.7342
RESTRICT	-1	-0.443846	0.202834	-2.188	0.0281
RESTRICT	-1	1.104562	0.359074	3.076	0.0018
RESTRICT	-1	0.000170	0.001151	0.148	0.8831
RESTRICT	-1	-0.136670	0.067498	-2.025	0.0424
RESTRICT	-1	0.005372	0.002124	2.530	0.0109
RESTRICT	-1	0.005369	0.002944	1.824	0.0680
RESTRICT	-1	0.003281	0.003878	0.846	0.3995
RESTRICT	-1	-0.001959	0.005129	-0.382	0.7040
RESTRICT	-1	0.000324	0.000227	1.428	0.1541
RESTRICT	-1	0.000040171	0.000307	0.131	0.8964
RESTRICT	-1	-0.000372	0.000250	-1.487	0.1375
RESTRICT	-1	0.030560	0.010952	2.790	0.0048
RESTRICT	-1	0.040597	0.014977	2.711	0.0063
RESTRICT	-1	-0.027914	0.021394	-1.305	0.1931
RESTRICT	-1	0.000156	0.000443	0.351	0.7267
RESTRICT	-1	-0.000343	0.000677	-0.507	0.6142
RESTRICT	-1	0.000551	0.000924	0.597	0.5526

Variable	DF	Variable Label
RESTRICT	-1	
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Appendix F: Means and Standard Deviations of all variables

Variable	Label	N	Mean	Std Dev	Minimum
ID	household id number	147	75.2653061	43.6869823	1.0000000
IPEA	seed input/peanut	147	880.8231293	773.7988456	38.0000000
IMILL	seed input/millet	147	20.7585034	14.8568920	0
IOC	seed input/other crop	147	4.9420408	8.4275236	0
IFERT	fertilizer input	147	333.8646259	492.7647131	0
IFUNG	fungicide input	147	607.8231293	576.2033472	0
IINSE	insecticide input	147	0.3257143	1.3259429	0
QMILL	qty of millet produced	147	2459.24	2063.25	0
QOC	qty/othercrop produced	147	904.7482993	2113.32	0
PIPEA	unit price/peanut seed	147	155.3122449	27.6602279	120.0000000
PIMILL	unit price/millet seed	147	128.8428571	13.7755441	100.0000000
PIOC	u.price/othercrop seed	147	3338.87	7743.40	0
PIFERT	unit price/fertilizer	147	87.4789116	74.3479742	0
PIFUNG	unit price/fungicides	147	9.5884354	4.5681674	0
PIINSE	unit price/insecticide	147	1051.38	3733.85	0
PMILL	unit price of millet	147	116.2061224	13.6026046	0
POC	unit price/other crops	147	83.8163265	75.1282137	0
DIOR	sandy soil	147	0.5918367	0.4931740	0
DEDIOR	deck-dior soil	147	0.3333333	0.4730162	0
CHCAS	backyard field	147	0.0340136	0.1818838	0
LAND	areas planted/all crop	147	2.7258503	1.7761390	0.4000000
CAP	capital	147	284188.95	203621.56	15900.00
QLAB	qty of hired labor	147	50.2312925	91.8704469	0
QPEA	qty of peanut produced	147	3291.80	3129.50	100.0000000
PPEA	unit price of peanut	147	127.2349190	8.6469776	115.8000000
PLAB	unit price of labor	147	309.9734694	427.9250986	0
QLABF	qty of family labor	147	606.2653061	421.7534066	80.0000000
NPIPEA	normalized PIPEA	147	1.2145240	0.2289539	0.7417143
NPIOC	normalized PIOC	147	26.0038426	60.6882177	0
NPIFERT	normalized PIFERT	147	0.7046159	0.6075246	0
NPIFUNG	normalized PIFUNG	147	0.0757463	0.0388544	0
NPLAB	normalized PLAB	147	2.4630149	3.4176384	0
NPPEA	normalized PPEA	147	0.9962609	0.1039045	0.7092913
NPMILL	normalized PMILL	147	0.9132470	0.1435057	0
NPOC	normalized POC	147	0.6520584	0.5858101	0
REV	total revenue	147	6167.97	5132.68	384.0526701
COST	total variable cost	147	1752.01	1513.70	57.4480000
PROF	total variable profit	147	4415.96	4103.42	-828.7393939

Variable	Label	Maximum
ID	household id number	150.0000000
IPEA	seed input for peanut crop	5100.00
IMILL	seed input for millet crop	80.0000000
IOC	seed inputs for other crops	45.0000000
IFERT	fertilizer input in kilos	2500.00
IFUNG	fungicide input in grams	3000.00
IINSE	insecticide input in liters	9.5000000
QMILL	quantity of millet produced	10000.00
QOC	quantity of other crops produced	19650.00
PIPEA	unit price of peanut seed	350.0000000
PIMILL	unit price of millet seed	175.0000000
PIOC	unit price of other crop seeds	38461.50
PIFERT	unit price of fertilizer	253.8000000
PIFUNG	unit price of fungicides	27.0000000
PIINSE	unit price of insecticides	20000.00
PMILL	unit price of millet	125.0000000
POC	unit price of other crops	210.0000000
DIOR	sandy soil	1.0000000
DEDIOR	deck-dior soil	1.0000000
CHCAS	backyard field	1.0000000
LAND	areas planted in all crops	8.9000000
CAP	capital	1276250.00
QLAB	quantity of hired labor	450.0000000
QPEA	quantity of peanuts produced	16000.00
PPEA	unit price of peanut crop	152.4000000
PLAB	unit price of labor	2000.00
QLABF	quantity of family labor used	2430.00
NPIPEA	normalized peanut seed price	2.8000000
NPIOC	normalized seed price of other crops	307.6920000
NPIFERT	normalized price of fertilizer	2.3072727
NPIFUNG	normalized price of fungicide	0.2454545
NPLAB	normalized price of labor	16.0000000
NPPEA	normalized price of peanut	1.2192000
NPMILL	normalized price of millet	1.2500000
NPOC	normalized price of other crops	1.6326531
REV	total revenue	26480.00
COST	total variable cost	7416.82
PROF	total variable profit	19480.15

Appendix G: Data

OBS	IPEA	IMILL	IOC	IFERT	IFUNG	IINSE	INSDUM	QMILL	QOC	PIPEA	PIMILL
1	110	7.0	0.0	0.0	50	0.00	0	800	0	129.0	117.9
2	400	15.0	0.0	0.0	100	0.00	0	1100	0	142.5	125.0
3	200	10.0	0.0	0.0	50	0.00	0	600	0	195.0	125.0
4	300	14.0	0.0	0.0	50	0.00	0	600	0	150.0	125.0
5	780	3.0	0.0	0.0	300	0.00	0	450	0	126.0	123.2
6	750	10.0	0.5	0.0	500	4.00	1	1100	3850	150.0	123.2
7	630	15.0	2.0	400.0	200	0.00	0	1500	300	165.6	135.0
8	400	8.0	0.0	100.0	150	0.00	0	900	0	145.5	135.0
9	277	15.0	0.1	300.0	200	0.00	0	1760	1000	167.2	150.0
10	265	8.0	2.5	200.0	300	0.00	0	1268	580	166.3	125.0
11	1700	10.0	0.5	1050.0	1400	0.00	0	1000	1800	171.6	136.3
12	800	8.0	3.0	0.0	800	0.00	0	800	400	134.7	136.3
13	1100	40.0	4.0	300.0	350	0.00	0	2100	600	162.0	120.0
14	700	25.0	4.0	0.0	300	0.00	0	1700	200	150.0	125.0
15	550	10.0	2.1	0.0	200	0.00	0	700	220	157.3	122.5

OBS	PIOC	PIFERT	PIFUNG	PMILL	POC	DIOR	DEDIOR	CHCAS	LAND	CAP	QLAB
1	0.0	0.0	10.0	120.0	0.0	0	0	1	0.5	71950	0
2	0.0	0.0	10.0	120.0	0.0	0	1	0	0.6	82350	36
3	0.0	0.0	10.0	120.0	0.0	1	0	0	0.4	74875	0
4	0.0	0.0	10.0	120.0	0.0	1	0	0	0.8	156175	2
5	0.0	0.0	10.0	120.0	0.0	0	1	0	1.1	100350	0
6	8000.0	0.0	10.0	120.0	46.8	0	1	0	0.9	352750	0
7	150.0	160.0	22.5	115.0	160.0	0	1	0	1.7	48475	24
8	0.0	160.0	10.0	115.0	0.0	0	0	1	0.6	50550	10
9	30000.0	115.5	13.5	115.0	40.0	1	0	0	1.1	42100	8
10	175.0	142.8	12.3	115.0	56.6	1	0	0	1.3	157500	51
11	8000.0	73.3	13.5	115.0	62.2	0	1	0	1.3	136450	40
12	100.0	0.0	5.0	115.0	120.0	1	0	0	2.6	182650	114
13	140.0	130.0	10.0	125.0	160.0	0	1	0	1.5	403500	28
14	175.0	0.0	10.0	116.7	200.0	1	0	0	1.9	319750	0
15	14438.0	0.0	13.0	116.7	105.5	1	0	0	4.1	64800	50

OBS	QPEA	PPEA	PLAB	QLABF	NPIPEA	NPIOC	NPIFERT	NPIFUNG	NPLAB	NPPEA
1	490	120.0	0.0	288	1.094	0.000	0.000	0.084	0.000	1.017
2	770	125.7	452.8	540	1.140	0.000	0.000	0.080	3.622	1.005
3	550	120.0	0.0	110	1.560	0.000	0.000	0.080	0.000	0.960
4	550	120.0	500.0	255	1.200	0.000	0.000	0.080	4.000	0.960
5	590	120.0	0.0	920	1.022	0.000	0.000	0.081	0.000	0.974
6	460	120.0	0.0	600	1.217	64.935	0.000	0.081	0.000	0.974
7	4100	124.3	770.8	144	1.226	1.111	1.185	0.166	5.709	0.921
8	1320	121.9	1100.0	180	1.077	0.000	1.185	0.074	8.148	0.902
9	1640	125.3	437.5	310	1.114	200.000	0.770	0.090	2.916	0.835
10	1175	125.1	417.6	170	1.330	1.400	1.142	0.098	3.340	1.000
11	4455	128.0	500.0	180	1.258	58.694	0.537	0.099	3.668	0.939
12	2050	133.4	1228.1	240	0.988	0.734	0.000	0.036	9.010	0.978
13	3670	134.8	625.0	210	1.350	1.167	1.083	0.083	5.208	1.123
14	2090	152.4	0.0	168	1.200	1.400	0.000	0.080	0.000	1.219
15	1700	124.7	671.1	210	1.284	117.861	0.000	0.106	5.478	1.017

OBS	NPMILL	NPOC	REV	COST	PROF	_OBSTAT_			
1	1.017	0.000	1312.98	124.60	1188.38	01101	0	0	0
2	0.960	0.000	1830.40	594.41	1235.99	01101	0	0	0
3	0.960	0.000	1104.00	316.00	788.00	01101	0	0	0
4	0.960	0.000	1104.00	372.00	732.00	01101	0	0	0
5	0.974	0.000	1012.99	822.08	190.91	01101	0	0	0
6	0.974	0.379	2981.98	986.20	1995.78	01101	0	0	0
7	0.851	1.185	5411.11	1419.46	3991.65	01101	0	0	0
8	0.851	0.000	1958.58	642.22	1316.36	01101	0	0	0
9	0.766	0.266	2986.67	601.10	2385.57	01101	0	0	0
10	0.920	0.452	2605.18	784.44	1820.75	01101	0	0	0
11	0.843	0.456	5851.50	3019.70	2831.80	01101	0	0	0
12	0.843	0.880	3033.53	1849.33	1184.20	01101	0	0	0
13	1.041	1.333	7112.42	1989.67	5122.75	01101	0	0	0
14	0.933	1.600	4455.25	869.60	3585.65	01101	0	0	0
15	0.952	0.861	2586.86	1248.90	1337.96	01101	0	0	0

OBS	IPEA	IMILL	IOC	IFERT	IFUNG	IINSE	INSDUM	QMILL	QOC	PIPEA	PIMILL
16	350	20.0	7.00	0.0	100	0.00	0	1520	1025	157.3	122.5
17	2400	10.0	0.00	0.0	1700	0.00	0	1900	550	162.0	122.5
18	450	10.0	2.00	0.0	900	0.00	0	1200	50	155.3	122.5
19	620	12.0	1.00	0.0	400	0.00	0	2100	500	140.4	125.0
20	440	20.0	0.00	0.0	500	0.00	0	2100	0	162.0	125.0
21	310	6.0	4.00	0.0	100	0.00	0	900	50	145.0	125.0
22	450	15.0	2.00	0.0	200	0.00	0	1000	50	150.0	125.0
23	800	10.0	0.00	0.0	100	0.00	0	1200	0	150.0	125.0
24	38	6.0	5.00	0.0	100	0.00	0	655	300	149.5	125.0
25	160	4.5	0.00	0.0	150	0.00	0	950	0	145.0	125.0
26	100	4.0	0.00	0.0	50	0.00	0	1150	0	145.0	125.0
27	450	10.0	2.00	0.0	0	0.00	0	1000	100	192.0	125.0
28	38	7.5	0.00	0.0	0	0.00	0	850	0	350.0	125.0
29	55	10.0	2.00	0.0	300	0.00	0	800	25	192.0	125.0
30	173	10.0	0.00	0.0	0	0.00	0	800	0	126.0	125.0

OBS	PIOC	PIFERT	PIFUNG	PMILL	POC	DIOR	DEDIOR	CHCAS	LAND	CAP	QLAB
16	128.6	0.0	6.0	125.0	174.6	1	0	0	1.6	108000	0
17	0.0	0.0	5.0	116.7	0.0	1	0	0	3.8	204750	100
18	200.0	0.0	5.0	100.0	200.0	1	0	0	1.7	112100	5
19	150.0	0.0	10.0	125.0	124.0	0	1	0	1.7	837500	210
20	0.0	0.0	5.2	125.0	0.0	1	0	0	2.3	69000	0
21	150.0	0.0	25.0	125.0	200.0	1	0	0	1.6	115000	0
22	200.0	0.0	10.0	125.0	200.0	1	0	0	1.3	177500	0
23	0.0	0.0	10.0	125.0	0.0	1	0	0	1.5	111250	0
24	200.0	0.0	5.0	125.0	200.0	1	0	0	1.1	242500	0
25	0.0	0.0	10.0	125.0	0.0	1	0	0	0.6	106250	0
26	0.0	0.0	10.0	125.0	0.0	1	0	0	0.7	53750	0
27	250.0	0.0	0.0	125.0	200.0	1	0	0	1.8	188500	26
28	0.0	0.0	0.0	125.0	0.0	1	0	0	1.0	95150	0
29	250.0	0.0	4.0	125.0	200.0	1	0	0	1.5	285375	0
30	0.0	0.0	0.0	125.0	0.0	1	0	0	1.3	96125	0

OBS	QPEA	PPEA	PLAB	QLABF	NPIPEA	NPIOC	NPIFERT	NPIFUNG	NPLAB	NPPEA
16	350	136.6	0.0	710	1.284	1.050	0.000	0.048	0.000	1.115
17	2000	120.0	100.0	1170	1.322	0.000	0.000	0.040	0.816	0.979
18	1600	145.9	1500.0	540	1.267	1.633	0.000	0.040	12.244	1.191
19	4200	124.3	357.1	175	1.123	1.200	0.000	0.080	2.856	0.994
20	3750	120.0	0.0	720	1.296	0.000	0.000	0.041	0.000	0.960
21	2340	123.0	0.0	80	1.160	1.200	0.000	0.200	0.000	0.984
22	1500	120.0	0.0	210	1.200	1.600	0.000	0.080	0.000	0.960
23	1100	120.	0.0	494	1.200	0.000	0.000	0.080	0.000	0.960
24	300	130.0	0.0	350	1.196	1.600	0.000	0.040	0.000	1.040
25	990	123.0	0.0	120	1.160	0.000	0.000	0.080	0.000	0.984
26	770	123.0	0.0	148	1.160	0.000	0.000	0.080	0.000	0.984
27	1650	120.0	384.6	926	1.536	2.000	0.000	0.000	3.076	0.960
28	330	120.0	0.0	138	2.800	0.000	0.000	0.000	0.000	0.960
29	1000	131.4	0.0	800	1.536	2.000	0.000	0.032	0.000	1.051
30	720	120.0	0.0	540	1.008	0.000	0.000	0.000	0.000	0.960

OBS	NPMILL	NPOC	REV	COST	PROF	_OBSTAT_			
16	1.020	1.425	3402.24	461.68	2940.57	01101	0	0	0
17	0.952	0.000	3769.22	3324.90	444.33	01101	0	0	0
18	0.816	1.632	2966.86	671.71	2295.14	01101	0	0	0
19	1.000	0.992	6772.48	1329.51	5442.97	01101	0	0	0
20	1.000	0.000	5700.00	591.04	5108.96	01101	0	0	0
21	1.000	1.600	3282.56	384.40	2898.16	01101	0	0	0
22	1.000	1.600	2520.00	559.20	1960.80	01101	0	0	0
23	1.000	0.000	2256.00	968.00	1288.00	01101	0	0	0
24	1.000	1.600	1447.00	57.45	1389.55	01101	0	0	0
25	1.000	0.000	1924.16	197.60	1726.56	01101	0	0	0
26	1.000	0.000	1907.68	120.00	1787.68	01101	0	0	0
27	1.000	1.600	2744.00	775.20	1968.80	01101	0	0	0
28	1.000	0.000	1166.80	106.40	1060.40	01101	0	0	0
29	1.000	1.600	1891.20	98.08	1793.12	01101	0	0	0
30	1.000	0.000	1491.20	174.38	1316.82	01101	0	0	0

OBS	IPEA	IMILL	IOC	IFERT	IFUNG	IINSE	INSDUM	QMILL	QOC	PIPEA	PIMILL
31	100	30	0.00	0.0	100	0.00	0	765	0	185.0	125.0
32	700	20	0.00	0.0	250	0.00	0	3080	0	200.0	150.0
33	350	15	2.00	0.0	150	0.00	0	300	0	150.0	136.7
34	400	30	3.00	0.0	200	0.00	0	300	25	185.0	136.7
35	210	3	10.00	0.0	500	0.00	0	100	50	230.0	136.7
36	60	5	0.10	0.0	100	0.00	0	270	375	160.0	135.0
37	300	12	0.00	1100.0	1500	0.00	0	4500	0	125.0	120.0
38	870	16	10.00	750.0	450	0.00	0	6900	500	163.2	125.0
39	1695	30	0.10	860.0	800	0.05	1	3000	200	137.7	122.5
40	3530	50	0.00	1750.0	1300	0.00	0	10000	0	144.4	122.5
41	300	20	15.20	1801.0	2000	0.00	0	4200	1600	141.4	122.5
42	680	10	0.00	1200.0	1200	0.00	0	1100	0	136.5	122.5
43	2995	25	25.00	1606.0	1400	0.15	1	7000	1000	130.2	125.0
44	1315	30	15.00	150.0	700	0.00	0	3000	300	127.8	125.0
45	600	6	0.00	150.0	500	0.00	0	350	0	160.0	125.0

OBS	PIOC	PIFERT	PIFUNG	PMILL	POC	DIOR	DEDIOR	CHCAS	LAND	CAP	QLAB
31	0.0	0.0	10.0	125.0	0.0	0	0	1	1.4	109400	0
32	0.0	0.0	10.0	125.0	0.0	1	0	0	4.1	273750	0
33	250.0	0.0	10.0	125.0	200.0	1	0	0	1.6	200250	11
34	250.0	0.0	12.5	125.0	200.0	0	1	0	1.9	155750	0
35	300.0	0.0	4.0	125.0	200.0	1	0	0	1.4	146250	0
36	19000.0	0.0	5.0	125.0	40.0	1	0	0	1.4	78250	0
37	0.0	162.0	10.0	125.0	0.0	1	0	0	2.8	610000	225
38	150.0	151.0	15.8	125.0	160.0	1	0	0	3.7	554750	42
39	30000.0	144.3	13.5	118.3	40.0	1	0	0	4.8	441800	60
40	0.0	101.2	11.1	118.3	0.0	1	0	0	8.6	820700	100
41	3806.3	78.9	6.0	118.3	85.0	1	0	0	4.9	458250	21
42	0.0	150.0	3.8	105.0	0.0	0	1	0	2.4	359250	75
43	150.0	135.2	11.5	125.0	160.0	1	0	0	6.8	524850	0
44	150.0	146.9	11.0	125.0	160.0	1	0	0	5.2	242750	0
45	0.0	160.0	10.0	125.0	0.0	1	0	0	1.3	385500	0

OBS	QPEA	PPEA	PLAB	QLABF	NPIPEA	NPIOC	NPIFERT	NPIFUNG	NPLAB	NPPEA
31	250	150.0	0.0	315	1.480	0.000	0.000	0.080	0.000	1.200
32	1060	150.0	0.0	384	1.333	0.000	0.000	0.066	0.000	1.000
33	600	150.0	454.5	193	1.097	1.829	0.00	0.073	3.324	1.097
34	220	150.0	0.0	385	1.353	1.829	0.000	0.091	0.000	1.097
35	200	150.0	0.0	490	1.682	2.195	0.000	0.029	0.000	1.097
36	100	150.0	0.0	432	1.185	140.741	0.000	0.037	0.000	1.111
37	6860	133.0	644.5	460	1.041	0.000	1.350	0.083	5.370	1.108
38	12000	132.4	714.3	315	1.305	1.200	1.208	0.126	5.714	1.059
39	7000	122.8	875.0	1080	1.124	244.898	1.177	0.110	7.142	1.002
40	6600	126.0	1000.0	1380	1.178	0.000	0.826	0.090	8.163	1.028
41	6750	127.4	833.3	720	1.154	31.072	0.644	0.048	6.802	1.040
42	3650	124.9	133.3	1170	1.114	0.000	1.224	0.031	1.088	1.019
43	10500	122.3	0.0	765	1.041	1.200	1.081	0.092	0.000	0.979
44	3300	123.0	0.0	480	1.022	1.200	1.175	0.088	0.000	0.984
45	1190	124.2	0.0	348	1.280	0.000	1.280	0.080	0.000	0.994

OBS	NPMILL	NPOC	REV	COST	PROF	_OBSTAT_			
31	1.000	0.000	1065.00	156.00	909.00	01101	0	0	0
32	0.833	0.000	3626.67	950.00	2676.67	01101	0	0	0
33	0.914	1.463	932.70	435.26	497.44	01101	0	0	0
34	0.914	1.463	552.30	565.11	-12.80	01101	0	0	0
35	0.914	1.463	384.05	389.90	-5.85	01101	0	0	0
36	0.925	0.296	472.22	88.89	383.33	01101	0	0	0
37	1.041	0.000	12293.33	3130.94	9162.40	01101	0	0	0
38	1.000	1.280	20254.00	2350.76	17903.24	01101	0	0	0
39	0.965	0.326	9982.86	3459.59	6523.27	01101	0	0	0
40	0.965	0.000	16447.18	6540.91	9906.27	01101	0	0	0
41	0.965	0.693	12186.20	2219.38	9966.82	01101	0	0	0
42	0.857	0.000	4665.31	2345.94	2319.37	01101	0	0	0
43	1.000	1.280	18560.00	5015.44	13544.56	01101	0	0	0
44	1.000	1.280	6632.00	1600.34	5031.66	01101	0	0	0
45	1.000	0.000	1533.20	1000.00	533.20	01101	0	0	0

OBS	IPEA	IMILL	IOC	IFERT	IFUNG	IINSE	INSDUM	QMILL	QOC	PIPEA	PIMILL
46	800	20.0	0.00	350.0	700	0.00	0	6000	0	150.0	125.0
47	2000	75.0	0.00	2500.0	2000	0.00	0	4800	0	142.0	125.0
48	1440	20.0	0.00	0.0	2000	0.00	0	3300	0	142.0	125.0
49	700	30.0	4.00	0.0	300	0.00	0	3600	115	160.0	150.0
50	300	10.0	3.00	0.0	150	0.00	0	1500	0	155.0	150.0
51	200	0.0	0.00	0.0	500	0.00	0	5500	0	160.0	150.0
52	800	20.0	0.30	3.1	800	0.00	0	4500	510	160.0	150.0
53	150	6.0	5.00	0.0	50	0.00	0	950	120	150.0	150.0
54	1000	15.0	16.00	0.0	500	0.00	0	2600	400	135.9	150.0
55	500	20.0	10.00	0.0	500	0.00	0	2150	200	160.0	120.0
56	650	20.0	0.10	5.0	400	0.15	1	2000	200	120.0	135.0
57	1700	20.0	15.00	0.0	400	0.00	0	1500	400	150.0	135.0
58	400	10.0	0.00	0.0	400	0.00	0	650	0	188.0	135.0
59	450	20.0	0.00	500.0	500	0.00	0	3000	0	180.0	135.0
60	290	12.0	0.00	150.0	100	9.00	1	3000	0	142.7	110.0

OBS	PIOC	PIFERT	PIFUNG	PMILL	POC	DIOR	DEDIOR	CHCAS	LAND	CAP	QLAB
46	0.0	140.0	10.0	125.0	0.0	1	0	0	5.4	659000	30
47	0.0	113.0	13.0	125.0	0.0	1	0	0	8.6	1276250	150
48	0.0	0.0	10.0	125.0	0.0	0	1	0	3.9	503000	0
49	200.0	0.0	10.0	125.0	210.0	0	1	0	2.8	175750	0
50	200.0	0.0	10.0	125.0	210.0	1	0	0	1.3	126250	0
51	0.0	0.0	5.0	125.0	0.0	0	1	0	2.1	145250	0
52	5000.0	70.0	5.0	125.0	60.0	1	0	0	3.5	498000	0
53	200.0	0.0	10.0	125.0	210.0	0	1	0	0.8	137500	0
54	160.0	0.0	10.0	125.0	160.0	1	0	0	3.7	709950	240
55	150.0	0.0	4.0	100.0	160.0	1	0	0	2.5	418750	12
5	30000.0	225.0	13.0	90.0	40.0	0	1	0	1.4	153300	10
57	150.0	0.0	11.3	101.0	160.0	1	0	0	3.3	397250	50
58	0.0	0.0	5.0	100.0	0.0	1	0	0	1.6	124000	0
59	0.0	130.0	5.0	90.0	0.0	1	0	0	3.3	348000	360
60	0.0	160.0	27.0	125.0	0.0	0	0	1	1.5	159250	0

OBS	QPEA	PPEA	PLAB	QLABF	NPIPEA	NPIOC	NPIFERT	NPIFUNG	NPLAB	NPPEA
46	12750	125.2	1000.0	491	1.200	0.000	1.120	0.080	8.000	1.001
47	13000	120.0	1488.1	2185	1.136	0.000	0.904	0.104	11.904	0.960
48	7200	120.0	0.0	1080	1.136	0.000	0.000	0.080	0.000	0.960
49	4400	136.0	0.0	600	1.066	1.333	0.000	0.066	0.000	0.906
50	2750	127.8	0.0	455	1.033	1.333	0.000	0.066	0.000	0.852
51	2150	131.0	0.0	630	1.066	0.000	0.000	0.033	0.000	0.873
52	2250	131.0	0.0	2430	1.066	33.333	0.466	0.033	0.000	0.873
53	150	120.0	1000.0	208	1.000	1.333	0.000	0.066	6.666	0.800
54	6760	134.5	666.7	540	0.906	1.067	0.000	0.066	4.444	0.897
55	4900	130.0	1666.7	255	1.333	1.250	0.000	0.033	13.889	1.083
56	1750	120.0	1350.0	345	0.888	222.222	1.666	0.096	10.000	0.888
57	2700	120.0	600.0	1000	1.111	1.111	0.000	0.083	4.444	0.888
58	2350	126.0	0.0	360	1.392	0.000	0.000	0.037	0.000	0.933
59	4900	121.4	430.6	630	1.333	0.000	0.962	0.037	3.189	0.899
60	4040	126.0	0.0	225	1.297	0.000	1.454	0.245	0.000	1.145

OBS	NPMILL	NPOC	REV	COST	PROF	_OBSTAT_			
46	1.000	0.000	18770.40	1648.00	17122.40	01101	0	0	0
47	1.000	0.000	17280.00	6525.72	10754.28	01101	0	0	0
48	1.000	0.000	10212.00	1795.84	8416.16	01101	0	0	0
49	0.833	1.400	7150.33	772.00	6378.33	01101	0	0	0
50	0.833	1.400	3593.33	324.00	3269.33	01101	0	0	0
51	0.833	0.000	6461.00	230.00	6231.00	01101	0	0	0
52	0.833	0.400	5919.00	891.45	5027.55	01101	0	0	0
53	0.833	1.400	1079.67	160.00	919.67	01101	0	0	0
54	0.833	1.066	8657.52	2023.12	6634.40	01101	0	0	0
55	0.833	1.333	7366.67	862.50	6504.16	01101	0	0	0
56	0.666	0.296	2948.15	746.8	2201.30	01101	0	0	0
57	0.748	1.185	3996.30	2161.26	1835.04	01101	0	0	0
58	0.740	0.000	2676.30	571.85	2104.44	01101	0	0	0
59	0.666	0.000	6408.52	2248.27	4160.25	01101	0	0	0
60	1.136	0.000	8036.73	618.94	7417.79	01101	0	0	0

OBS	IPEA	IMILL	IOC	IFERT	IFUNG	IINSE	INSDUM	QMILL	QOC	PIPEA	PIMILL
61	1030	15.0	0.00	300	200	0.00	0	4000	0	152.4	110.0
62	1000	40.0	5.00	50	700	0.00	0	2500	250	138.9	110.0
63	1600	30.0	0.00	1200	1500	0.00	0	3000	0	120.3	110.0
64	1025	20.0	0.00	450	1600	0.00	0	2350	0	138.9	110.0
65	280	20.0	0.00	300	500	0.00	0	1300	200	140.0	110.0
66	800	20.0	0.00	500	250	0.00	0	2000	0	152.7	110.0
67	1200	25.0	0.00	700	500	0.00	0	4100	0	141.6	115.0
68	830	20.0	0.00	880	550	0.00	0	2500	0	148.2	112.5
69	1230	30.0	0.00	650	850	0.00	0	5000	600	133.4	112.5
70	730	20.0	2.00	650	1000	0.00	0	1600	200	161.0	112.5
71	758	20.0	0.50	407	1100	0.00	0	160	1000	153.5	112.5
72	5100	48.0	22.00	0	600	0.00	0	6000	1875	140.5	110.0
73	1200	40.0	20.00	300	500	0.00	0	7500	500	140.0	110.0
74	1515	30.0	8.00	275	450	0.00	0	5000	400	130.1	110.0
75	1560	20.0	10.50	1210	800	0.08	1	3000	2000	133.5	110.0

OBS	PIOC	PIFERT	PIFUNG	PMILL	POC	DIOR	DEDIOR	CHCAS	LAND	CAP	QLAB
61	0.0	160.0	27.0	125.0	0.0	0	1	0	2.4	251250	120
62	140.0	130.0	10.0	125.0	160.0	0	1	0	2.1	195800	75
63	0.0	161.5	10.0	125.0	0.0	0	1	0	4.0	381450	0
64	0.0	140.0	10.0	125.0	0.0	0	1	0	2.5	297350	450
65	140.0	150.0	10.5	125.0	160.0	1	0	0	2.9	191250	210
66	0.0	167.6	10.0	122.5	0.0	1	0	0	1.3	205375	0
67	0.0	164.0	10.0	125.0	0.0	1	0	0	2.3	332250	0
68	0.0	150.1	12.5	122.5	0.0	0	1	0	1.6	397500	0
69	140.0	143.9	10.7	122.5	160.0	0	1	0	4.1	335750	150
70	205.0	160.0	11.3	122.5	145.0	0	1	0	2.6	172250	0
71	20000.0	160.7	7.4	120.0	40.0	1	0	0	1.6	279500	0
72	150.0	0.0	10.0	112.5	160.0	1	0	0	8.0	975250	120
73	145.0	100.0	10.0	125.0	160.0	1	0	0	2.9	466375	120
74	150.0	134.7	11.6	112.5	160.0	1	0	0	4.0	235450	0
75	1015.0	123.7	13.5	112.5	100.0	0	1	0	3.7	108050	25

OBS	QPEA	PPEA	PLAB	QLABF	NPIPEA	NPIOC	NPIFERT	NPIFUNG	NPLAB	NPPEA
61	6960	126.0	625.0	360	1.385	0.000	1.454	0.245	5.681	1.145
62	3177	120.0	1000.0	310	1.262	1.273	1.181	0.090	9.090	1.090
63	10300	120.2	0.0	440	1.093	0.000	1.468	0.090	0.000	1.093
64	6150	120.0	366.7	630	1.262	0.000	1.272	0.090	3.333	1.090
65	6350	120.0	357.0	450	1.272	1.273	1.363	0.095	3.245	1.090
66	3530	123.7	0.0	204	1.388	0.000	1.523	0.090	0.000	1.125
67	4580	121.9	0.0	550	1.231	0.000	1.426	0.086	0.000	1.060
68	2200	124.5	0.0	250	1.317	0.000	1.334	0.111	0.000	1.107
69	5100	122.2	533.3	1200	1.185	1.244	1.279	0.095	4.740	1.086
70	2900	129.2	0.0	1235	1.431	1.822	1.422	0.100	0.000	1.148
71	4550	127.7	0.0	720	1.364	177.778	1.428	0.065	0.000	1.135
72	8275	120.2	750.0	618	1.277	1.364	0.000	0.090	6.818	1.093
73	5490	122.6	708.3	490	1.272	1.318	0.909	0.090	6.439	1.114
74	1450	123.1	0.0	435	1.182	1.364	1.224	0.105	0.000	1.119
75	6900	122.1	600.0	1025	1.213	9.227	1.124	0.122	5.454	1.110

OBS	NPMILL	NPOC	REV	COST	PROF	_OBSTAT_			
61	1.136	0.000	12517.82	2594.29	9923.53	01101	0	0	0
62	1.136	1.454	6670.36	2073.64	4596.73	01101	0	0	0
63	1.136	0.000	14672.73	3648.00	11024.73	01101	0	0	0
64	1.136	0.000	9379.55	3512.61	5866.93	01101	0	0	0
65	1.136	1.454	8695.45	1494.73	7200.73	01101	0	0	0
66	1.113	0.000	6199.09	1895.09	4304.00	01101	0	0	0
67	1.086	0.000	9313.91	2519.30	6794.61	01101	0	0	0
68	1.088	0.000	5157.78	2328.61	2829.16	01101	0	0	0
69	1.088	1.422	11840.44	3081.84	8758.60	01101	0	0	0
70	1.088	1.288	5330.67	2073.24	3257.42	01101	0	0	0
71	1.066	0.355	7227.11	1776.87	5450.24	01101	0	0	0
72	1.022	1.454	17911.36	7416.82	10494.55	01101	0	0	0
73	1.136	1.454	15368.85	2644.51	12724.35	01101	0	0	0
74	1.022	1.454	7318.18	2186.95	5131.24	01101	0	0	0
75	1.022	0.909	12550.00	3585.40	8964.60	01101	0	0	0

OBS	IPEA	IMILL	IOC	IFERT	IFUNG	IINSE	INSDUM	QMILL	QOC	PIPEA	PIMILL
76	1317	20.0	0.50	265	1000	0.00	0	2900	6650	125.0	110.0
77	1000	20.0	1.00	650	700	0.00	0	2600	5000	150.0	110.0
78	800	12.0	0.55	300	800	0.00	0	800	2925	129.8	175.0
79	600	8.0	0.40	300	0	0.00	0	600	2650	151.7	106.0
80	995	20.0	0.55	913	900	0.55	1	1400	50	170.0	140.5
81	1045	10.0	0.50	672	800	2.50	1	1300	1200	160.1	140.5
82	285	10.0	0.25	150	500	0.00	0	500	1950	240.0	140.5
83	75	20.0	0.30	300	1100	0.00	0	400	1000	139.4	140.5
84	200	20.0	2.20	0	400	0.00	0	1700	1050	150.0	150.0
85	300	20.0	2.10	100	2600	0.50	1	1150	1155	160.0	150.0
86	300	14.0	3.60	0	150	0.05	1	700	200	157.5	150.0
87	800	30.0	0.05	0	200	0.00	0	1500	0	160.0	150.0
88	900	28.0	0.00	150	400	0.00	0	3300	0	160.0	150.0
89	200	20.0	5.25	0	800	0.00	0	0	1525	160.0	165.0
90	200	10.0	3.00	0	1200	0.00	0	310	300	160.0	165.0

OBS	PIOC	PIFERT	PIFUNG	PMILL	POC	DIOR	DEDIOR	CHCAS	LAND	CAP	QLAB
76	22000.0	131.8	7.8	112.5	47.2	1	0	0	4.3	170000	210
77	22000.0	253.8	15.4	100.0	40.0	0	1	0	4.2	431500	340
78	3182.0	165.0	10.0	125.0	46.2	0	1	0	1.8	245400	0
79	4250.0	165.0	0.0	125.0	43.4	0	1	0	1.3	230750	0
80	30000.0	123.8	12.3	125.0	200.0	1	0	0	2.5	260750	12
81	22000.0	137.4	12.1	125.0	150.0	1	0	0	2.0	213900	0
82	10000.0	160.0	5.4	125.0	48.7	0	1	0	2.0	94150	0
83	8333.3	160.0	5.8	125.0	40.0	0	1	0	1.9	332000	0
84	1136.0	0.0	3.0	116.7	47.6	1	0	0	3.6	256200	0
85	1714.0	60.0	1.1	110.0	46.8	1	0	0	1.5	237875	0
86	1076.0	0.0	10.0	116.7	200.0	1	0	0	1.5	137150	0
87	12000.0	0.0	10.0	116.7	40.0	1	0	0	1.4	196750	50
88	0.0	70.0	11.3	115.0	0.0	0	1	0	1.8	295250	0
89	952.0	0.0	4.0	0.0	44.3	0	1	0	4.8	195000	0
90	400.0	0.0	4.2	115.0	100.0	0	1	0	6.8	434750	0

OBS	QPEA	PPEA	PLAB	QLABF	NPIPEA	NPIOC	NPIFERT	NPIFUNG	NPLAB	NPPEA
76	7900	120.3	381.0	765	1.136	200.000	1.198	0.070	3.463	1.094
77	1500	120.0	470.6	810	1.363	200.000	2.307	0.140	4.278	1.090
78	1270	124.1	0.0	240	0.741	18.183	0.942	0.057	0.000	0.709
79	330	124.0	0.0	225	1.431	40.094	1.556	0.000	0.000	1.169
80	800	126.2	500.0	930	1.209	213.523	0.881	0.087	3.558	0.898
81	850	126.4	0.0	730	1.139	156.584	0.977	0.086	0.000	0.900
82	700	124.7	0.0	585	1.708	71.174	1.138	0.038	0.000	0.887
83	900	124.2	0.0	720	0.992	59.312	1.138	0.041	0.000	0.884
84	1050	120.0	0.0	810	1.000	7.573	0.000	0.020	0.000	0.800
85	1000	120.0	0.0	720	1.066	11.427	0.400	0.007	0.000	0.800
86	300	115.8	0.0	330	1.050	7.173	0.000	0.066	0.000	0.772
87	2400	135.0	200.0	595	1.066	80.000	0.000	0.066	1.333	0.900
88	3230	120.0	0.0	294	1.066	0.000	0.466	0.075	0.000	0.800
89	950	132.5	0.0	1400	0.969	5.770	0.000	0.024	0.000	0.803
90	2050	130.0	0.0	1155	0.969	2.424	0.000	0.025	0.000	0.787

OBS	NPMILL	NPOC	REV	COST	PROF	_OBSTAT_			
76	1.022	0.429	14466.18	2712.38	11753.80	01101	0	0	0
77	0.909	0.363	5818.18	4615.95	1202.24	01101	0	0	0
78	0.714	0.264	2244.43	931.94	1312.49	01101	0	0	0
79	1.179	0.409	2178.58	1341.70	836.89	01101	0	0	0
80	0.889	1.423	2035.59	2247.33	-211.74	01101	0	0	0
81	0.889	1.067	3202.85	1995.14	1207.71	01101	0	0	0
82	0.889	0.346	1742.10	694.66	1047.44	01101	0	0	0
83	0.889	0.284	1436.65	479.25	957.40	01101	0	0	0
84	0.778	0.317	2495.80	224.66	2271.14	01101	0	0	0
85	0.733	0.312	2003.69	403.06	1600.63	01101	0	0	0
86	0.778	1.333	1042.87	350.82	692.04	01101	0	0	0
87	0.778	0.266	3327.00	937.33	2389.67	01101	0	0	0
88	0.766	0.000	5114.00	1060.13	4053.87	01101	0	0	0
89	0.000	0.268	1172.32	243.62	928.69	01101	0	0	0
90	0.696	0.606	2013.03	231.76	1781.27	01101	0	0	0

OBS	IPEA	IMILL	IOC	IFERT	IFUNG	IINSE	INSDUM	QMILL	QOC	PIPEA	PIMILL
91	1000	5.0	5.00	50	550	0.00	0	900	30	175.0	165.0
92	1700	55.0	11.50	0	250	0.60	1	1200	10755	150.0	165.0
93	200	8.0	0.00	0	100	0.00	0	200	0	160.0	165.0
94	800	5.0	2.00	0	200	0.00	0	4500	34	155.0	165.0
95	750	35.0	0.00	200	300	0.00	0	1400	0	136.5	137.5
96	1080	40.0	13.10	320	500	3.00	1	4500	1000	154.2	137.5
97	300	20.0	2.00	100	150	0.00	1	3130	48	140.0	125.0
98	1400	50.0	2.50	0	400	0.00	1	5500	400	125.0	150.0
99	950	20.0	6.50	300	1200	0.00	0	2330	175	143.2	137.5
100	200	10.0	0.50	0	300	0.00	0	800	1760	120.0	137.5
101	100	20.0	32.00	100	100	6.00	1	1200	2250	130.0	125.0
102	200	25.0	45.00	150	50	9.50	1	3000	1505	154.1	125.0
103	780	30.0	0.05	900	2000	1.00	1	6000	19650	206.3	125.0
104	350	25.0	15.30	63	400	5.00	1	1200	2846	154.1	125.0
105	900	16.0	45.00	200	200	0.00	0	4900	1530	140.0	125.0

OBS	PIOC	PIFERT	PIFUNG	PMILL	POC	DIOR	DEDIOR	CHCAS	LAND	CAP	QLAB
91	300.0	200.0	10.0	115.0	200.0	0	1	0	4.0	383000	240
92	2826.0	0.0	12.0	115.0	41.9	1	0	0	5.0	154000	0
93	0.0	0.0	12.0	115.0	0.0	1	0	0	1.5	219125	0
94	300.0	0.0	10.0	115.0	200.0	0	1	0	1.9	202750	0
95	0.0	100.0	16.	116.7	0.0	1	0	0	2.7	246350	55
96	572.5	146.9	10.0	116.7	88.0	0	1	0	3.2	241250	50
97	0.0	152.0	16.7	125.0	187.0	0	0	0	1.0	162250	0
98	175.0	0.0	2.3	125.0	160.0	1	0	0	3.2	234500	120
99	124.3	135.0	5.0	100.0	165.7	1	0	0	4.2	213600	0
100	125.0	0.0	6.0	116.7	101.7	0	1	0	1.5	15900	30
101	100.0	162.0	13.0	100.0	121.8	0	1	0	2.7	274750	18
102	103.0	162.0	16.0	95.0	167.0	1	0	0	1.1	317500	200
103	6000.0	160.0	5.0	95.0	54.4	1	0	0	8.9	572000	225
104	5369.6	165.9	13.0	90.0	85.0	1	0	0	1.4	315500	47
105	105.6	136.0	16.0	95.0	169.3	0	0	0	3.5	518000	420

OBS	QPEA	PPEA	PLAB	QLABF	NPIPEA	NPIOC	NPIFERT	NPIFUNG	NPLAB	NPPEA
91	1100	132.5	833.3	240	1.060	1.818	1.212	0.060	5.050	0.803
92	950	120.0	0.0	615	0.909	17.127	0.000	0.072	0.000	0.727
93	450	132.5	0.0	150	0.969	0.000	0.000	0.072	0.000	0.803
94	1230	147.6	0.0	180	0.939	1.818	0.000	0.060	0.000	0.894
95	1800	120.0	591.0	330	0.992	0.000	0.727	0.116	4.298	0.872
96	2150	121.3	460.0	356	1.121	4.164	1.068	0.072	3.345	0.882
97	1260	140.0	0.0	216	1.120	0.000	1.216	0.133	0.000	1.120
98	4455	140.0	375.0	280	0.833	1.167	0.000	0.015	2.500	0.933
99	1350	120.0	0.0	1710	1.041	0.904	0.981	0.036	0.000	0.872
100	1100	116.1	216.7	270	0.872	0.909	0.000	0.043	1.576	0.844
101	600	120.0	1111.1	1400	1.040	0.800	1.296	0.104	8.888	0.960
102	800	130.0	50.0	1233	1.232	0.824	1.296	0.128	0.40	1.040
103	8000	126.5	300.0	1360	1.650	48.000	1.280	0.040	2.400	1.012
104	1850	120.0	542.5	780	1.232	42.957	1.327	0.104	4.340	0.960
105	2530	120.00	500.0	585	1.120	0.845	1.088	0.128	4.000	0.960

OBS	NPMILL	NPOC	REV	COST	PROF	_OBSTAT_			
91	0.696	1.212	1546.97	2375.71	-828.74	01101	0	0	0
92	0.696	0.253	4258.39	1760.60	2497.79	01101	0	0	0
93	0.696	0.000	500.76	201.21	299.55	01101	0	0	0
94	0.696	1.212	4277.87	767.27	3510.59	01101	0	0	0
95	0.848	0.000	2759.13	1161.31	1597.82	01101	0	0	0
96	0.848	0.640	6357.45	1811.23	4546.23	01101	0	0	0
97	1.000	1.496	4613.01	477.64	4135.37	01101	0	0	0
98	0.833	1.066	9168.00	1475.72	7692.28	01101	0	0	0
99	0.727	1.205	3083.62	1333.44	1750.18	01101	0	0	0
100	0.848	0.739	2909.54	235.37	2674.17	01101	0	0	0
101	0.800	0.974	3728.40	429.60	3298.80	01101	0	0	0
102	0.760	1.336	5122.68	564.44	4558.24	01101	0	0	0
103	0.760	0.435	21211.68	3061.71	18149.97	01101	0	0	0
104	0.720	0.680	4575.28	1417.91	3157.37	01101	0	0	0
105	0.760	1.354	8225.03	2969.22	5255.82	01101	0	0	0

OBS	IPEA	IMILL	IOC	IFERT	IFUNG	IINSE	INSDUM	QMILL	QOC	PIPEA	PIMILL
106	1800	20.0	38.00	550	750	0.00	0	7900	2035	140.0	125.0
107	460	10.0	8.15	304	500	0.50	1	350	1650	167.0	133.3
108	180	3.5	25.25	157	500	1.00	1	850	3500	170.0	125.0
109	845	10.0	10.10	455	750	2.00	1	1500	2300	176.6	133.3
110	465	12.0	4.00	150	300	0.00	0	550	150	151.0	133.3
111	235	4.0	0.00	150	100	0.00	0	600	0	158.0	150.0
112	2320	80.0	0.00	1950	500	0.00	0	10000	0	147.9	125.0
113	830	15.0	0.00	600	200	0.00	0	2550	0	147.2	125.0
114	2295	50.0	4.00	1350	400	0.00	0	6000	400	135.2	125.0
115	1465	25.0	0.00	150	400	0.00	0	10000	0	134.3	125.0
116	1500	27.0	0.00	1150	700	0.00	0	4000	0	138.6	125.0
117	565	15.0	5.00	400	400	0.00	0	1500	200	137.0	125.0
118	1000	40.0	10.50	0	400	0.50	1	2800	2950	153.6	122.5
119	2780	30.0	8.50	2250	1300	0.00	0	6000	2900	151.5	122.5
120	860	30.0	25.00	800	1200	0.00	0	1400	500	164.7	122.5

OBS	PIOC	PIFERT	PIFUNG	PMILL	POC	DIOR	DEDIOR	CHCAS	LAND	CAP	QLAB
106	107.9	138.4	10.0	95.0	168.0	0	0	0	4.1	499750	0
107	539.9	150.7	11.0	105.0	50.9	1	0	0	1.8	222750	0
108	366.3	147.3	8.0	105.0	60.0	0	1	0	0.9	109875	150
109	420.8	146.7	12.8	111.7	55.7	1	0	0	1.8	266500	0
110	150.0	146.9	12.	111.7	160.0	1	0	0	1.7	345000	0
111	0.0	165.0	10.0	111.7	0.0	1	0	0	1.0	160000	0
112	0.0	140.7	5.0	125.0	0.0	1	0	0	5.1	373500	360
113	0.0	132.5	0.0	100.0	0.0	0	1	0	1.7	126750	0
114	125.0	141.7	10.0	100.0	160.0	1	0	0	4.8	985850	120
115	0.0	146.9	13.0	100.0	0.0	0	0	0	2.7	409850	15
116	0.0	120.0	12.5	100.0	0.0	1	0	0	3.0	485700	70
117	100.0	131.3	12.5	100.0	100.0	1	0	0	1.2	172250	0
118	15289.8	0.0	12.5	111.0	68.5	1	0	0	2.8	59500	15
119	376.5	153.7	10.0	100.0	97.9	1	0	0	3.1	435500	104
120	150.0	138.8	13.5	110.0	160.0	1	0	0	2.8	211500	0

OBS	QPEA	PPEA	PLAB	QLABF	NPIPEA	NPIOC	NPIFERT	NPIFUNG	NPLAB	NPPEA
106	7865	120.0	0.0	1020	1.120	0.863	1.107	0.080	0.000	0.960
107	1825	141.2	0.0	760	1.252	4.050	1.130	0.082	0.000	1.059
108	900	145.0	460.0	180	1.360	2.930	1.178	0.064	3.680	1.160
109	2650	139.0	0.0	495	1.324	3.157	1.100	0.096	0.000	1.04
110	700	127.5	0.0	260	1.132	1.125	1.102	0.092	0.000	0.956
111	1710	142.5	0.0	290	1.053	0.000	1.100	0.066	0.000	0.950
112	15500	132.9	708.3	495	1.183	0.000	1.125	0.040	5.666	1.063
113	6000	123.5	1254.0	235	1.177	0.000	1.060	0.080	10.032	0.988
114	16000	121.7	833.3	519	1.081	1.000	1.133	0.080	6.666	0.973
115	7800	121.6	2000.0	980	1.074	0.000	1.175	0.104	16.000	0.972
116	5000	120.0	928.6	266	1.108	0.000	0.960	0.100	7.428	0.960
117	4400	125.1	0.0	630	1.096	0.800	1.050	0.100	0.000	1.000
118	1300	130.0	1333.3	740	1.253	124.815	0.000	0.1020	10.88	1.061
119	9400	132.1	721.2	1050	1.236	11.237	1.254	0.081	5.887	1.078
120	2450	128.0	0.0	1155	1.344	1.224	1.133	0.110	0.000	1.045

OBS	NPMILL	NPOC	REV	COST	PROF		_OBSTAT_		
106	0.760	1.344	16289.44	2717.76	13571.68	01101	0	0	0
107	0.787	0.381	2839.35	994.25	1845.10	01101	0	0	0
108	0.840	0.480	3438.00	1087.80	2350.20	01101	0	0	0
109	0.837	0.417	4983.20	1724.12	3259.07	01101	0	0	0
110	0.837	1.200	1310.47	724.23	586.23	01101	0	0	0
111	0.744	0.000	2071.47	419.20	1652.27	01101	0	0	0
112	1.000	0.000	26480.00	6999.85	19480.15	01101	0	0	0
113	0.800	0.000	7972.00	1629.41	6342.59	01101	0	0	0
114	0.800	1.280	20892.00	4848.60	16043.40	01101	0	0	0
115	0.800	0.000	15588.80	2031.88	13556.92	01101	0	0	0
116	0.800	0.000	8000.00	3357.22	4642.78	01101	0	0	0
117	0.800	0.800	5764.00	1083.40	4680.60	01101	0	0	0
118	0.906	0.559	5566.33	2768.51	2797.82	01101	0	0	0
119	0.816	0.799	17356.00	7075.10	10280.90	01101	0	0	0
120	0.897	1.306	4471.84	2225.57	2246.27	01101	0	0	0

OBS	IPEA	IMILL	IOC	IFERT	IFUNG	IINSE	INSDUM	QMILL	QOC	PIPEA	PIMILL
121	1040	30.0	8.05	1004	800	0.00	0	3100	1975	137.8	122.5
122	1360	50.0	10.00	1300	800	0.00	0	4500	700	160.0	125.0
123	1790	40.0	0.00	1600	300	0.00	0	4500	0	153.8	120.0
124	1000	10.0	5.10	300	0	1.00	1	2000	2050	150.0	127.5
125	915	10.0	14.50	300	450	0.00	0	1500	850	158.3	127.5
126	300	4.0	3.25	3	400	0.50	1	1450	6600	140.0	127.5
127	280	10.0	0.50	0	200	0.00	0	2200	1760	150.0	127.5
128	795	10.0	0.00	700	400	0.00	0	2520	0	160.0	125.0
129	2260	50.0	6.00	150	400	0.00	0	4250	700	160.0	130.0
130	600	80.0	30.00	0	3000	0.00	0	6100	3500	180.0	125.0
131	3800	55.0	4.00	0	2100	0.00	0	4700	1150	134.2	125.0
132	2000	40.0	2.00	0	2600	0.00	0	4900	250	160.0	125.0
133	2400	25.0	4.00	0	2000	0.00	0	3500	400	155.8	125.0
134	2000	50.0	0.00	0	1200	0.00	0	2500	0	155.0	125.0
135	800	15.0	0.00	0	600	0.00	0	1500	0	150.0	125.0

OBS	PIOC	PIFERT	PIFUNG	PMILL	POC	DIOR	DEDIOR	CHCAS	LAND	CAP	QLAB
121	22235.4	157.6	12.5	125.0	95.7	1	0	0	5.7	201250	0
122	150.0	166.2	8.8	110.0	160.0	1	0	0	3.2	448050	0
123	0.0	160.6	11.7	110.0	0.0	0	1	0	3.1	456750	0
124	21979.8	100.0	0.0	117.5	58.5	1	0	0	1.8	182500	0
125	132.9	143.5	12.1	117.5	110.6	1	0	0	2.7	67375	12
126	18946.6	200.0	5.3	117.5	46.2	1	0	0	4.2	205250	0
127	19888.1	0.0	5.0	125.0	41.5	1	0	0	1.4	101200	0
128	0.0	141.8	10.0	110.0	0.0	0	1	0	1.5	291250	120
129	150.0	165.0	10.0	117.5	160.0	0	1	0	4.4	293000	240
130	135.5	0.0	1.5	110.0	76.9	1	0	0	6.4	747000	0
131	150.0	0.0	4.7	110.0	85.7	0	1	0	6.0	585900	0
132	150.0	0.0	6.2	110.0	160.0	1	0	0	6.8	282500	24
133	150.0	0.0	10.0	110.0	160.0	0	1	0	4.2	355000	0
134	0.0	0.0	10.0	110.0	0.0	0	0	0	7.6	622250	0
135	0.0	0.0	1.0	110.0	0.0	1	0	0	3.1	481000	120

OBS	QPEA	PPEA	PLAB	QLABF	NPIPEA	NPIOC	NPIFERT	NPIFUNG	NPLAB	NPPEA
121	5900	123.9	0.0	1260	1.124	181.513	1.286	0.102	0.000	1.011
122	3460	126.0	0.0	413	1.280	1.200	1.329	0.070	0.000	1.008
123	3550	126.9	0.0	301	1.281	0.000	1.338	0.097	0.000	1.057
124	2700	120.0	0.0	485	1.176	172.391	0.784	0.000	0.000	0.941
125	3650	131.3	666.7	392	1.241	1.042	1.125	0.094	5.229	1.030
126	1050	120.0	0.0	630	1.098	148.601	1.568	0.041	0.000	0.941
127	900	140.0	0.0	600	1.176	155.985	0.000	0.039	0.000	1.098
128	3560	130.8	266.7	434	1.280	0.000	1.134	0.080	2.133	1.046
129	6700	143.1	625.0	490	1.230	1.154	1.269	0.076	4.807	1.101
130	5450	142.3	0.0	1840	1.440	1.084	0.000	0.012	0.000	1.138
131	8000	130.6	0.0	1200	1.073	1.200	0.000	0.037	0.000	1.044
132	2700	120.0	729.2	1450	1.280	1.200	0.000	0.049	5.833	0.960
133	1300	120.0	0.0	1000	1.246	1.200	0.000	0.080	0.000	0.960
134	7686	138.0	0.0	962	1.240	0.000	0.000	0.080	0.000	1.104
135	2826	120.0	250.0	480	1.200	0.000	0.000	0.008	2.000	0.960

OBS	NPMILL	NPOC	REV	COST	PROF	_OBSTAT_			
121	1.020	0.781	10674.35	4004.39	6669.96	01101	0	0	0
122	0.880	1.280	8343.68	3537.60	4806.08	01101	0	0	0
123	0.916	0.000	7879.17	4464.77	3414.40	01101	0	0	0
124	0.921	0.458	5324.90	2290.96	3033.95	01101	0	0	0
125	0.921	0.867	5880.08	1594.25	4285.83	01101	0	0	0
126	0.921	0.362	4716.04	833.70	3882.34	01101	0	0	0
127	0.980	0.325	3717.96	415.25	3302.71	01101	0	0	0
128	0.880	0.000	5943.20	2099.71	3843.49	01101	0	0	0
129	0.903	1.230	12082.88	4163.46	7919.42	01101	0	0	0
130	0.880	0.615	13725.48	932.52	12792.96	01101	0	0	0
131	0.880	0.685	13282.84	4163.44	9119.40	01101	0	0	0
132	0.880	1.280	7224.00	2831.37	4392.63	01101	0	0	0
133	0.880	1.280	4840.00	3156.16	1683.84	01101	0	0	0
134	0.880	0.000	10685.34	2576.00	8109.34	01101	0	0	0
135	0.880	0.000	4032.96	1204.80	2828.16	01101	0	0	0

OBS	IPEA	IMILL	IOC	IFERT	IFUNG	IINSE	INSDUM	QMILL	QOC	PIPEA	PIMILL
136	900	13.0	0.00	200	300	0.00	0	600	0	165.0	135.0
137	900	26.0	0.00	150	200	0.00	0	2300	0	130.0	100.0
138	785	10.0	12.00	300	400	0.00	0	1500	1000	124.7	117.5
139	335	4.0	1.00	150	200	0.00	0	850	100	135.5	117.5
140	1500	20.0	7.00	700	800	0.00	0	2000	500	155.0	117.5
141	620	20.0	2.00	150	200	0.00	0	1950	300	155.0	117.5
142	655	20.0	15.00	450	1000	0.00	0	2500	500	170.3	125.0
143	410	25.0	8.00	700	700	0.00	0	1800	50	289.3	125.0
144	300	10.0	4.00	200	250	0.00	0	600	120	200.0	125.0
145	1100	26.0	5.25	275	300	0.25	1	2300	1650	150.0	125.0
146	1305	10.0	0.13	450	1500	0.00	0	2400	0	147.6	125.0
147	865	40.0	0.00	300	500	0.00	0	1700	0	183.1	125.0

OBS	PIOC	PIFERT	PIFUNG	PMILL	POC	DIOR	DEDIOR	CHCAS	LAND	CAP	QLAB
136	0.0	140.0	5.0	125.0	0.0	0	0	0	1.8	180450	162
137	0.0	150.0	3.5	125.0	0.0	0	1	0	1.8	127500	0
138	136.0	130.0	11.8	125.0	118.0	1	0	0	2.7	293450	0
139	150.0	140.0	13.5	125.0	160.0	1	0	0	1.1	84750	0
140	138.0	163.0	12.5	125.0	118.0	0	1	0	2.9	222500	0
141	150.0	146.9	13.5	125.0	160.0	0	0	1	1.8	166600	0
142	0.0	159.0	11.5	125.0	160.0	0	1	0	1.9	264250	240
143	700.0	153.3	10.3	125.0	160.0	1	0	0	2.0	503500	240
144	110.4	150.0	10.0	125.0	125.0	0	1	0	1.2	81500	0
145	18221.2	150.0	12.0	125.0	58.2	0	1	0	3.2	392750	15
146	38461.5	150.0	8.4	125.0	40.0	0	1	0	1.8	292500	0
147	0.0	150.0	8.2	125.0	0.0	0	1	0	2.6	114750	0

OBS	QPEA	PPEA	PLAB	QLABF	NPIPEA	NPIOC	NPIFERT	NPIFUNG	NPLAB	NPPEA
136	1815	120.0	0.0	540	1.222	0.000	1.037	0.037	0.000	0.888
137	1870	120.0	0.0	342	1.300	0.000	1.500	0.035	0.000	1.200
138	5100	121.2	0.0	935	1.061	1.157	1.106	0.100	0.000	1.032
139	1550	125.8	0.0	190	1.153	1.277	1.191	0.114	0.000	1.070
140	2350	120.0	0.0	540	1.319	1.174	1.387	0.106	0.000	1.021
141	1200	120.0	0.0	582	1.319	1.277	1.250	0.114	0.000	1.021
142	2445	127.8	312.5	246	1.362	0.000	1.2720	0.092	2.500	1.022
143	3500	132.8	604.2	566	2.314	5.600	1.226	0.082	4.833	1.062
144	450	120.0	0.0	186	1.600	0.883	1.200	0.080	0.000	0.960
145	1500	150.0	500.0	624	1.200	145.770	1.200	0.096	4.000	1.200
146	3175	125.6	0.0	1260	1.180	307.692	1.200	0.067	0.000	1.005
147	2700	123.7	0.0	1170	1.464	0.000	1.200	0.065	0.000	0.989

OBS	NPMILL	NPOC	REV	COST	PROF	_OBSTAT_			
136	0.925	0.000	2168.89	1318.52	850.37	01101	0	0	0
137	1.250	0.000	5119.00	1402.00	3717.00	01101	0	0	0
138	1.063	1.004	7864.68	1219.08	6645.60	01101	0	0	0
139	1.063	1.361	2700.00	589.30	2110.70	01101	0	0	0
140	1.063	1.004	5029.79	3043.11	1986.67	01101	0	0	0
141	1.063	1.361	3708.51	1030.94	2677.57	01101	0	0	0
142	1.000	1.280	5641.20	2156.77	3484.43	01101	0	0	0
143	1.000	1.280	5584.00	3069.93	2514.07	01101	0	0	0
144	1.000	1.000	1152.00	743.53	408.47	01101	0	0	0
145	1.000	0.465	4868.24	2504.09	2364.15	01101	0	0	0
146	1.000	0.320	5592.00	2221.74	3370.26	01101	0	0	0
147	1.000	0.000	4372.00	1659.85	2712.15	01101	0	0	0