Farm-Household Analysis of Policies Affecting Peanut Production in Senegal

by

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Abstract

A farm-level survey of 150 households was conducted in the peanut basin of Senegal, and a profit function system estimated, for the purpose of analyzing the effects of policies affecting the peanut sector. Producer price of peanuts has relatively little effect on production, but producer price of millet influences peanut seed demand.

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Groundnuts are the most important agricultural commodity in Senegal, but production and exports of the crop have been in decline in recent years. Efforts to understand the reasons for this decline, including the importance of government policies, have been hindered by the absence of an understanding of the basic supply and demand relationships for agricultural commodities in the country. Public involvement in the agricultural sector has declined and major currency shifts have occurred in the past few years. Unfortunately, adequate time series data for the sector do not exist to estimate reliable aggregate economic relationships. In an effort to better understand what is occurring in the peanut basin, a study of farm-household level relationships on the production side was completed using primary data generated through a survey of 150 farm households. This paper reports on the results of the analysis of that data, including the effects of the 50 percent currency devaluation that occurred in 1994.

Background

Groundnuts are currently the second-ranked export commodity in Senegal after fish products. With 40 percent of cultivated land used for producing groundnuts, and one million people involved in growing and processing the crop, the level of groundnut production has a major impact throughout the economy. The government has historically been heavily involved in supplying inputs, marketing, and processing, and recent efforts to liberalize the economy have not been as rigorously applied in the groundnut sector as

other sectors (Pison et al, 1995). The removal of input subsidies, however, and the currency devaluation have had potentially significant effects on incentives to produce groundnuts.

Small farms produce most of Senegal's groundnuts. These farms are usually not owned and operated by nuclear families, but instead are organized around compounds made up of two to five nuclear families, unmarried males, and hired laborers. A male typically heads the compound whose household includes his wife or wives and his young children. Other male relatives such as brothers, cousins, or sons head the secondary households within the compound.

The compound usually grows millet as a subsistence crop, groundnuts as a cash crop, and minor crops such as vegetables and roots. The head of the compound has responsibility for allocating the various fields among the members of the compound. He ensures that enough land is planted to millet before the other land is distributed so that basic food needs are met. Everyone works in the communal millet fields. The other fields are allocated among the various adult members of the compound who manage them according to their own resources and needs. Labor is readily shared within the compound. Although labor for seasonal needs may also be hired from outside the compound, relatively little is (Kelly et al, 1996). Recipients of land distributed by the head typically "pay" for the land by working on the head of the compound's fields in the morning before working on their own fields. The proceeds from selling output from an individual's fields typically belong to the individual, particularly in the case of groundnuts or other cash crops.

There are a variety of policy instruments that might influence groundnut production, including direct policies that influence output price and policies that influence agricultural inputs such as seeds, fertilizer, pesticides, labor, and equipment. Credit policy has been a favorite instrument in the past, although most credit subsidies have now been removed (Kelly et al, 1996, Diagana et al, 1996). Indirect policies such as exchange rate policies can be as important as direct policies. These policies may affect household members differently. Labor policies may influence adult members to leave the compound to seek employment, although women, who are very active in farming in Senegal, rarely migrate for off-farm work. Peanut price policy can influence millet production and vice versa.

In order to assess the effects of government policies, it is essential to have elasticities to measure output and input responsiveness to price policies, taxes, and other government interventions that seek to increase groundnut production or increase food self-sufficiency. They are also needed to help quantify the impacts of exogenous shocks, such as currency devaluation, on production in the groundnut basin.

Model specification and data

Duality theory provided the conceptual framework for analyzing the output and input demand responses. It was necessary to assume that producers are price takers and that production and consumption decisions are separable so that the production side could be modeled alone. The following normalized quadratic variable profit function was used to model profit maximization in Senegal's peanut basin:

$$\Pi = \sum_{i=1}^{8} \alpha_i P_i + \frac{1}{2} \sum_{i=1}^{8} \sum_{k=1}^{8} \varphi_{ik} P_i P_k + \sum_{i=1}^{4} \beta_i Z_i + \frac{1}{2} \sum_{i=1}^{4} \sum_{k=1}^{4} \gamma_{ik} Z_i Z_k + \sum_{i=1}^{8} \sum_{k=1}^{4} \rho_{ik} P_i Z_k$$

where P is a vector of prices that includes both factor and output prices, and the Z vector contains fixed and environmental factors thought to explain variation in profit levels.

By Hotelling's Lemma, output supply and input demand equations are derived by differentiating the profit function with respect to output and input prices. The derived equations are linear and each contains the same set of right hand side variables. The equations were normalized on the millet seed variable. Because the error terms across equations may be correlated, estimating the system of eight equations using the Seemingly Unrelated Regression technique increased the efficiency of estimation.

A survey of farm households in the Kaolack and Fatick regions of the groundnut basin was conducted to obtain the data to estimate the system. The survey was pre-tested and revised to capture the complexity of the household structure. Twenty villages were selected randomly for the survey, with roughly seven randomly selected households per village. Among the data gathered were: household characteristics, acreage of each crop, prices received, quantities produced, inputs applied and their prices, wage rates, and information on environmental factors such as soil type. Secondary data were collected on official prices of inputs and outputs and on government pricing and other policies.

The producer prices collected were prices received by the farmer in the 1995-96 season. The survey was conducted in the middle of the 1996-97 season. Farmers were asked about the prices that they received for the previous year's crops and these prices were used as expected output prices in the equations. Outputs included were groundnuts, millet, and "other crops". Input prices were the prices paid for groundnut seed, "other crop" seed, fertilizer, fungicide, and hired labor. Measurement of each of these variables was relatively straightforward except for labor. The labor variable was defined as man-

days of work. Adult female labor input was assumed to be equivalent to that of an adult male. Child labor was valued at 50 percent of adult labor. No differentiation was made between the labor input of male and female children.

The environmental variables were: land; a proxy for the service flow from capital; family labor; and dummy variables for soil type and for insecticide use. The use of insecticide was limited to the "other crops" variable because farmers do not use insecticides in the production of groundnuts or millet, but do use them on watermelon, cotton, and the other minor cash crops. Family labor was considered a fixed cost, as there were no economically competing activities in which a family member could engage during the cropping season.

During model estimation, symmetry and other restrictions were placed on the equations and tested. After estimation, elasticities were calculated and policy effects were analyzed. A descriptive analysis of peanut policies in Senegal was also completed to supplement the quantitative results.

Results

Estimation results for the three output supply equations and for groundnut seed demand are presented in tables 1 to 4. In the discussion that follows, the maximum p-value for a variable to be defined as "significant" (under the null hypothesis that it equals 0) is 0.10.

Table 1: Estimation of peanut 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	-886.20	-0.69	.49

Table 2: 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

* N prefix = normalized; (PIPEA=price of groundnut seed; PIOC=price of 'other crops' seed; PIFERT=price of fertilizer; PIFUNG=price of fungicides; PLAB=price of labor (hired); PPEA=producer price of groundnuts; PMILL=price of millet; POC=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' and clay 'Deck'soils; CHCAS=garden soil

Table 3: 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**	2560.29	6.37	.00
DIOR	237.75	0.32	.75
DEDEIOR	156.37	0.20	.84
CHCAS	-479.78	-0.43	.67

* As above.
** Dummy variable for insecticide

Table 4: Estimation of peanut 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

* As above.

Results for the groundnut supply equation are found in Table 1. The dependent variable is the quantity of groundnuts produced. The coefficient on the normalized price of groundnuts (NPPEA) is positive in the equation, but not very significant (p-value = 0.14). The input price of groundnut seed (NPIPEA) has a negative impact on the quantity of groundnuts produced, as expected, and is significant (p-value = 0.10).

Contrary to expectations, the signs on the hired labor (NPLAB) and family labor (QLABF) variables are positive and negative, respectively. There are several possible explanations. First, the labor market in the region is not highly developed and wage rates do not fully capture the cost of labor. Second, especially in the case of family labor, the wrong sign may indicate variable mis-specification. Labor in the region is a continuing sequential activity involving land clearing, seeding, weeding, and harvest. Workers may be hired for one particular activity or for all activities. Similarly, each family member may not engage in all activities as assumed. Another problem related to the absence of a well-functioning labor market is the difficulty of calculating the opportunity cost of labor. In this study, the opportunity cost of the family labor was assumed to be zero because it was assumed that it had few opportunities for outside employment. However, that may not be the case.

The price of millet has a significant (p-value = .04) and positive impact on groundnut supply. The response of groundnut output to changes in the price of millet is inelastic with a cross-price elasticity of supply of 0.55. Peanut and millet thus appear to be weak production complements. The aggregate variable, "other crops" has a negative and significant impact on groundnut output (p-value = 0.06) as expected. The elasticity of

supply of groundnuts with respect to the price of "other crops" is -0.11. Land and capital have positive and significant impacts on groundnut supply.

The estimation results for the output supply equation for millet and “other crops” are found in Table 2 and 3. The dependent variables are the quantity of millet produced, and the quantity of "other crops" produced. 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 groundnuts 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. It should be noted, however, that strategies to expand land area within the region are becoming more and more problematic as the available bush fallow lands become scarcer due to increased population pressure.

For the groundnut seed demand equation (Table 4), only two price variables are significant: the normalized prices of groundnuts and millet. Although the sign for the price of groundnut seed (NPIPEA) appropriately indicates a downward-sloping input demand function, the size of the rejection region is too large to render a conclusion. The groundnut producer price variable (NPPEA) is significant and has a positive impact on the demand for groundnut seed as expected. The normalized millet output price (NPMILL) is also significant, but with a positive effect on the demand for groundnut seed, contrary to expectations. This is additional evidence that there may be a complementary relationship between groundnut and millet production.

The land variable, representing the number of hectares that are available to the household, has a significant and positive impact on the demand for groundnut seed. The

capital variable is statistically significant (p-value = 0.03), but has a negligible impact on the demand for groundnut seed. Finally, little can be said about the impact of family labor and soil type on the demand for groundnut seed given their significance levels.

Elasticities and policy implications

The own-price elasticity of supply for peanuts is inelastic at 0.77, perhaps explaining in part the relatively small response to the 1994 currency devaluation. The supply of groundnuts may be inelastic because farmers tend to plant some groundnuts whether the producer price is favorable or not, perhaps because groundnuts is the crop in which they have the most experience. However, the supply response is not highly inelastic and diversification is occurring in the region. The data collected reveal that 98 out of 150 households surveyed, or 65.3 percent, planted other crops during the 1996-1997 growing season: crops such as watermelon, vegetables, and maize. The presence of these crops reduces the dependency on groundnuts as the only cash crop.

The estimation of the input demand for groundnut seed revealed that producer prices of both groundnuts and millet have significant impacts on groundnut seed demand. A positive relationship found between the producer price of millet and the demand for groundnut seed implies a possible complementary relationship between groundnuts and millet, unlike the substitute relationships found between and groundnuts and other crops. Higher millet prices apparently increase groundnut supplies. The results suggest the need for the government to explore policies that reduce the constraints to acquiring groundnut seeds and to encourage a more competitive price for millet. Parameters in the fertilizer equation (not reported on in the tables) were mostly non-significant, making it difficult to

draw conclusions for fertilizer policy. Additional work is currently underway to expand the data set on both the production and consumption sides and to analyze the plot-level data on women's versus men's plots as women may face special constraints to increasing production that differ from men's.

A recent report has noted that groundnut output levels are on the decline (Freud et al, 1997). Indeed, researchers at Senegal's agricultural research institute (ISRA) are very interested in finding the cause of the fall in groundnut output. It must be noted that the decrease observed is in the volume of groundnuts moving through official channels. The question arises whether the observed fall is an actual decline in groundnut production, or reflects a growing tendency to sell output on the parallel market rather than on the official market (Gaye, 1996).

Analysis in this paper suggests that there may be several reasons for the decline in groundnut production. In addition to the apparent complementary role millet may be playing in groundnut output supply, producers are exploring certain other cash crops such as watermelon. Also, farmers are seeking to add value to their groundnuts by selling on the parallel market. The official channels only accept unshelled groundnuts. The household survey indicated that about 25 percent of producers sold on the parallel market. Other reasons for the apparent decline in output may include natural resource degradation, higher auto-consumption, declining seed quality leading to lower yields, and (illegal) exports to neighboring countries.

Conclusion

The Senegalese government has set as a top priority for agriculture, the movement towards greater self-sufficiency in food combined with an increase in groundnut production. To achieve food self-sufficiency, the government has encouraged import substitution of millet for rice by reducing rice imports. At the same time, some have suggested increasing the government price of groundnuts to encourage increased production, although not by too much for fear of reducing millet production (Frued, 1997). No recommendations are made here for a particular set of pricing policies, but it appears that policies that serve to increase groundnut prices and production would have relatively little effect on millet production. These crops tend to serve different purposes for the household and are not strong competitors and may even be complementary in production. This possibility warrants further investigation.

In addition, groundnut supply is relatively inelastic implying that policies designed to directly increase groundnut production may also have relatively small effects on production, at least in the short run. It may be that problems in acquiring credit and inputs are greater constraints to increased production. This conclusion is reinforced by the relatively small impact of the 1994-currency devaluation that increased groundnut prices to some extent, but had little impact on groundnut supply.

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