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dissertation entitled

MARKET REFORMS, FOOD SECURITY AND THE CASH CROP-FOOD CROP DEBATE IN SOUTHEASTERN SENEGAL

presented by

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has been accepted towards fulfillment
of the requirements for

Ph.D. degree in Agricultural Economics

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May 7th, 1990
Date

MARKET REFORMS, FOOD SECURITY, AND THE CASH CROP-FOOD CROP DEBATE IN SOUTHEASTERN SENEGAL

by

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A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Agricultural Economics

1990

ABSTRACT

MARKET REFORMS, FOOD SECURITY, AND THE CASH CROP-FOOD CROP DEBATE IN SOUTHEASTERN SENEGAL

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The Government of Senegal has set the goal of achieving 80% food self-sufficiency. Policy instruments initially chosen to attain this goal include a producer floor price for cereals; increased sales on credit of cereals fertilizer and improved seed varieties; and reduced sales on credit of peanut seed. The general intent of these policies is to encourage farmers to switch from cash to food crop production. In order to inform decision-makers about the cost-effectiveness and likely effects of these policies on household food security, questionnaires were administered to 215 farm households located in the high rainfall, southeastern part of Senegal. Surveys covered opinions of household heads; manifest production and marketing behavior; and potential behavior in the form of responses to hypothetical questions. Tabular and econometric analyses were carried out at the individual household member and at the aggregate household level.

Five principal conclusions emerge regarding the policy instruments chosen by policy makers. First, while private agricultural credit is indeed a severe constraint, making draft equipment more available, rather than fertilizer, would have higher payoffs, especially in the Casamance. Second, there is an important complementarity between peanut seed used to attract additional workers to the household and the increased food production made possible with those workers. Third, economies of scope in producing both food and cash crops on the same farm leads to better utilization of resources. This finding complements the previous one in suggesting that the cash crop-food crop trade-

off in southeastern Senegal is less severe than commonly imagined. Fourth, farmers prefer a variety of cereals in their diets, and this needs to be considered along with relative processing costs and storability of different cereals in designing national food policies. Finally, many households in southeastern Senegal are currently unable to produce enough food to meet annual consumption needs, and in the short run may have difficulty responding to a floor price incentive. Attention needs to be focused on raising the productivity of rural labor working both on and off the farm.

ACKNOWLEDGEMENTS

I gratefully acknowledge the contributions of all those who have made this dissertation possible. My foremost thanks are due to Michael T. Weber for his unfailing support throughout my graduate training, including the field work in Senegal and the completion of this thesis. The other members of my committee, Eric W. Crawford, James D. Shaffer and John M. Staatz, provided research support in Senegal and on campus in the preparation of the thesis. In addition, John S. Holtzman on many occasions shared his experience, and James F. Oehmke commented on portions of this thesis.

My appreciation also goes to former colleagues Jacques Faye, P. Leopold Sarr, Ismaël S. Ouedraogo, Bocar N. Diagana, A. Abdoulaye Fall, Bashir Diop and, especially, Ousseynou Ndoye. Janet Munn, Chris Defouw, Sally Petersen, Alioun Dieng, Fatoumata Mbengue, Margaret Beaver and Mamadou Mané provided important services to the project. The surveys were implemented by Abdou Karim Diallo and Papa D. Diack (supervisors) and Godel Ba, Ousmane Sakho, Djibril Diop, Souleyman Balde and Youssef Camara (enumerators). Results presented here would of course not have been possible without the collaboration of the farmers, traders, and chiefs of farmer organizations surveyed.

The study was funded jointly by the Bureau of Science and Technology, the Africa Bureau, USAID Washington, D.C., and USAID, Dakar, Senegal. In addition, the overall study benefitted from discussion with Wayne Nilsetuen, Moribijan Keïta, Lamine Thiam, John Balis and Richard Caldwell.

Finally, for contributing more than they can imagine, my deep appreciation goes to my family, near, far, and not quite so far away.

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ABBREVIATIONS

ABP	Association de Base des Producteurs (SODEFITEX)
AEC	Adult-equivalent-consumer
AEP	Adult-equivalent-producer
APS	Agricultural Production Support Project (USAID, Dakar)
BAME	Bureau d'Analyses Macro-Economiques
CEP	Consumable Product Equivalents
CGIAR	Consultative Group for International Agricultural Research
CRZ	Centre de Recherches Zootechnique
CSA	Commissariat a la Sécurité Alimentaire
FAO	Food and Agriculture Organization (United Nations)
FCFA	Franc de la Communauté Francophone Africaine (West African Currency Unit; 1 FCFA = 50 French Francs; $1 U.S. = approx. 300 FCFA)
FSP	Food Security Project (ISRA/MSU)
GOS	Government of Senegal
ISRA	Institut Sénégalais de Recherches Agricoles
MADIA	Managing Agricultural Development in Africa (World Bank)
MDR	Ministère de Développement Rural
MSU	Michigan State University (USA)
NAP	New Agricultural Policy (Nouvelle Politique Agricole)
ONCAD	Office National de la Coopération et d'Assistance pour le Développement
PPF	Production Possibilities Frontier
RDS	Regional Development Society
SAED	Société d'Aménagement et d'Exploitation des Terres du Delta
SODAGRI	Société de Développement Agricole et Industriel
SODEFITEX	Société de Développement des Fibres Textiles
SODEVA	Société de Développement et de la Vulgarisation Agricole
SONACOS	Société Nationale de Commercialisation des Oléagineux du Sénégal
USAID	United States Agency for International Development

CHAPTER I

INTRODUCTION AND RESEARCH CONTEXT

Like many African countries, Senegal is seeking to reform the political-economic organization of its agricultural sector to reduce national dependence on world markets for food. The perceived need for reforms has arisen out of Senegal's colonial legacy combined with recent changes in the world markets for primary commodities. A central goal of the reforms planned in Senegal is to induce farmers to switch away from peanut production and towards increased food crop production.

Two principal empirical issues implicit in this reform strategy form the central focus of the present study. First, what is the precise nature of the relationship or "trade-off" between food and cash crop production in Senegal? Are factors of production other than land better utilized when cash and food crops are grown on the same farm? Are there also sectoral benefits, for example in the creation of infrastructure, to growing both types of crops in the same region? Second, which policy can be expected to be most cost-effective and equitable in raising food crop production? Is a commodity-oriented policy, such as a floor price for coarse grains, cost effective and likely to raise food production? If an input distribution policy reform is envisioned, what type or types of inputs should or should no longer be distributed?

The general goal of this study is to assist policy makers in addressing these two key issues, using primary data collected in Senegal during 1986-87. The following section of this chapter briefly reviews Senegal's agricultural history to provide the context for recent policy reforms in general and this study in particular. This is followed by a synopsis of the New Agricultural Policy (NAP) formulated in 1984, and an expanded

statement about the objectives of the study. A discussion about the availability of data in Senegal and the sampling and data collection methods used in the study follow, while the last section describes the organization of the remaining chapters of the thesis.

1.1. A BRIEF HISTORY OF AGRICULTURAL POLICY IN SENEGAL

Since independence from French colonial rule in 1963, Senegal has by and large continued the agricultural food strategy pursued since the early 1900's: peanuts, the principal cash crop, were exported to France while rice was imported from Asia for domestic consumption.[1] Local coarse grains (millet, sorghum and maize) were consumed primarily on the farms where they were produced, and marketed surpluses were limited. Smallholder cotton cultivation was introduced into the higher rainfall, southeastern areas of Senegal in 1963 as a cash crop alternative to peanuts (Lele, van de Walle and Gbetibouo, 1989).

Perhaps the most salient feature of Senegalese agriculture was the involvement of parastatals in virtually all aspects of draft equipment and cash crop input and output marketing. Organized within rural peanut cooperatives, farmers received peanut seeds and other inputs (fertilizer, fungicides) on credit during the planting season and repaid (or failed to repay) production credits in the post-harvest season under alternative reimbursement systems (Crawford et al., 1987; Kelly 1988a). Other parastatals (such as SAED in the Fleuve) operated with a mandate similar to that of the peanut parastatal. Extension and marketing services, attached to the delivery of inputs on credit, were provided through the parastatal system.

This organization of commodity assembly and purchasing services to agricultural producers left little role for a private sector, except where special circumstances gave rise to a parallel private market. These included the development of private sector rice

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[1]Stomal-Weigel (1988), p.18, points out that at the turn of the last century peanuts were not destined for sale (they were consumed on the farms where they were produced).

processing in the Fleuve, which drew heavily on technology and production infrastructure created by SAED (Morris, 1988), and spatial arbitrage by small traders (or farmers) where price differences across international borders created profitable opportunities.

In the late 1970's, unfavorable events in international markets combined with widespread drought to produce a severe balance of payments and public finance crisis, shattering the public's confidence in rural institutions. In 1980 the crisis led to the closing of ONCAD, the largest parastatal, after it had accumulated sizeable debts.[2] With this action virtually all formal-sector credit and equipment supply to principal production areas were eliminated.

To a large extent the institutional sector and public finance crisis was precipitated by declining cereals and peanut production caused largely by reduced rainfall, stagnant or declining groundnut export revenues with poor long-term prospects, and a more than tripling of rice imports from 100,000 tons in 1975 to 320,000 tons in 1986, with a high of 380,000 tons in 1983.[3] Figure 1-1 shows only about 50% of national cereals needs are estimated to have been produced in the country during the past decade. Figure 1-2 indicates that real prices for major primary commodities have tended to decline together since 1950, although the real price of peanuts has declined by more than that of rice, so that the terms of trade have moved unfavorably for Senegal.

1.2. THE NEW AGRICULTURAL POLICY OF 1984

Faced with a financial crisis in the late 1970s and dismal projections for the cereals situation, the Government of Senegal (GOS) in 1984 formulated a new food strategy. The primary goal is to achieve on average 80% cereals self-sufficiency by the year 2000. Specific objectives of the new food strategy include increased cereals

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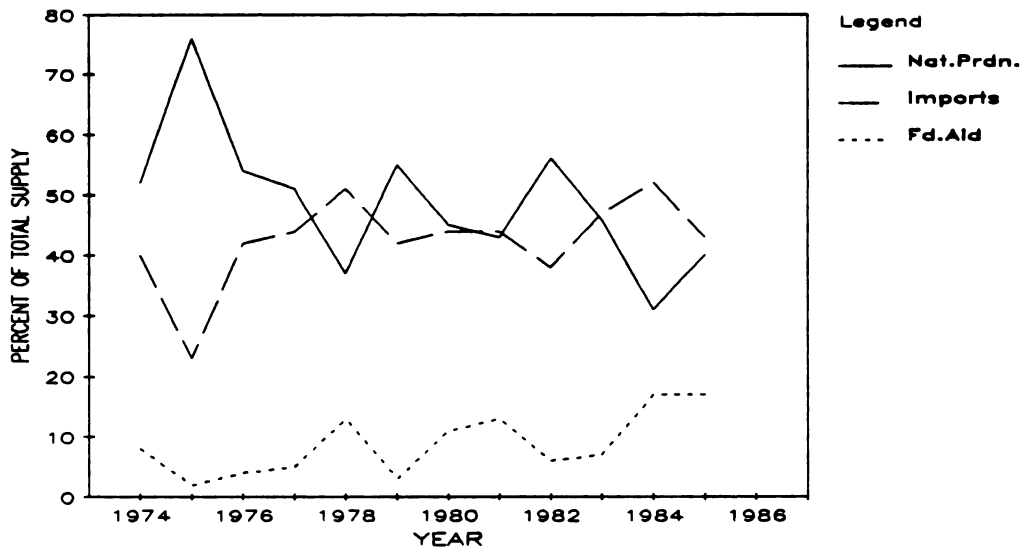
[2]This was not the first time that large amounts of credit given to farmers were simply forgiven.

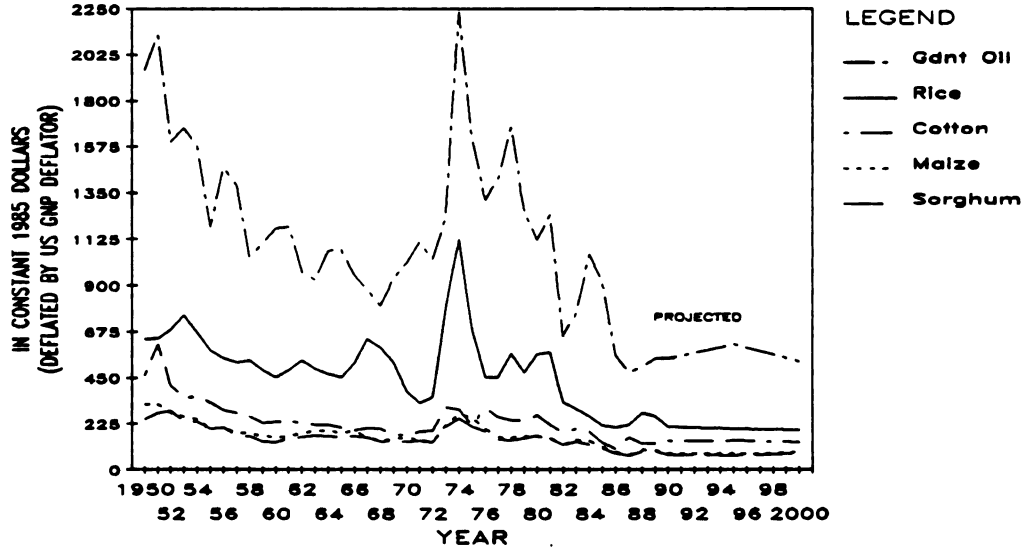
[3]Crawford, 1988.

FIGURE 1-1: CEREALS SUPPLY SITUATION IN SENEGAL: 1974-1986, IN ESTIMATED PERCENT BY SOURCE



Source: F. Martin (1988)

FIGURE 1-2: PRICES OF MAJOR PRIMARY COMMODITIES 1950-1987 (ACTUAL) AND 1988-2000 (PROJECTED)



SOURCE: WORLD BANK (1988)

production through substitution of coarse grain for peanut production, combined with an intensification and extensification of coarse grains production (FAO, 1984; USAID/APS, 1987). Maize has been singled out due to its allegedly profitable yield response to mineral fertilizer. A second objective includes expanded regional trade in domestic coarse grains and, a third, continued state withdrawal from input and output marketing (MDR/GOS, 1984).

Since the GOS arrived at these national self-sufficiency objectives drawing upon both economic and political considerations, the purpose of this study is not to calculate an economic benefit-cost ratio for achieving national food self-sufficiency, a task requiring more data than currently available. Instead, taking the broad policy environment and national objectives as predetermined in the short-run, the study attempts to identify a combination of specific policies and programs that can reduce the cost of achieving food self-sufficiency (this may be thought of as raising the benefit-cost ratio, or at least maintaining that ratio, while paying attention to the resulting distribution of rural incomes). Examples include assessing the anticipated consequences of reducing parastatal activity to the benefit of private traders; the effect of emphasizing agronomic research on cereals to the detriment of cash crops; and eliminating the distribution of peanut seed to farmers on a credit basis. Making decisions to assist in achieving the goal of greater food self-sufficiency requires a basic understanding of Senegal's agriculture, mainly at the micro- but also at the macro-level, to the extent that macro variables affect micro-level behavior. It also requires a knowledge of technological relationships and trade-offs, for example, between cash and food crop production at the farm level.

Given the GOS's stated objectives, and the policy instruments chosen to achieve each objective, a number of implicit and researchable hypotheses can be established (Table 1-1). For example, to increase cereals production, a pan-seasonal and pan-territorial producer floor price is to be implemented, presupposing a certain willingness

TABLE 1-1:
POLICY OBJECTIVES,[a] INSTRUMENTS AND RESEARCHABLE HYPOTHESES

Policy Objective	Policy "Instrument"	Researchable Hypothesis	Thesis Chpts.
Increased Cereals Production & Sales. (Raise Rural Income?) Emphasis on Maize.	Producer floor price for cereals.	Producers willing & able to respond to price incentive.	V
	Increased sales of cereals fertilizer and improved seeds.	Fertilizer & Seed profitable, and limiting factors of production.	III
	Reduced sales of cash crop inputs (peanuts).	Minimal economies of scope in cash and food crop production.	IV
		No interdependencies among labor & peanut seed.	III
Expanded Trade in Domestic Cereals.	Remove legal barriers to cereals trade: "Market Liberalization."	Existing rules constrain trade; potential markets already exist.	V
State Withdrawal from Input/Output Marketing.	Credit for private cereals traders (from banking system). Emphasis on farmer organizations: "Market Privatization."	Private Sector: Waiting to "fill in the vacuum"; More efficient/ cost effective.	III & V

a. An additional objective is the expansion of (irrigated) rice and maize production in the Fleuve.

and ability of farmers to respond to output price incentives. Sales of fertilizer and improved cereals seed to farmers presume that a lack of fertilizer and improved seeds currently constrains cereals production.

Similarly, the removal of legal barriers to regional cereals trade ("market liberalization") presumes existing regulations constrain trade in cereals, and that potential sources of demand and supply will readily be articulated once the legal rules change. The provision of credit to private cereals traders (USAID/APS, 1987) assumes the private sector is prepared to "fill in the vacuum" left by state withdrawal fairly rapidly and, more generally, that it can carry out input/output marketing functions more cost-effectively in the long-run than parastatals.

The table also serves as a reminder that market liberalization is a question of degree rather than a discrete choice between private versus public coordination of economic activity.[4] On the one hand, all trade in cereals within the country is to be "free", while on the other hand, the government intends to influence price formation by mandating and supporting a cereals floor price. A farmer's freedom to sell at a floor price, provided it is effectively implemented, becomes a private trader's legislated constraint when providing arbitrage services over time and between food deficit and surplus areas.

In retrospect, and as will be demonstrated in this study, the GOS was rushed into choosing these policy instruments without adequate knowledge about the economic reality of rural Senegal. This was largely due to the poor rural data base in the country, as discussed in Section 1.4.

1.3. OBJECTIVES OF THE STUDY

The specific objectives of this study are [1] to describe and analyze the existing economic system facing farm households, and to explain the behavior of households

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[4]See also Staatz et al. (1989) on this point.

towards input use and investments, production and marketing; [2] to evaluate the ability of rural households to respond to the NAP and to assess the likely effects of NAP incentives (intended or unintended) on the welfare of rural households in general and their food security status in particular; and [3] to identify points of leverage in the broader food system facing rural households that can complement current policy instruments in achieving public objectives in an equally or more cost effective manner, while at the same time contributing to improved income distribution and economic growth in rural areas of Senegal in the intermediate and long run.

While the primary focus of the study is on the behavior of rural households and their ability to respond to the NAP, the analysis is extended to private traders where relevant. In particular, the welfare of rural households under the NAP cannot be adequately examined without understanding the anticipated effects of transferring input/output marketing activities from parastatals to private agents.

The more specific research questions addressed in the study include:

1. Why are many households in southeastern Senegal poor and living at or near subsistence? If there are better-off households or "success stories", what can be learned from them that is transferable to the rest of the rural population?
2. How does the household obtain access to factors of production and why do some households use more resources than others? Why are rural households organized the way they are; can complementarities between labor, equipment and technical inputs be exploited to increase total agricultural production; and what are the anticipated effects of privatizing input distribution activities.
3. How do households decide on crop mixes to be grown and which variables subject to policy influence affect household output and incomes? Are

there complementarities between cash and food crop production and marketing?

4. Which variables affect the behavior of households in the coarse grains cash market and how can these variables be influenced by policy so as to increase regional surpluses of food grains marketed while also assuring food security at the level of individual households?

5. Which strategies do households pursue to achieve food security and long-term survival goals; how are these affected by public policy (reform), i.e., changes in the institutional environment?

6. What can be learned from farmers' potential behavior (as indicated by responses to hypothetical questions concerning investment priorities and opinions about policy reform) to inform decision-makers in planning and implementing cost-effective rural development policies that do in fact achieve desired objectives?

7. Finally, can we develop an operational model of farm household behavior that recognizes individual agents' cognitive limitations under genuine uncertainty and yet allows for generalizable policy prescriptions beyond a description of agent-specific rules of thumb? Such a model should be helpful in informing policy makers about market reforms/structural adjustment in other food deficit African countries (with at least similar environments--cf. Eicher (1982) on the diversity of African countries), rather than be limited to the geographic confines of this study. A starting point for such a framework will lie in endogenizing constraints faced by food system participants, i.e., in allowing the legal rules and institutional "givens" determining the status quo to enter the analysis as variables so that they may in turn be subject to policy design and influence. This last

question is not answered definitively. Its purpose is to guide the analysis in the thesis.

1.4. DATA AVAILABILITY IN SENEGAL

> ... policy changes and planning for the resumption of growth in [African] agriculture are hampered by a pervasive lack of country-specific information. Reform efforts all too often try to apply general remedies to Africa's diverse problems.
>
> U. Lele, 1989, p.45.

The agricultural data base in African countries is generally poor (Lele, 1989; Eicher, 1982) and Senegal is not an exception. Aside from general census data collected every 10 years or so, and official annual regional agricultural production data of questionable quality (Holtzman, 1987, discusses problems with using official data), there is very little empirical information on rural households in Senegal; this makes it difficult to construct even a simple food balance sheet for the country.[5] When farm-level information is available, it tends to be concentrated in certain parts of Senegal such as the Peanut Basin, which has historically attracted the predominant share of researchers, notably French agronomists and farm management specialists.

While socio-economic household data are now being collected by Senegal's Agricultural Research Institute (ISRA), the data are from specific regions, such as the Fleuve, Kaolack and Ziguinchor. Consequently, there was a large part of the country where little systematic socio-economic information had been collected prior to the Food Security Project surveys.[6] Data collection was all the more urgent since it was precisely

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[5]The construction of food balance sheets is advocated as a first step in food policy analysis by Timmer, Falcon and Pearson (1983). These difficulties notwithstanding, Martin (1988, pp.68-71) has constructed regional food balance sheets for Senegal using official data.

[6]At the time of these surveys, applied crop research was being initiated by the cotton parastatal SODEFITEX (Cellules Recherches et Developpement and Suivi et Evaluation) in Tambacounda, while research on livestock and pastoral systems was already underway at ISRA/CRZ in Kolda.

in these areas, where rainfall tends to be high relative to the rest of the country, that the government hopes to achieve its cereals self-sufficiency objective.

Select references providing information on southeastern Senegal, at various levels of aggregation, include the AgroProgress Report (1970); Bertrand and Valenza (1970); B. Diop (1986); Havard (1986a,b); Jolly, C. et al. (1985); Landais (1985); MDR/SODEFITEX-SONED (1980); SODEFITEX (1986 Annual Report) and SONED-SODETEG (1977). The information available in each of these references is reviewed in Goetz with Dieng (1987). This report also presents a shift-share analysis for regional production of principal crops for the period 1961-1986 using (official) secondary data. The analysis reveals that the Casamance and Senegal Oriental (Tambacounda), despite their higher annual rainfall, are losing out in their share of national millet/sorghum and maize production, while the Peanut Basin's share is increasing. The following section describes the data collection method used in this study, including the sample design and a table of questionnaires administered to farm households.

1.5. SAMPLING AND DATA COLLECTION

Southeastern Senegal (see Map 1-1) was selected as the research area for two reasons. First, this area has been relatively neglected in recent socioeconomic surveys (see Section 1.4).[7] Second, this is the principal area in which the government plans to implement the New Agricultural Policy (MDR/GOS, 1984). The procedures used to identify villages and households for the final sample are discussed in Goetz and Diagana with Diallo (1987).

A research planning matrix and activity calendar (Figure 1-3), described in more detail in Crawford et al. (1988), were used to guide the survey work. Agricultural households, defined from the production side (i.e., as units of production--see

[7]Hence the survey work was intended to spatially complement related research of the macro-economic analysis unit (BAME) of Senegal's Agricultural Research Institute (ISRA).

MAP 1-1: SENEGAL

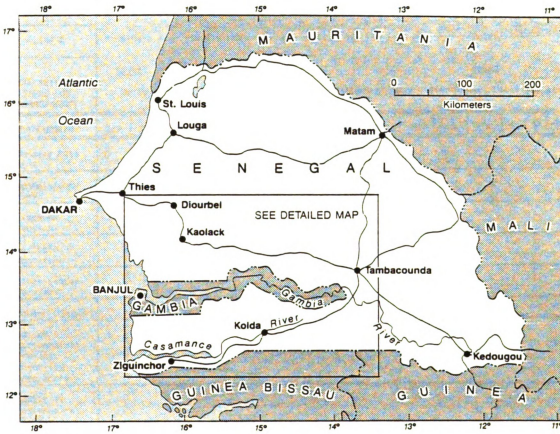
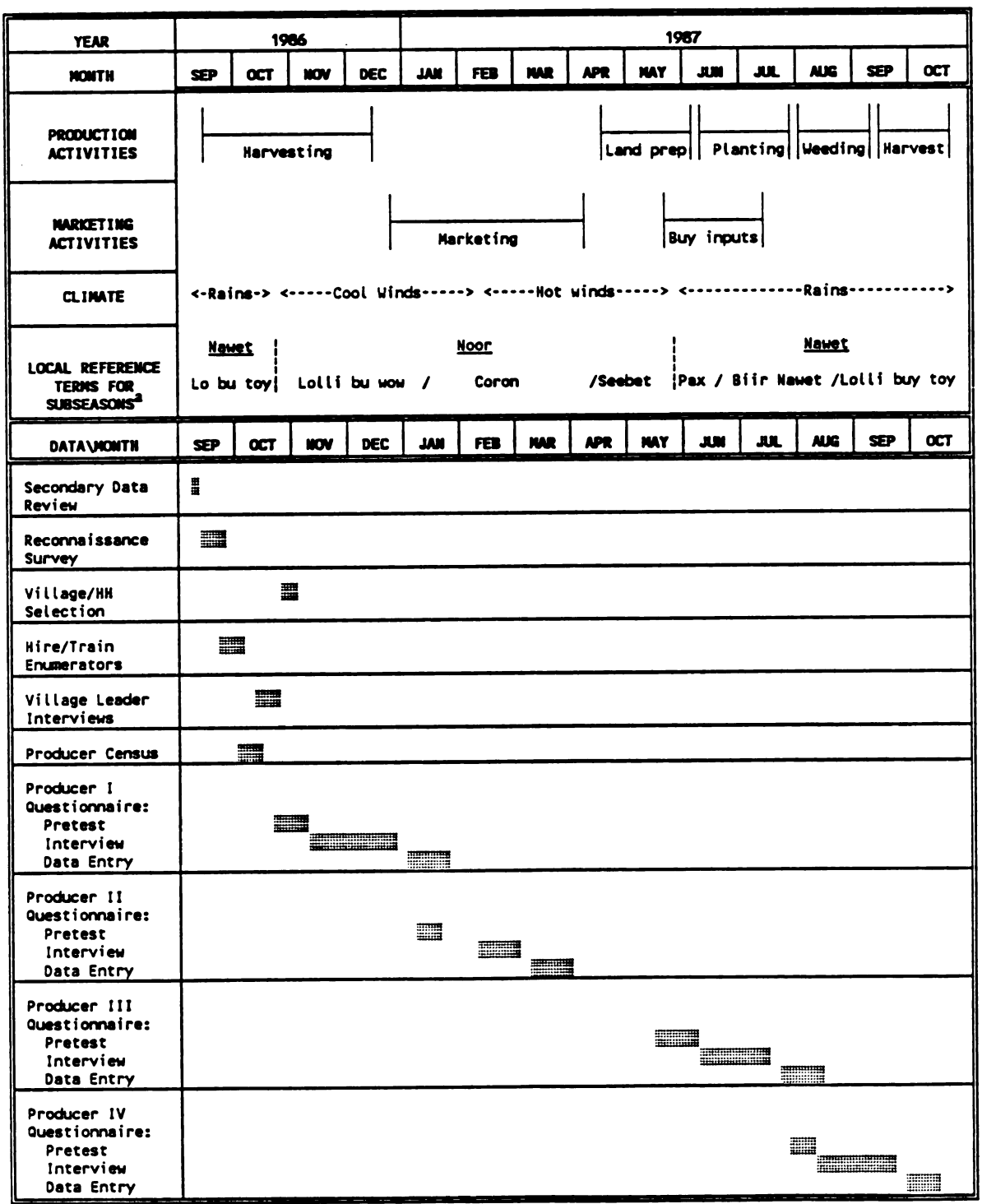


FIGURE 1-3: TASK CALENDAR: SURVEY ACTIVITIES, SENEGAL



a. Benoit-Cattin & Faye, 1982.

Benoit-Cattin and Faye, 1982) were chosen as basic units of observation in the farmer surveys. While questionnaires (see Table 1-2) were administered to individual household members when necessary (especially in survey 1b), most questions were addressed to household heads.

The agricultural households were conceptually embedded within a food system subsector (Shaffer, 1980), incorporating the market and trader, parastatal, and household levels (Figure 1-4).[8] The basic macro sample units were five triads, each consisting of a weekly coarse grain market and two satellite villages, one of which had better and one which had worse access to the market village.[9] Each enumerator worked with a total of 45 households in one triad. Two triads were located to the north of the Gambia ("North") while three were located in the Upper Casamance ("South"), as shown in Map 1-2. Overall study goals and resources available (2 supervisors and 5 enumerators) resulted in this spatial organization of the survey sites.

1.6. ORGANIZATION OF THE THESIS

The remainder of this thesis is organized as follows. Chapter II provides concepts for studying farm-household behavior and growth under uncertainty. Chapters III, IV and V examine input, production and marketing issues pertinent to the NAP, respectively. Chapter VI presents a synthesis of the empirical findings, draws conclusions and provides recommendations for agricultural policy makers in Senegal.

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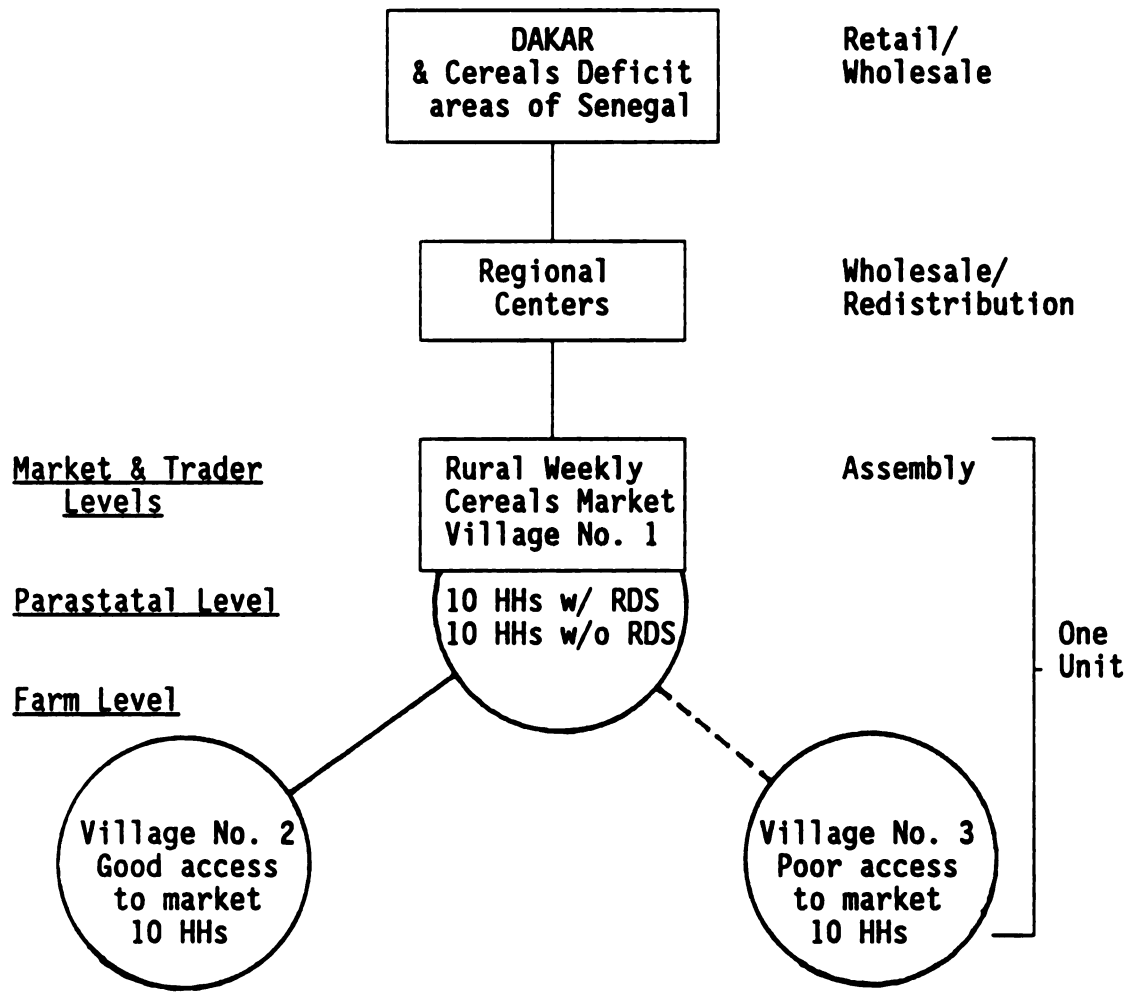
[8]For a summary of results from the farmer organization- and trader-level surveys, see Goetz et al., "Executive Summary" (1988), and the references cited therein.

[9]This stratification was intended to capture the effect of physical market access on household marketing behavior.

TABLE 1-2: FARM-LEVEL SURVEY INSTRUMENTS

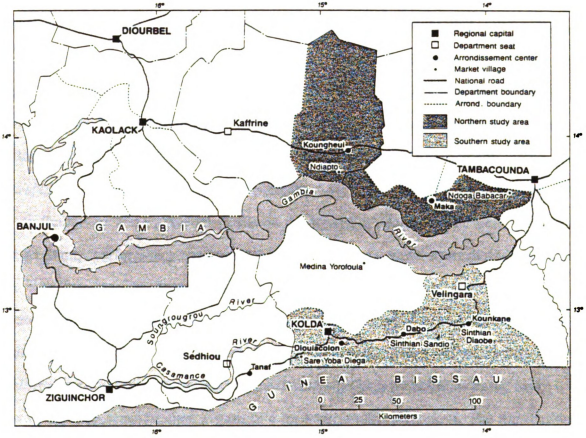
Survey Number	Contents	Month Administered
Census 400 HHs	Household head sex; ethnicity; number of active workers and total members; crop mixes; parastatal participation; equipment ownership; land expansion; storage out of 1985 production; off-farm incomes.	October 1986
No. 1a 215 HHs	Detailed household demography (listing of each member's relationship to the household head, age number of fields cultivated, worker status). Literacy; recent changes in total area and reason; crop mix of household head and recent changes; livestock transactions; ranking of field size by field owner; chemical input use.	November 1986
No. 1b	Seed and chemical input usage in 1985 & 1986 (member, seed/input type, source, quantity used vs. desired, mode of acquisition, total cost, timeliness, quality of inputs). Use of inputs by crop. Detailed balance sheet of recent crop transactions.	December 1986
No. 2	Equipment ownership (type, number, source, owned since when, condition) and use by crop. Parastatal participation (by parastatal), year of initiation, why participate, satisfaction. Constraints to extensification in 1986. Private credit transactions; livestock transactions; crop production, transactions and stocks.	February 1987
No. 3a	Coarse grain transformation and storage issues; consumption preferences and changes (rice); peanut seed market opinion questions; non-agricultural activities; chemical input acquisition (preliminary); livestock transactions; crop transactions and stocks.	July 1987
No. 3b	Determinants of area seeded to cereals, opinions of cereals market reform; maize production problems; general questions related to fertilizer marketing.	August 1987
No. 4a	Investment preferences and opinions; fertilizer yield response; perceptions of and stated responses to the APS project.	September 1987
No. 4b	Opinions about the organization of the cereals market; peanut seed production constraints and anticipated responses to price changes; demographic changes; use of fertilizer inputs (sources, quantity); livestock ownership.	October 1987

FIGURE 1-4: VILLAGE TRIAD SAMPLE UNITS



Notes: HH = household
RDS = regional development society
5 triads * 43 households/triad = 215 hhs (maximum).

MAP 1-2: FOOD SECURITY PROJECT RESEARCH SITES



CHAPTER II

FARM HOUSEHOLD BEHAVIORAL CONCEPTS

This chapter presents concepts of farm household behavior which are used to guide the subsequent analyses in the thesis. Since African farmers are currently and on average unable to feed themselves, let alone their nations, the concepts of food production versus food consumption security in rural areas are examined in Section 2.1. More specifically, the prospects for and potential of a food price policy, intended to raise food production, is examined under different lengths of run. A preliminary analysis of 1986 per capita cash and food crop production data shows some households in southeastern Senegal are unable to meet both their estimated cash and food needs out of crop production alone. This motivates the discussion of an Environment-Strategies-Performance paradigm in Section 2.2. Uncertainty and associated market imperfections are included as key elements of the environment facing food system participants. Also included are consequences of these phenomena, such as market interdependencies, credit limitations and transactions costs on the strategies adopted by farmers to survive. Subsequently, performance outcomes associated with the various strategies are examined.

A key strategy concerns horizontal and vertical extension or integration of households. This is examined in Section 2.3. within the context of households as coalitions of individuals with divergent economic interests. The argument is that coalitions form in response to market uncertainty and high transactions costs; hence households in a sense become a substitute for labor and food markets. The implications of the concepts developed here for the subsequent analysis are summarized in Sec. 2.4.

2.1. FOOD SECURITY AND THE SCOPE FOR PRICE POLICY

The fact that Senegal imports an estimated 50% of national food needs, while over 75% of the population is engaged in farming, implies a number of rural households produce insufficient amounts of food to meet own-consumption needs. Food price policy

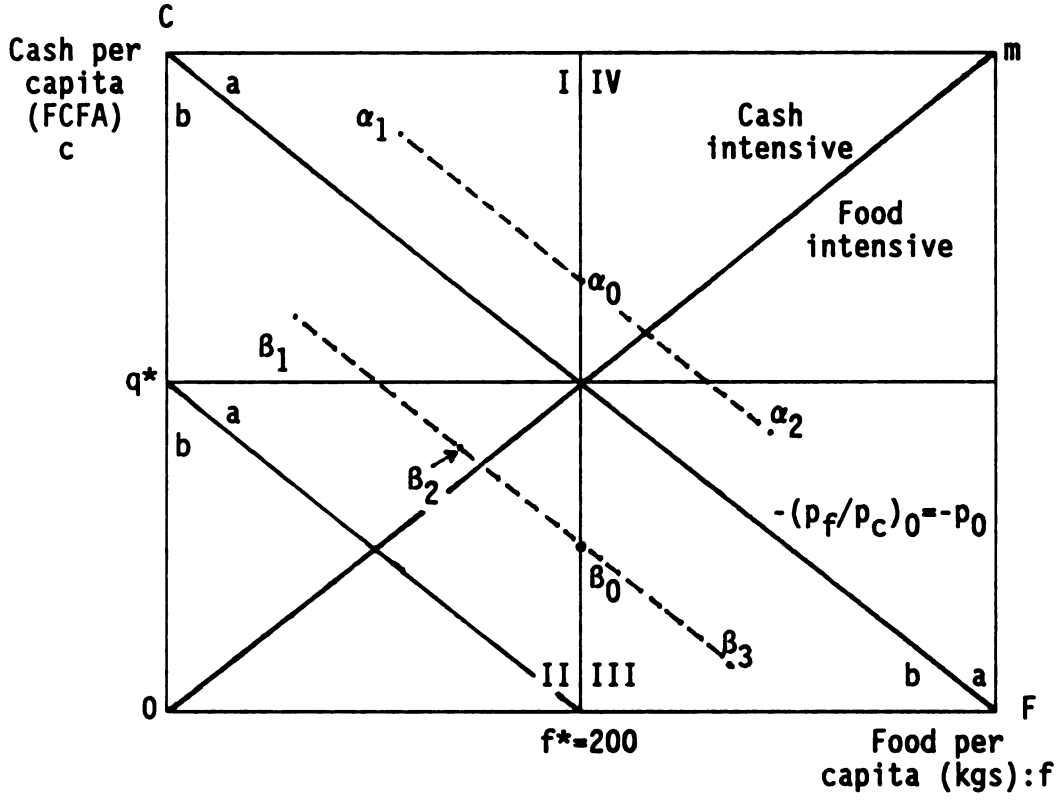
therefore must begin by examining whether or not rural households are food production deficit or surplus, and what the characteristics of each group are. In addition, the amount of time allowed for farm-level adjustments to output price changes has to be made explicit to fully assess the impact of a price policy through time. The amount of empirical data required to predict the consequences of price policies evidently increases with the length of the adjustment period. The purpose of this section is to provide a framework for evaluating the consequences of and prospects for food price policies under different lengths of run, and to specify the data needed to evaluate such policies.

2.1.1. Short Run Effects of Food Price Changes

To assess the distributional effect of an increase in the relative price of food in the short-run, defined here as a period in which all farm-level resources are fixed between alternative production activities, it is necessary to know food and cash crop production levels per household consumer. In practice, the short-run refers to a period between planting and the next year's harvest, so that the household is not able to change its output mix in response to the change in food prices. Under this scenario households can be classified according to their pre-trade (production) and post-trade (consumption) positions.[1] In a given growing season, a household's per capita output of cash (c) crops and food (f) crops is given by a point in Figure 2-1. Line $f^* = 200$ represents per capita food requirements and q^* refers to minimum annual cash needs per capita, consisting of rural head taxes, clothing, and other necessary consumption items. Line (0,m) is a ray from the origin through the intersection of q^* and f^*. If food crop markets exist, a household's trading opportunities are given by a line with slope $(-p_f/p_c)$, where $p_c \equiv 1$,

[1]See also Reardon et al. (1988), who stratify their Burkinabé sample as food production and/or consumption secure.

FIGURE 2-1: HOUSEHOLD CASH AND FOOD PRODUCTION AND CONSUMPTION POSSIBILITIES



Note: q* = minimum amount of cash per capita needed in the household, 200 = fixed requirement of cereals (food). p_c = price of cash crops, p_f = price of food crops (cereals). Line $-(p_f/p_c)_0$ shows initial terms of trade between cash and food.

through the point of cash and food crop production.[2] Households can then be classified as follows with respect to their pre- and post-trade positions.

[i] Production: Pre-trade. Households producing above line (0,m) in Figure 2-1 are cash crop intensive, those below food crop intensive producers, relative to cash requirements q^* and food consumption needs f^*. Further, if we consider only crop production activities[3] and q^* as the minimum amount of cash required annually per household consumer, the following is true prior to trade of households located in these quadrants contained within the area given by lines 0CmF:

Quadrant I : Food deficit, cash crop surplus producers;

II : Food and cash crop deficit producers;

III : Food surplus, cash crop deficit producers;

IV : Food and cash crop surplus producers.

Households located in quadrant II are producing insufficient levels of cash (from cash crop production) and food crops to meet minimum subsistence needs of cash and food. They rely on non-crop inflows--off-farm activities, transfers and gifts, etc.--to survive, or they have reduced consumption levels.

[ii] Consumption: Post-trade. We next examine how the situation of households located in each quadrant changes if there are opportunities for trade. Households producing in triangle Ia are food crop production deficit, cash crop production surplus, and food and cash consumption secure: at prevailing prices a household located at α_1 can become food consumption secure by trading cash for food up to point α_0 and remain

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[2]Relative prices are assumed to be identical across all households for the sake of clarity. In practice, buying and selling prices are likely to differ, which could be represented by different slopes of the line (p_o).

[3]The main concern here is with crop production activities since we are dealing with allegedly agrarian areas. If off-farm incomes and transfers are known, they can of course be added to cash "production" in Figure 2-1 since the y-axis measures (non-food) income. These funds would result in an outward shift of the trading constraint.

cash surplus. A household in area Ib (e.g., at β_1) can become food secure by trading to β_0 but is forced into a cash deficit situation in the process. To pay taxes and meet other required cash expenses, this household would have to draw on proceeds from non-crop activities and external transfers to move from β_0 to [q*,200]. Alternatively, the household may be forced to forego food consumption security for the sake of meeting cash expenditure requirements (i.e., move to a point to the left of f=200). The difference between households located in Ia and Ib, therefore, is that both are food production deficit, but those located in Ia are able to become food consumption secure at relative prices using only proceeds from agricultural activities, while those located in Ib have to draw on non-crop incomes to become food consumption secure and continue to meet cash expenditure requirements.

Households located in triangle IIa, for example at β_2, can become food consumption secure at prevailing relative prices (by trading to β_0) but will become more cash deficit in the process. They are thus in a situation similar to that of households in Ib. Households located in IIb can not become food consumption secure at existing prices using only cash proceeds from agricultural production. They rely on off-farm activities and other transfers to meet both their food consumption needs (f*) and cash expenditure requirements (q*).

Households in III are in a position opposite to that of households located in I. For example, a household producing at β_3 in IIIb can trade surplus food for "cash" to point β_0. It would then also need off-farm income or transfers to move to [q*,200]. This also shows that food production secure households are not necessarily food consumption secure, since a household producing at β_3 may have to give up food consumption security to meet cash expenditure requirements. It can be seen, finally, that a household located at α_2 is in the same position as a household at point α_1, except that it trades in the opposite direction.

Rural head taxes reduce the amount of cash available to be traded for food by shifting the trading possibilities line towards the origin. The higher the tax, the more households producing in triangles Ib, IIa and IIb will have to draw on off-farm activities and transfers to move towards [q*,200], other factors equal. Similarly, it is possible that households producing at a point beyond [q*,200] become food consumption deficit and/or fail to meet cash expenditure requirements as a result of the tax.

Using the concepts developed in Figure 2-1, a scatter plot of empirical data has been created using information from households studied in the ISRA/MSU sample. This helps show the potential distributional consequences of an increase in the relative price of food in the short run. In particular, households producing insufficient amounts of food to meet annual per capita requirements ($f<200$) will be worse off with higher food prices as measured by the reduced availability of cash under the deteriorated terms of trade of cash for food, while households producing $f>200$ will be better off. This is of course not a surprising result, but it is significant to observe the large proportion of households shown in Figure 2-2 which are worse off in the short-run with a higher price of food.[4]

For lack of a better measure, it is assumed in Figure 2-2 that minimum annual per consumer cash needs are given by the sample mean (q^*=c-bar = 33,000 FCFA) of the value of cash crops produced per capita.[5] This is calculated as the value of peanut (90 FCFA/kg) and cotton (100 FCFA/kg) production divided by the number of adult-equivalent consumers per household. The per capita food production sample mean, calculated as the per adult-equivalent consumer quantity of millet, sorghum, maize and rice

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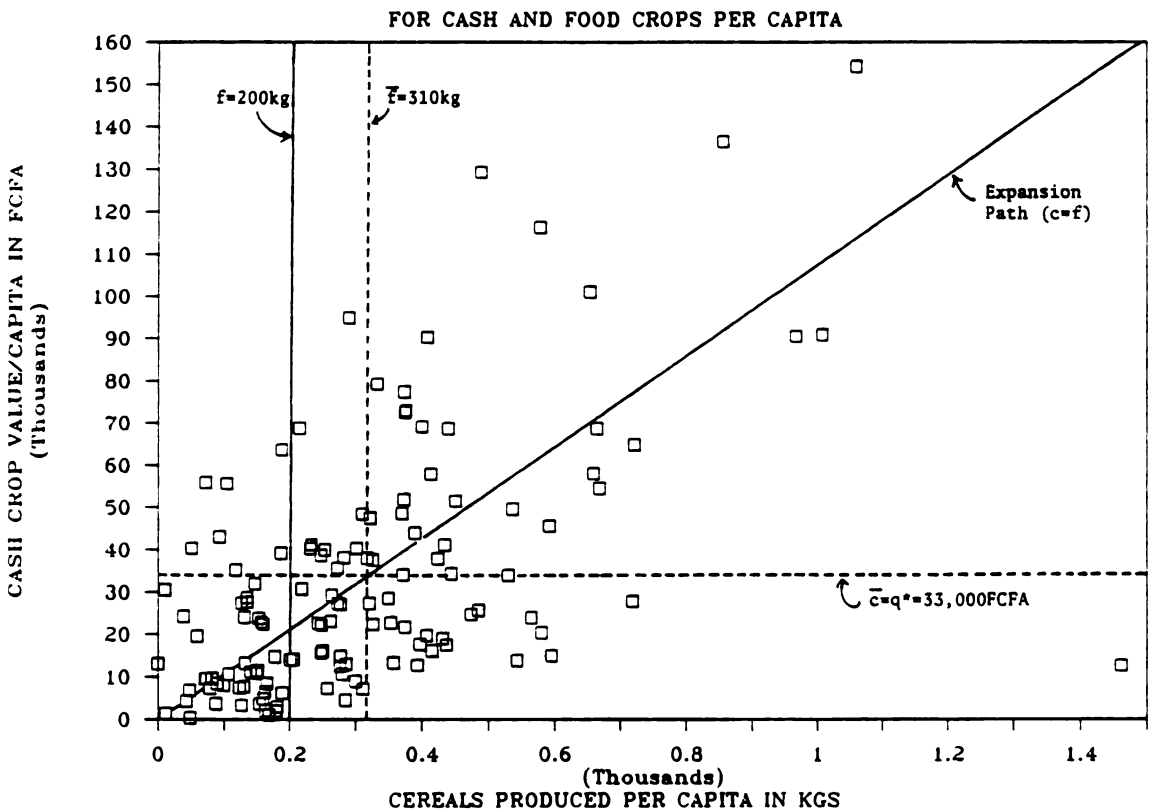
[4]See Chapter III for a description of consumption requirement standards and the conversion from unmilled to milled coarse grains.

[5]This compares favorably with a number of FCFA 30,000 per adult equivalent consumer obtained in a survey of village chiefs for both cash and food expenditure needs of a typical household.

FIGURE 2-2: HOUSEHOLD PRODUCTION DATA



produced, is 310 kgs. The distribution of households among the different quadrants is as follows (there is a significant difference between northern and southern regions):

I = 5% II = 32% III = 30% IV = 33%

Consequently, 37% of the households would unambiguously be worse off under a regime of higher food prices in the (very) short-run. Since higher cash prices would also affect barter prices of cereals, households not participating in cash markets would also be affected by the price increase. In Figure 2-2, a higher price of food is represented as a clock-wise rotation of the trading constraints. From this it is possible to determine the new number of households falling into the different categories after the price increase.[6]

With the exception of one household, the general trend for the production expansion path in Figure 2-2 is towards cash (crop) intensive production (especially if the line 0,m is redefined as the ray from the origin through the mean points of production [33,000 FCFA, 310 kgs]). This may be due to the nature of the production surface (cash-crop biased technology) and/or the higher expected profitability of cash crop production, given the fixed prices of cash crops. It is noteworthy that the data in the ISRA/MSU sample of households were collected in a year of adequate rainfall (1986), following drought conditions in 1984/85. To some extent the average production of food (310 kgs) may reflect the accumulation of security stocks (s) in anticipation of subsequent years of drought (i.e., E[s] = 110 kgs = 310-200 kgs).

Given information on transfers and non-crop farm income it is also possible to specify the proportion of households among those producing f<200 which would continue to meet food consumption and cash expenditure requirements after a food price

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[6]Note on recent (1988) price policy changes in Senegal: Old and new prices for peanuts are 90 and 70 FCFA/kg, respectively. For cereals they are unchanged at 70 FCFA/kg, while for rice they have fallen from 160 to 130 FCFA/kg. Data show a small increase in the price of rice relative to peanuts (from 1.78 to 1.86), and a sizeable increase in the price of cereals relative to that of peanuts (0.78 to 1.00). Food prices are official.

increase (i.e., only experience a reduction in q) and those which have to increase the flow of off-farm incomes and/or transfers to meet these requirements. Similarly, the number of households that are better off after the food price increase (those in quadrants III and IV), or can reduce their reliance on off-farm activities to meet cash expenditure needs, can be determined.

This analysis shows how crucial the timing of the introduction of the higher food price is for food production deficit households, assuming it in fact affects all households.[7] For households currently producing f<200 which are able to increase food production in response to higher food prices, whether the price change is introduced (or announced) after or prior to planting can spell the difference between a season (a) of food scarcity and (b) increased availability of cash combined with satisfactory food consumption following a change in the output mix. In practice the government will not deliberately mislead farmers in the timing of price changes, although public coffers have to be protected against the possibility of exceptionally good harvests when floor prices are fixed (example of two good consecutive cereals harvests in Mali). This may explain why the official buying or floor price for cereals has in some years been announced rather late in the growing season in Senegal.[8]

Households not able to respond to the food price increase will have few alternatives to allocating more labor to non-crop production activities to meet cash and food expenditure requirements. This brings us to intermediate run adjustments to food price increases.

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[7]See Chapter V.

[8]In 1988 the official peanut price reduction (to 70 FCFA/kg, i.e., corresponding to an increase in the relative price of local coarse grains) was announced three months prior to planting, allowing farmers to make adjustments.

2.1.2. Intermediate Run Adjustments

The intermediate run is defined as a period in which resources can be reallocated between crop enterprises but are fixed at the farm-level (e.g., a two-year harvest-to-harvest period, which constitutes the conventional short-run in supply studies) and from crop to non-crop enterprises where that is feasible. In reality it may be fairly easy to adjust the amount of non-family labor from one production season to the next. However, to the extent that hired labor is paid with food during the production season (it is actually not possible to retain seasonal labor unless there is sufficient food in the household), food deficit households will suffer from a food price increase in two senses: (a) by experiencing a higher cost of food to the family and (b) by a reduction in the use of hired labor which in turn shrinks the production possibilities frontier (ppf) towards the origin, other factors held constant.[9]

In the intermediate-run, with resources assumed to be fixed at the farm but not the crop level, it is possible for the household to change its crop mix by producing at a different point on its ppf. The size of the crop substitution will depend on the degree to which inputs can be reallocated among cash and food crops, as measured by the slope of the ppf, i.e., dc/df.[10] A key variable determining the effect of a food price increase in the intermediate run is the maximum quantity of food the household can produce per capita with its fixed resources, i.e., the size of f_{max}, given $c = 0$. If farmers maximize profits and face identical expected prices, an upper bound for f_{max} is given by the intersection of the line of relative prices passing through the point of production (c_0,f_0) with

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[9]It is important to distinguish seasonal workers, who eat regularly in the household (surghas and navetaans), from hourly wage laborers. See also Section 2.3.

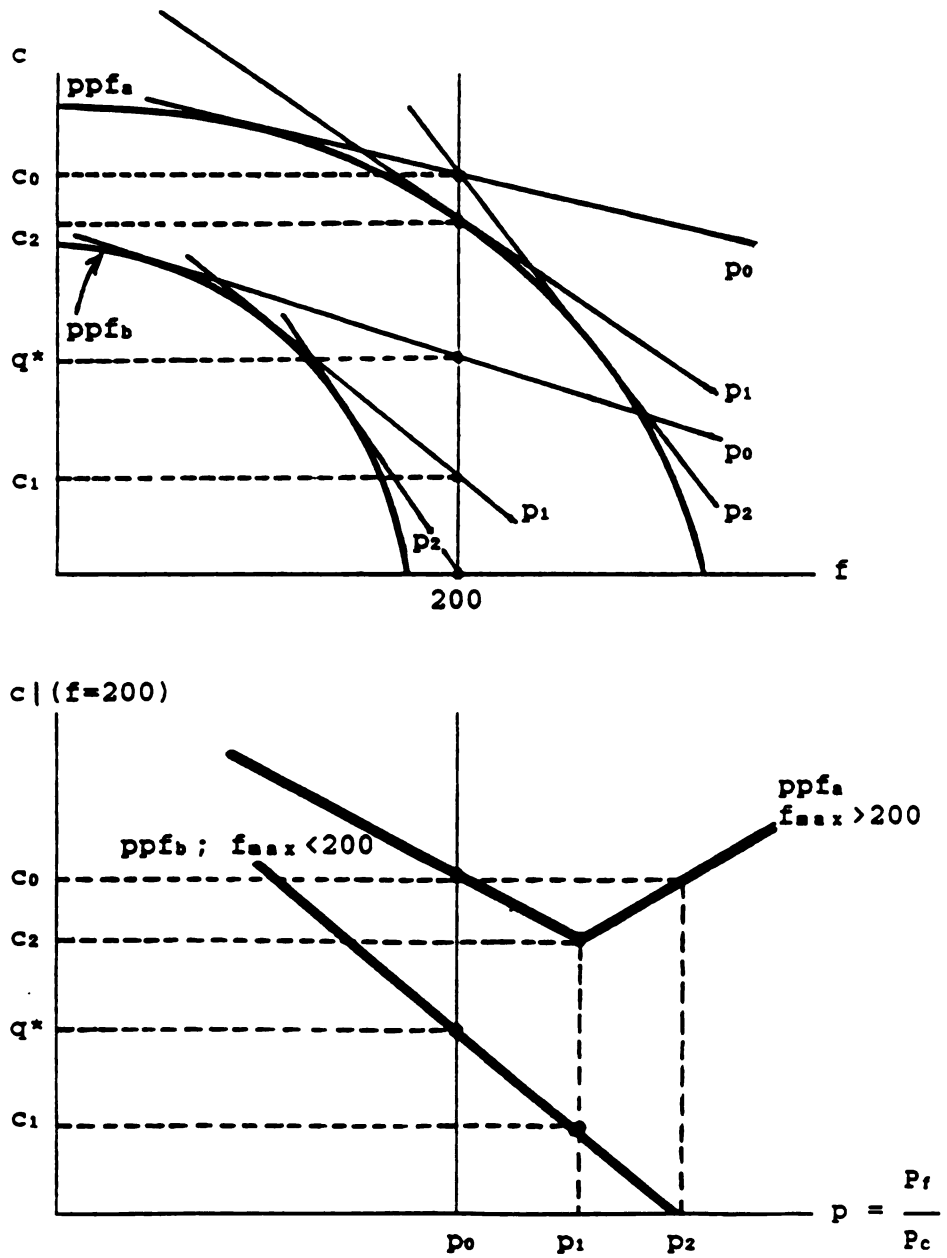
[10]The elasticity of substitution among outputs $(\delta c/\delta f)(f/c)$ depends on the degree to which capital and labor are fixed in the production of each crop. In practice it may be easy for the farmer to reallocate hoes, seeders and labor from cash to food crop production, implying a fairly flat slope of the ppf leading to a (food) corner solution (assuming perfect knowledge of prices).

the f-axis (due to an assumption of strict quasi-convexity of the ppf). The number of households located in IIb (Figure 2-1) gives the minimum number of households not able to produce f > 200 in the intermediate run. If the assumption of price homogeneity across households does not hold and if data on price expectations in each household are not available, it is necessary to estimate each household's ppf given its fixed resources (denoted by subscript 0), i.e., $c = g(f,k_0,l_0)$ to determine f_{max} for $c = 0$. This permits a more precise, production-based classification of households according to the size of f_{max}.

These results are summarized schematically in Figure 2-3. The upper diagram shows a cash crop (c) and food crop (f) production possibilities frontier (ppf) for households capable of producing more than enough food to meet household consumption requirements (ppf_a). Households not able to meet household food needs, even if all resources were devoted to food crop production, are represented by ppf_b. The bottom diagram traces out levels of household income as the relative price of food changes, holding constant the intake of food at 200 kgs/capita.

Three cases may be distinguished for a given set of relative prices: 1. households producing $f < 200$ for which $f_{max} < 200$ [i.e., $f < 200 > f_{max}$]; 2. households producing $f < 200$ for which $f_{max} > 200$ [i.e., $f < 200 < f_{max}$]; and 3. households producing $f > 200$ [i.e., $f > 200 < f_{max}$] at current prices. The bottom portion of the figure shows households in the first category are unambiguously worse off as the relative price of food rises towards p_2. An important implication is that unless these households can expand their ppfs by reallocating resources from non-crop to crop activities, and/or through input price and distribution policies, so that f_{max} exceeds 200, they may be forced to exit agriculture to work in the non-crop sector. Given their current situation, these households are unable to increase cereals production sufficiently to cover consumption needs. Households whose members are unable to migrate to Dakar or rural towns

FIGURE 2-3: IMPLICATIONS OF A RELATIVE INCREASE IN FOOD PRICES[a]



a. Depending on whether or not the ppf is such that f>200 when c=0; intermediate run adjustments are assumed, with resources fixed at the farm-level.

(and/or that are unable to send offspring) may go hungry to the extent that rural demand for labor declines as the price of food rises.

Consequences for households in the second category [i.e., $f < 200 < f_{max}$], as measured by income q, depend on the size of the relative food price increase. In particular, there is a range of prices in Figure 2-3 (from p_0 to p_2) in which income declines, showing these households to be worse off in the intermediate run. Households in the third category, for which $f > 200$ under current prices, experience improved incomes as they increase the production and sales of cereals in response to higher prices.

One important empirical task then is to estimate the proportion of households in each of these categories. Targeted policy interventions in input markets can subsequently be used to increase the ppfs to $f_{max} > 200$, if that is deemed desirable, and output price policies can then be used to influence the mix of cash and food crop production without introducing adverse distributional consequences for households' access to food.

To summarize, if expected output prices vary for individual households, it is impossible to predict which households will be unable to respond to food price increases until the shape of the ppf is known. In particular, when examining individual points in cash crop-food crop space, it is not known a priori how far each pff "stretches" along the food axis, nor how this intercept shifts outward if resources previously allocated to non-crop production activities during the growing season are committed entirely to food production at the new price of food.[11] Given empirical data, it is, however, possible to unambiguously estimate the number of households gaining and losing from an increase

[11]Households relying on off-farm income during the growing season to purchase food to maintain labor productivity will expend more effort on such activities, further reducing their agricultural ppfs. If perfect capital markets existed (through time), food production deficit households could borrow funds against expected future revenues from sales of food due to higher food prices and hence expand their ppfs.

in relative food prices, once the shapes of the different ppfs are estimated. Since the data collected for this study do not include input allocations by crop, this analysis was not performed.

2.1.3. Food Price Policies in the Long Run

Two principal research questions arise in predicting rural household responses to changes in food price policies over the long-run, when household resources and production technologies are variable.[12] The first concerns the rate and level of adoption of existing technology (K) by individual households, which in traditional analyses depend on the profitability of that technology via (effective) derived demand functions. Given Senegal's history of state intervention in agriculture, however, more than farm-level demand equations for improved inputs are involved. For example, agricultural draft equipment was historically made available mainly to the Peanut Basin, and not the higher-potential agricultural areas of the Upper Casamance in Senegal (e.g., Havard, 1986a; Ndoye, 1980). Improved technology was therefore not necessarily distributed or adopted according to expected economic pay-offs, but through political decisions which in turn influenced the (ex-post) comparative advantage (i.e., factor endowments) of the different regions of Senegal. To the extent that private markets for agricultural technology failed to develop, a broader examination and understanding of the public (parastatal) sector in Senegal and its role in enabling the adoption, maintenance and ownership of equipment through time is necessary (see also Sec. 2.2.).

A second question relates to changes in the relationship between inputs and outputs over time, i.e., changes in the implicit production function M. In general, this kind of analysis uses historical production and price data to evaluate whether technological change is biased towards a particular agricultural output or whether production

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[12]The focus here is solely on technology, not labor.

functions are homothetic (see Antle, 1984; Kuroda, 1988; and the references contained therein). Given the paucity of reliable time series data in Senegal it is impossible to pursue this kind of analysis. Nevertheless, even though reliable research expenditure data are difficult if not impossible to come by, and even though a recent World Bank study (Lele et al., 1989) concludes more research is needed to increase the productivity of cash crop production, it is probably correct to argue that most of the agronomic research in Senegal and West Africa to date has been directed towards improving the on-farm productivity of cash crops (see also the discussion in Eicher (1989, p.18) regarding the low use of improved cereals varieties and the relatively large stock of on-the-shelf technology for cash crops in Africa).

It can be shown that the ratio of cash to food crop production, at any given price ratio, is higher the more cash crop-biased the technology employed. This also suggests that the more food crop-biased the agricultural technology, the less food prices have to rise relative to cash crop prices to achieve the same ratio of cash and food crop production. However, if technological change is biased exclusively in the direction of food crops and if prices of food eventually decline as supply meets demand, the theoretical possibility of "immiserizing farm-level growth" can not be ruled out.[13]

To conclude this section, Table 2-1 provides an overview of the assumptions, data needs and classification of households to evaluate the consequences of a food price increase in food deficit nations such as Senegal. It is argued that households in rural Senegal have a variety of economic options for achieving food consumption security, and that own-food production represents only one option. The argument is not that food price policy is ineffective. Instead, the sequencing of agricultural policies is critical, and before food price policies can bring about broad-based distributional benefits it is

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[13]The notion of immiserizing growth in the case of a country engaged in international trade is discussed by Bhagwati (1982, orig. 1956).

TABLE 2-1: ASSUMPTIONS, DATA NEEDS, AND CLASSIFICATION OF HOUSEHOLDS TO EVALUATE CONSEQUENCES OF A FOOD PRICE INCREASE

Assumptions or Data Needs	Length of Run: Short Run 12 months	Intermediate Run 12-24 mths	Long Run 24 mths +
1-Resources (K,L)	Fixed within crop enterprises	Fixed at the Farm Level	Variable
1a-Technology [M]	Fixed	Fixed	Variable
2-Data Needs (cumulative)	Nbr. of consumers Kgs food produced Kgs cash produced Exogenous income[a] Output prices	Units of labor and capital used [output price]	Institutional Environment Input prices Investment demand fctn. Bias in M; Heterotheticity
3-Notation	c_0, f_0, a_0[a]	$m(c,f,k_0,l_0)=0$ $(a=a_0)$	$m(c,f,k,l)=0$ but $k=g(x_1)$ and $l=h(x_2)$ $m=m(time)$
4-Household Response	$\delta q/\delta p_f$ (given f and c fixed)	$(\delta c/\delta f)(\delta f/\delta p_f)$ Total k,l fixed	Same as i/r but k,l not fixed
5-"Test" Statistic	Percent of hhs with $f < 200$	Percent of hhs with $f_{max} < 200$	% of hhs w/ c/f = 1.0
6-Refined Classification	Cash/food production and consumption secure or insecure	$f < 200 > f_{max}$ $f < 200 < f_{max}$ $f > 200 < f_{max}$	

a. This information is required if the intention is to distinguish households becoming food consumption insecure from those which merely experience a decline in cash consumption as a result of the food price increase.

essential to determine households' existing food production possibilities and (if necessary) to expand these by relaxing non-price constraints and/or to seek ways of increasing the productivity of labor in non-crop activities. This may be an obvious assertion, but it is often ignored when well-meaning assumptions have to be used to compensate for a lack of empirical data.

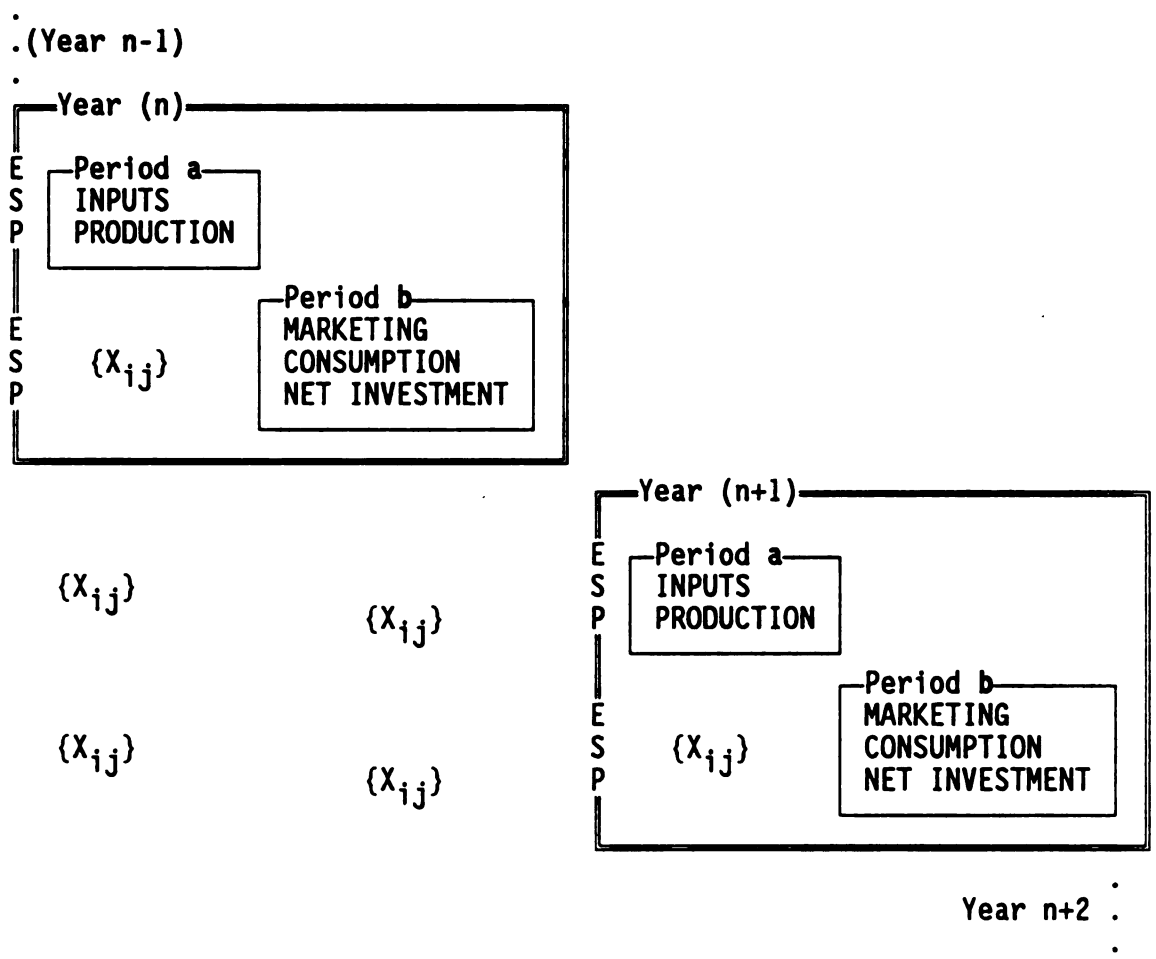
The following section examines the household's decision problem in a more dynamic and recursive perspective, drawing on concepts developed in the present section, and on the work of Shaffer (1980), O.E. Williamson (1986) and Sen (1987). The remainder of this Chapter attempts to lay the conceptual groundwork for analyzing food strategies pursued by households, taking into account the food system environment facing farmers in southeastern Senegal, which are examined in the remainder of the thesis.

2.2. E-S-P: A DYNAMIC VIEW OF HOUSEHOLD BEHAVIOR

Figure 2-4 shows the recursive relationship between select decision variables of a household for two years, each of which is divided into two periods. Each year, input use and crop mix decisions are made during period **a** (the rainy season), while marketing and (net) investment activities take place in period **b**. Consumption is listed explicitly in period **b**, even though it takes place throughout the year, to emphasize the maintained hypothesis that consumption decisions are made at least in part after production is known (i.e., at harvest). For example, an unexpected shortfall in cereals output due to drought may force the household to change its mix and level of cereals consumption.

As in a multi-period recursive Linear Programming tableau, the performance of one period feeds into the entitlements of subsequent periods (denoted as a transfer of performance outcomes $\{X_{ij}\}$), thus shaping and constraining the choice set and, ultimately, the performance of that subsequent period. The quantity of cereals produced in period **a** of year n, for example, provides part of the entitlement to consume and sell

FIGURE 2-4:
THE RECURSIVE ENTITLEMENT-STRATEGY-PERFORMANCE (ESP) CONTINUUM



Note: As in the multiperiod or intermediate inputs linear programming tableau, $\{X_{ij}\}$ shows the transfer of performance outcomes (e.g., production, net investment in equipment, etc.) into the entitlements of subsequent period(s).
Period a = rainy season.
Period b = dry season (post-harvest).

cereals in period **b**, but also provides the entitlement to cereals seed as an input in period **a** of year n+1.

Own-production provides only one side (i.e., the supply side) of the entitlement to sell cereals; a complementary entitlement is the presence of a buyer willing to trade cash for cereals at an acceptable price. The demand side of this entitlement may arise in the form of a cereals harvest failure on a neighbor's plot. Hence, neither the supply nor the demand side of a potential exchange can be taken for granted (see also Shaffer et al., 1983; and Binswanger and McIntire, 1987).

The by and large random production outcome in year n therefore not only affects the marketing, consumption and net investment opportunities or entitlements of that year, but also the production possibilities in year n+1 via the quantity of cereals carried over as seed stock and as food to feed the household during the crop growing season (i.e., the hungry season). Not only resource endowments, but also the productivity of resources, may change from year to year. For example, increased food availability in period **a** will raise the productivity of labor, and fertilizer residues in fields previously planted to cotton will tend to raise the productivity of that land in producing maize in the second year.[14]

Figure 2-5 shows in more detail the entitlement set, strategies and performance dimensions of interest in this study. The diagram highlights how the performance outcome of period **a**, along with variables beyond the immediate control of the household, such as access to parastatals and marketing opportunities, becomes the entitlement set for the subsequent period (**b**).

Table 2-2 provides an overview of alternative strategies available to households in south-eastern Senegal for achieving food security. Following Sen (1987), strategy A.3.

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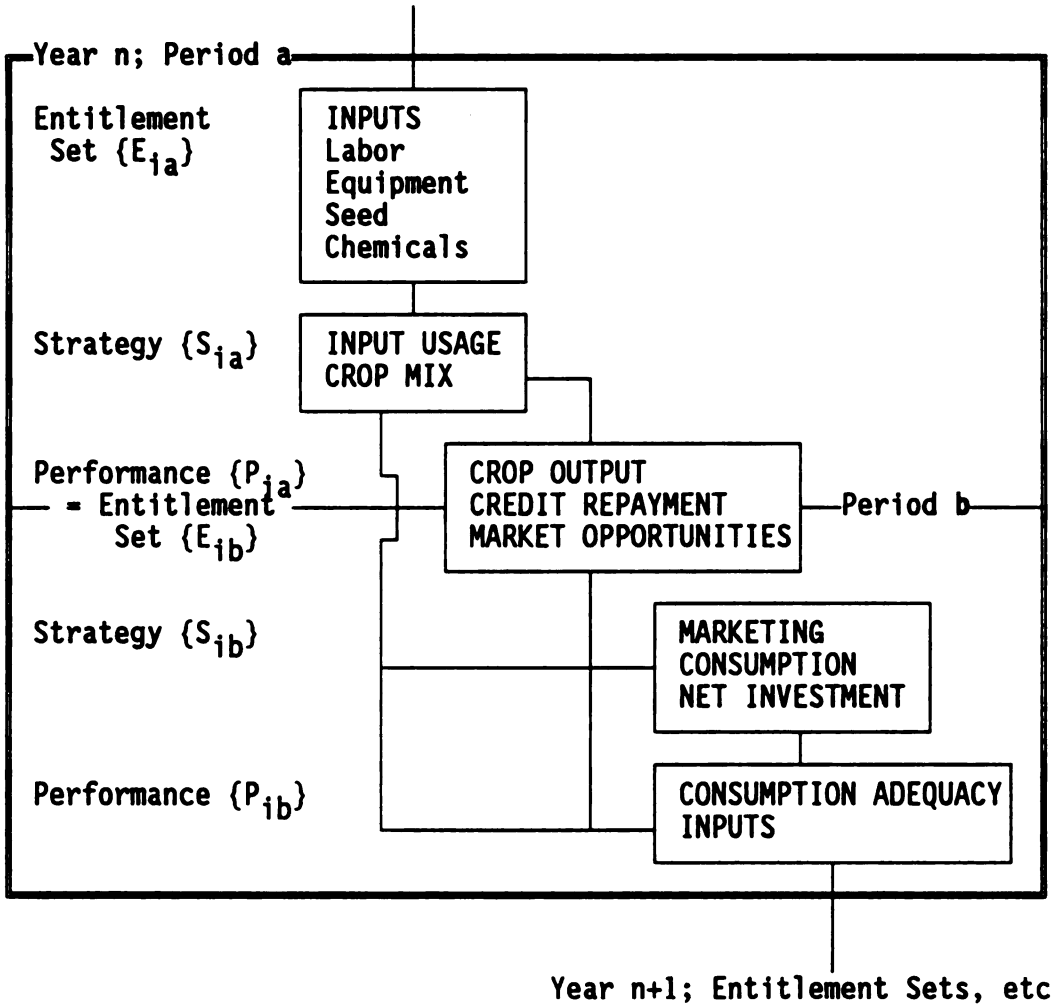
[14]Similarly, the nitrogen-fixing ability of peanuts (as a legume) benefits millet grown in the same field in the following year.

FIGURE 2-5:
DETAILS OF THE E-S-P SET OF A HOUSEHOLD IN A GIVEN YEAR



Note: i denotes the i-th household.
Some strategies (not shown) may be pursued throughout the year;
e.g.: - off-farm activities/incomes
- livestock raising and transactions
- borrowing credit for short-term consumptions purposes.

yields production-based entitlements to food. Strategies A.4. and B.1. involve trade-based entitlements, while strategies B.2. and B.3. are based on transfer entitlements. Different strategies involve different levels of complexity and riskiness. For example, to trade cotton for cereals a seller requires a market outlet for cotton and at least one food system participant willing to exchange cereals for cash at an acceptable price. More complex strategies thus involve more interdependence and require higher degrees of market coordination.

Reliance on food aid is risky since it often comes late, if at all. The borrowing strategy, similarly, may fail if all households in a given area produce insufficient quantities of food, as is usually the case when entire regions of a country are stricken by drought. Several combinations of strategies are possible, leading to more complex observed outcomes, and given the uncertainty associated with agricultural production, one may expect to see households pursuing more than one strategy.

Non-agricultural activities are potentially important in that they can help households to survive crop failures and also to facilitate investments in agricultural inputs. The steady income stream they provide may also increase the willingness and ability of households to sell and buy food. Off-farm activities carried out during the growing season (period **a**) may tend to conflict with agricultural production. Consequently, more information is required to gauge whether non-agricultural activities "compete with" or "complement" agricultural activities.

The choice of a given strategy would in principle depend on two key factors: (a) its availability--i.e., whether or not the decision-maker is entitled to pursue it--and (b) its expected effectiveness in contributing to the goal of achieving a minimum level of food security and/or cash income. This dichotomy is more apparent than real, however. For example, if the cotton parastatal does not operate in a given region, the cost of inputs needed to produce cotton becomes very high and the selling price of cotton very low for

TABLE 2-2:
STRATEGIES FOR ACHIEVING FOOD SECURITY IN SOUTHEASTERN SENEGAL[a]

A. CROP PRODUCTION-BASED STRATEGIES

1. Equipment-Use
   - use traditional hand tools
   - borrow entire set of draft equipment
   - borrow partial set of draft equipment
   - own a full complement of equipment
2. Labor-Use Strategies
   - use family labor only
   - use seasonal labor (surghas, navetaans.)
   - hire hourly or daily wage labor
3. Food Crop Production (Self-Sufficiency)
   - traditional coarse grains (millet, sorghum and maize)
   - rice
4. Cash Crop Production
   - peanuts
   - cotton

B. NON-CROP PRODUCTION STRATEGIES

1. Income From Other Sources
   - agricultural labor (off-the-farm)
   - livestock
   - non-agricultural activities
2. Gifts
   - traditional gifts (dons, assaka)
   - food aid
3. Borrowing
   - cash
   - in-kind

a. Not shown are strategies of using improved technical inputs such as herbicides, fertilizer, insecticides and fungicides.

a farmer in that region, so that a strategy of growing cotton is ineffective in contributing to food consumption security. The advantage of asking two (a and b) rather than one question (only b) is that the institutional environment giving rise to different sets of entitlements to produce and market cereals and/or cash crops becomes a variable in the analysis, and thus subject to policy influence.

The concept of a demand function for certain factors of production (derived from a production function under profit-maximizing behavior) has to be modified here to reflect the fact that observed outcomes--such as the use of herbicides--do not simply result from the anonymous working of an invisible hand.[15] Instead, observed outcomes of input use reflect the intersection of a parastatal's decision to provide a household with the input (and the crop) and the household's decision to agree to the terms and conditions of the input delivery.[16]

Following Poirier (1980), this entails the following model: the farmer wants to work with the parastatal (i.e., to receive fertilizer) = y_2^*, and the parastatal "accepts" the farmer = y_1^* (here the * reflects a latent or unobserved variable; we observe the unstarred variable y_i).

Parastatal decision: $y_1^* = x\beta_1 + u_1$

Household decision: $y_2^* = x\beta_2 + u_2$

$$y_i = \begin{cases} 1 \text{ if } y_i^* \geq 0, \text{ (for } i=1,2) \\ 0 \text{ otherwise} \end{cases}$$

In the model, we observe:

$$Z = y_1 \cdot y_2 = \begin{cases} 1 \text{ if } y_1 = y_2 = 1 \\ 0 \text{ otherwise} \end{cases}$$

Z could be a continuous (tobit) variable, e.g., if data exist on the kilograms of fertilizer used. Poirier assumes a bivariate normal distribution in his analysis:

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[15]See also the discussion in Binswanger and Rosenzweig, 1986, p.510.

[16]Moral hazard and adverse selection pose further analytical challenges to modelling household input demand functions.

$$\begin{bmatrix} u_1 \\ u_2 \end{bmatrix} = \text{iid BN} \left[0, \begin{bmatrix} 1 & \sigma_u \\ \sigma_u & 1 \end{bmatrix} \right]$$

$$\text{Then} \quad P(Z=1) = P(-u_1 \leq x\beta_1, -u_2 \leq x\beta_2)$$
$$= F(x\beta_1, x\beta_2, \sigma_u),$$

where F is the bivariate standard normal density. From this a likelihood function can be set up to obtain maximum likelihood parameter estimates.

Figure 2-5 does not explicitly show interdependencies among inputs. In addition to technological complementarities among inputs, we may define a market-based complementarity in environments where markets do not function well for some or all inputs (including credit). For example, Kelly and Gaye (1986) argue that household heads can only attract non-family workers and married sons (i.e., form coalitions) by providing peanut seed, which traditionally has been received from the government on a credit basis.[17] Hence a reduction in peanut seed credit may lead to lower availability of labor to household heads. Similarly, household heads owning draft equipment may be in a better position to attract non-family workers and/or retain married sons within their households. The forming of coalitions among and within households is discussed in detail in Section 2.3.

Delgado and McIntire (1982), and Dione (1989) argue that farmers in the Sahel will not adopt fertilizer and equipment unless they also have access to additional labor due to the labor-shifting effects of new technology--e.g., increased weeding and harvest

[17]Kelly and Gaye also argue that this custom makes it difficult for household heads to invest in improved cereals production technology (e.g., fertilizer) since whatever means (cash) are available at planting must be devoted to the acquisition of peanut seed.

labor requirements.[18] To the extent that there are complementarities between labor and equipment or fertilizer use, households with access to a larger labor force will be more likely to use improved technologies, ceteris paribus. Senegal's fertilizer distribution policy may confront reluctance from farmers if they cannot also hire more labor, for example, by having increased peanut seed and food available to attract that labor at planting. Since private sector credit is a severe constraint, it may be necessary to provide farmers with short-term consumption credit so that they can provide additional laborers with food. (The relationship between a household's labor force and the use of fertilizer is examined further in Chapter III.)

Marketed surplus elasticities for crops can be calculated directly from reduced form equations, or as the (quantity-) weighted difference between demand and supply elasticities of the good in question (see, e.g., Strauss, 1984, and Chapter V). In this study, and consistent with the framework presented earlier, marketed surpluses are treated as a valve for adjusting household-level stocks of food to cope with uncertainty, rather than a planned, static quantity. Hence, net marketed surpluses depend in part on beginning stocks (i.e., levels of output in period **a**).

Furthermore, given uncertainty and thin markets in southeastern Senegal, transactions costs--manifest in a differential between buying and selling prices--are allowed for when a good is bought or sold. With transaction costs, adjustment is no longer frictionless, and marketed surpluses respond only to large values of predetermined variables.[19] If Y denotes the actual change in stocks (i.e., net sales) and Y* the desired change, then the relationship between these two variables is as shown in Figure 2-6 (Rosett, 1959). α_1

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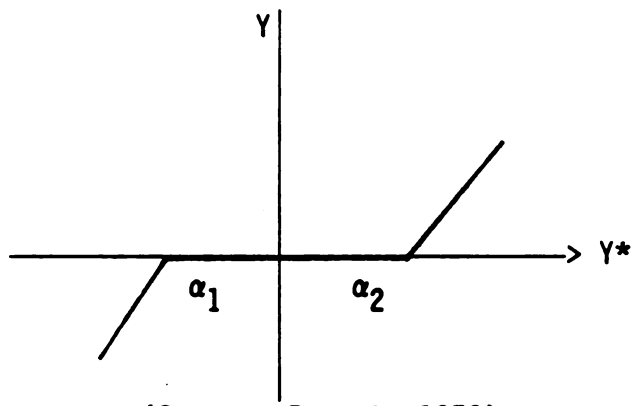
[18]Note that late rains during the peanut harvest are a problem for peanuts not yet brought in from the fields; this means farmers cannot postpone the storage of peanuts indefinitely.

[19]See Maddala, 1988, p.162, ff. for a discussion of this class of models.

(α_2) represents a desired decrease (increase) in stocks, and $Y = Y^*$ only for large (absolute) values of the predetermined variables. The implication of recognizing transaction costs is that economic adjustments have to be modelled statistically in two steps. First, there is the yes-no decision of whether or not to adjust (and in which direction); this involves a threshold, and a comparison of the benefits to and costs of crossing that threshold. Second, a continuous decision is made regarding by how much to adjust, conditional on having crossed the threshold. These concepts are discussed and applied in more detail in Ch. V.

FIGURE 2-6: ADJUSTMENTS WITH FRICTION



(Source: Rosset, 1959)

As indicated earlier, the recursive nature of outcomes, and the associated uncertainty, has implications for the ability of specific output price policies to effect production increases. A higher official post-harvest food price announced before planting can only affect total production if there is an intertemporal market (i.e., for credit), which allows producing units to capitalize the higher expected future benefit into current-period inputs, or if liquidity from other sources (e.g., investments in non-farm activities) can be bid away to farm activities. For a production unit operating near subsistence and having to decide whether to consume or to plant coarse grain seeds left in storage from

the previous year's production, the prospect of a higher post-harvest price will offer little immediate incentive.

The framework presented here therefore indicates that relative prices and fixed factors are not the only variables governing economic behavior; production outcomes and access to resources do influence consumption and marketing decision as well as the acquisition of inputs such as labor through complementarities arising from market uncertainty.[20] Questions to be asked should include: Which households have which resources and why? This contrasts with a static model where production and consumption in essence take place at a single point in time. The conditional recursive satisficing ESP model is also not the same as the ex ante maximization of a net present value function over multiple periods, since outcomes for production and consumption variables are not assumed to be known a priori. More generally, the purpose of this exposition is to describe and organize events and ideas (Thurow, 1984, p.23), explicitly taking into account uncertainty and lags in agricultural production, consumption and investment behavior. This will lead to a richer understanding of economic behavior, for example in the case of marketed surpluses, which would otherwise be summarized as a point-estimate of an elasticity.

A further question to be investigated in more depth in this study is whether or not there are cost savings when cash and food crops are produced within the same firm rather than two separate (specialized) firms. This would further strengthen the argument that cash crop- and food crop-producing households are better off by forming a household coalition and perhaps encouraging specialization within households. Figure

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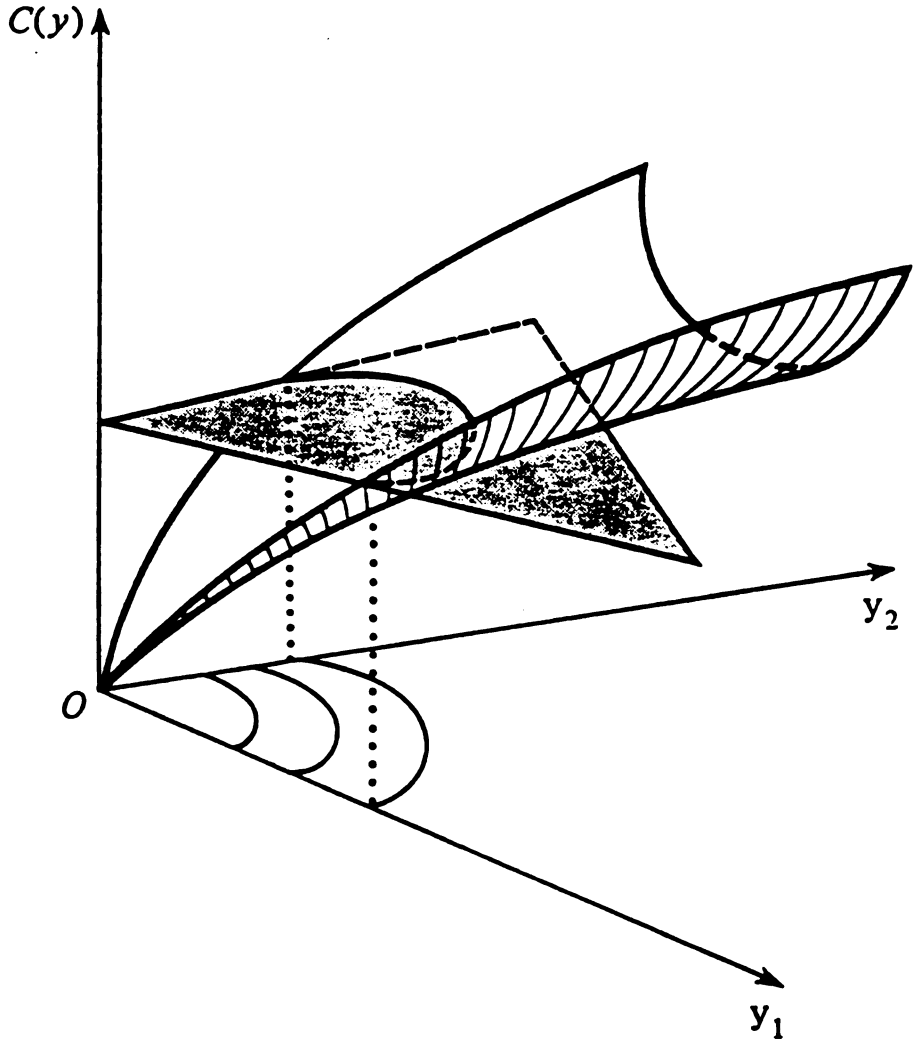
[20]This is similar to the constrained maximization problem developed by Chambers and Lee (1986) and Lee and Chambers (1986), who use duality results to estimate an expenditure-constrained profit function; while allowing for credit market imperfections, these authors also assume perfect foresight, however. A similar (revenue-maximizing) approach is found in Gordon, 1989.

FIGURE 2-7: COST SURFACE FOR TWO OUTPUTS



(Source: Baumol et al., 1982, p.84)

2-7 shows a hypothetical cost surface for a firm and three production possibilities frontiers reflecting the trade-off between y_1 (the cash crop) and y_2 (the food crop). Cost concepts associated with multi-product firms are investigated in more detail in Ch. V (see also Baumol et al., 1982). In this diagram the cost surface is "bent inward", indicating it is cheaper to produce a linear combination of Y_1 and Y_2, instead of specializing in the production of only one of the two products.

The estimated parameters of a cost function permit testing the hypothesis that the existing farm technology--and not only transactions costs, uncertainty and input complementarities--reduce the propensity of households to specialize into cash or food crop production. Estimates of product-specific scale economies provide information as to where households are currently operating on their cost curves, and how the average household's costs of production will change if crop substitution takes place as planned under the NAP. For example, if the per unit cost of producing food increases, there will be important implications for net buying households.

In summary, the analysis in Section 2.1. was based on a strict trade-off between food and cash crop production. The discussion here raises the possibility that there are nevertheless certain complementarities between food and cash crops, to the extent that costs (resources) are saved--or inputs used more optimally--when both are produced on the same farm. In a broader sense, the two types of crops may also complement one another in that cash crops, with their assured market outlets, allow farmers to pursue investments in resources such as draft technology. Hence dynamic elements come into play which may not be picked up in a static analysis.

2.3. RURAL ORGANIZATION: FARM HOUSEHOLDS AS COALITIONS

> [I]f ... the differences between LDCs and the more developed countries lies largely in matters of economic organization, then the first item on the research agenda should be a better understanding of the microeconomics of LDCs. What is needed is a theory of rural organization, as well as a theory of industrial organization focusing on the special characteristics of the LDCs (emphasis in original).
>
> J.E. Stiglitz, 1989, p.202.

Uncertainty and transaction costs affect the ability of markets to function effectively. Alternatively, they may also lead to the formation of institutions such as coalitions, manifest in the form of integrated or extended households. That possibility and its implications for economic analysis is examined in this section.

Agricultural households--as opposed to individual workers or villages--are appropriate units of observation for economic analyses since they are generally the level at which production, consumption, land allocation and resource investment decisions are made.[21] Households are not composed of individuals with identical status, rights and goals, however, and it is important to understand how the various actors cooperate (or fail to do so) in a household coalition.

A general and workable definition of an agricultural household in Senegal from the production side is provided by Benoit-Cattin and Faye (BCF, 1982, p. 83)[22]:

> L'exploitation agricole familiale est l'unité de production constituée par l'ensemble des membres d'un groupement familial qui partagent la même cuisine et dont l'aîné assure la charge en y affectant une partie de sa production en contrepartie du travail que lui allouent les autres membres du groupement. Le reste du temps de travail est utilisé librement pour

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[21] See Casley and Lury, 1982, for issues involved in defining farm households in traditional agrarian societies.

[22] Translation: The agricultural household family is the production unit made up of all members of a family group which shares the same kitchen and for which the eldest member assures the sustenance by providing part of his output in exchange for the labor of other group members. The remaining labor is used freely to cultivate land belonging to the group and managed by the elder, and the output of which is individually appropriated.

> cultiver sur les parcelles appartenant au groupement et gerées par l'aîné et dont la production est appropriée individuellement.[23]

Implicit in this definition is a creditor-debtor or patron-client dependency between the household head--or borom ndieul, the "owner of the kitchen"--and his surghas (see also Monnier, 1974; Diop, 1985).[24] The word surgha derives from sur: to satisfy hunger and ga: to cause to work.[25]

A further useful concept for understanding dependence among relatives is that of household integration or extension. Binswanger and McIntire (1987) define two forms of household extension (p.81-2):

> (1) a vertically extended household, composed of nuclear units of succeeding generations, and (2) a horizontally extended household, composed of nuclear units of siblings. ...[A] household can be both vertically and horizontally integrated.

These relationships are shown in Figure 2-8, which also defines household-related terms used in the present study. In the vertically extended household the head is called a chef d'exploitation, while in the horizontally extended case he is a chef de concession (CC). Concessions consist of two or more horizontally integrated exploitations, wherein the CC (usually the oldest brother) allocates land belonging to the concession among the independent exploitations. While the latter make their own production decisions, they are therefore constrained in terms of their access to land through their membership in

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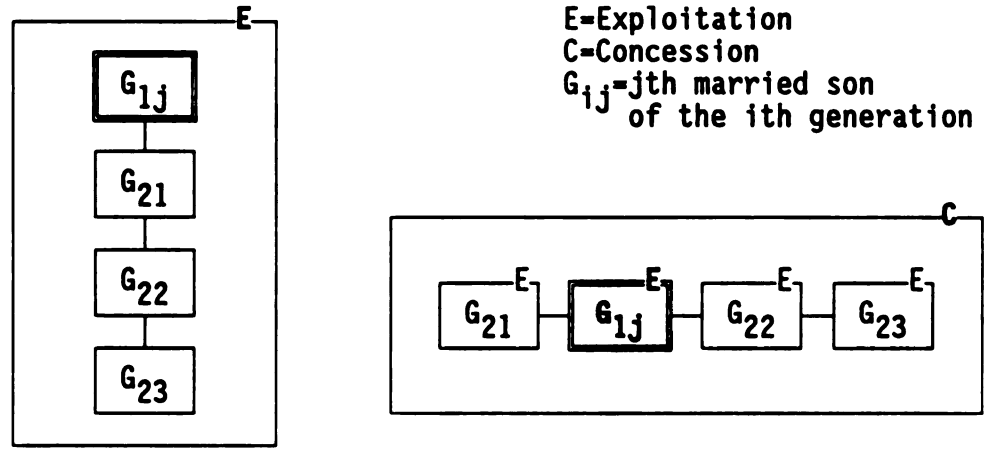
[23]FSP experience shows it is not necessarily the oldest person who decides. Monnier (1974, p.37) quantifies labor exchange flows in one household.

[24]BCF (p.35) use the term surgha to include all dependent household members, i.e. nawetaans (those that come during the nawet, or rainy season), surghas (defined is this study as non-family workers who reside permanently in the household), and family members including wives. Nawetaans were actively recruited during the colonial era (Ba, 1986, p.214). The firdu make up another category of (young male) migrants, arriving in the Peanut Basin during the peanut harvest season (Ba, 1986, p.210, 214).

[25]BCF, ibid. Literally, the word means to feed someone in exchange for that person's labor.

FIGURE 2-8: VERTICAL AND HORIZONTAL EXTENSION OF HOUSEHOLDS



(i) Vertical Extension [1 decision-making unit]

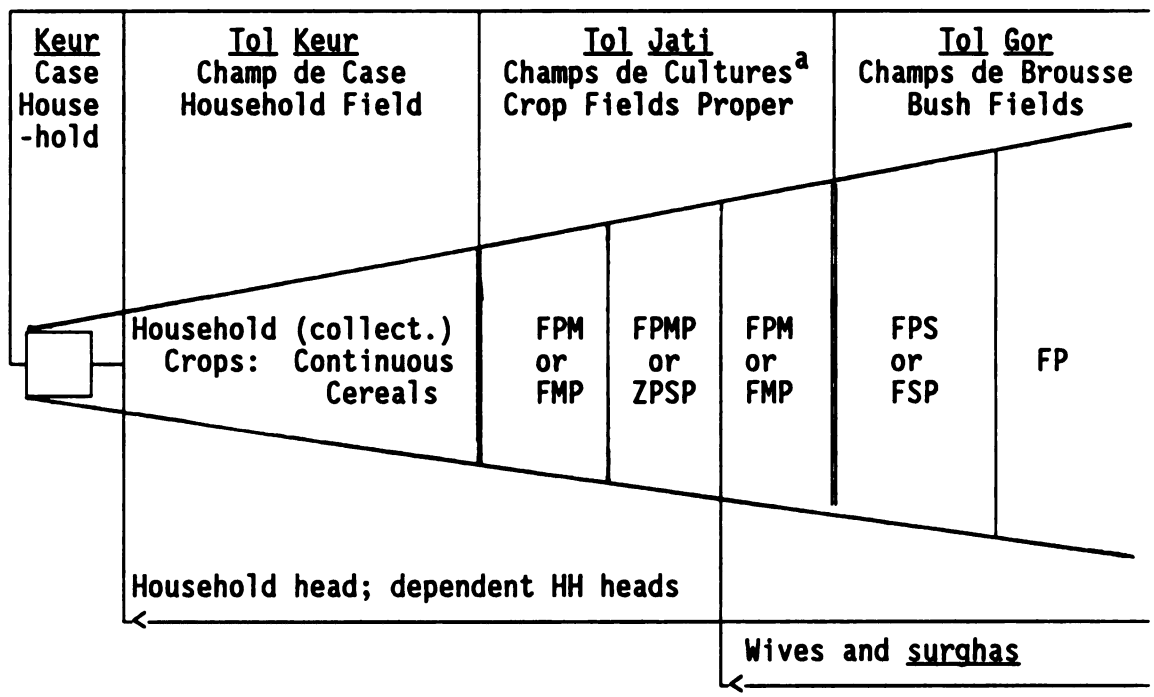
(ii) Horizontal Extension [4 interdependent decision-making units]

the concession. A possible benefit to being a member of a concession may be that it facilitates the borrowing of agricultural equipment.

To fulfill the requirement of feeding his dependents (both relatives and non-relatives), the household head (chef d'exploitation cultivates a collective cereals field (BCF, 1982; Diop, 1985; Goetz and Diagana, 1987), to which each dependent (surgha) supplies a predetermined amount of labor.[26] This amount can differ by dependency status, household, region and ethnicity. Proceeds from the collective field can also be used to purchase clothing for dependent workers and, when all other needs have been met, for the household head--who generally also owns personal fields to meet his cash requirements. To some extent a measure of the degree of solidarity of the household (Diop, p.176), the collective field is generally closest to the household (Figure 2-9), and at least in the Peanut Basin is continuously cropped to early-maturing millet which

[26]See also Stomal-Weigel, 1988, p.23. He reports that some villages in the Peanut Basin have millet fields which are collective at the level of a village quarter (quartier).

FIGURE 2-9: DEPENDENCY STATUS AND LAND USE



a. Proprement dits.
Crop rotation legend: F=Fallow, P=Peanuts, M=Millet, S=Sorghum, Z=Maize.

(Source: Monnier, 1974, p.25.)

benefits from animal manure and/or "night soil".[27] As discussed in Ch. IV, the distinction between "home maize" (maïs de case) and "field maize" (maïs de champ) is important. The potential for expanded production of the former is limited while--depending on the region--lack of soil fertility and attacks of wild animals constrain the expansion of the latter.

In the cash crop-food crop debate it is often argued that farmers face a trade-off in terms of producing both types of crops. In this regard it is interesting to note that BCF (pp.69-70) argue that the introduction of expanded[28] peanut production led to an extension of the work day and work week, eliminated certain labor slack periods, and attracted migrant workers. They also contend that peanuts displaced cereals formerly used for sale rather than consumption, and therefore did not disturb the household's food balance.

Stomal-Weigel (1988, p.29) states that the household head in general controls the production of the food crop and has the right to manage it, but does not own it. Accordingly, this constitutes one factor preventing food crops from becoming more of a "cash crop"[29]:

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[27]See Monnier, 1974. Informal survey evidence suggests this constellation of fields is also prevalent in the southern research areas.

[28]At the turn of the last century peanuts were cropped only in small quantities that were destined solely for on-farm consumption. This raises the question of which mechanisms were put into place so that peanuts could become more of a commercial crop.

[29]This argument pertains to Wolof and Serer ethnic groups in the Peanut Basin. It is not known to what extent the results can be transferred to other groups, such as the Peulh. Translation: Being a collective good, [the household head] does not dispose of the millet (food crop), being a collective good, at will and in theory cannot sell it without the group's consent; if he does frequently sell it in practice, it is because he can assure the food supply of the collective with other means. Therefore, given conflicting social needs within the household, and each individual seeking to meet his own endogenous objectives through sales of the commodity, millet must lose its collective character and become an individual commodity; ...

> Le mil étant un bien collectif, [le chef d'exploitation] n'en dispose pas librement et, théoriquement, il ne peut pas le vendre sans le consentement du groupe; s'il le fait souvent en pratique, c'est parce qu'il est en mesure d'assurer autrement les besoins en vivres de la collectivité. Or, pour devenir une production commerciale au sens strict du terme et étant donné les contraintes sociales en présence, chaque individu ayant ses objectifs endogènes à satisfaire grâce à une participation à la production marchande, le mil doit perdre son caractère collectif et devenir un bien individuel; ...

Most dependent household heads (married sons) grow food crops so that their wives can supplement the food provided by the household head when it is their turn to prepare the meal of the household (BCF, p.76). Married women have their own personal fields, the proceeds of which are used to purchase condiments for cooking and household items, and to satisfy personal needs.

Stomal-Weigel (ibid.) maintains that peanut sales are not well-suited for meeting daily cash needs of females, since the peanut marketing season is of limited duration and peanuts are difficult to store (his observations are based on experiences in the Thiès and Diourbel regions). Therefore (p.29),[30]

> [c]e sont surtout les femmes, ayant une obligation de founir quotidiennement les condiments nécessaires pour la préparation des repas, qui apprécient la régularité des revenus que leur assure la petite parcelle cultivée en mil.

It is not obvious how to measure the welfare of females or wives. In rural Senegal, marriages are interpreted as "alliances" between different families (Diop, p.206) and should not be confused with Western notions of matrimony.[31] The argument is sometimes made that a wife approves of the husband marrying further wives since this

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[30]Translation: It is mainly the women, with the daily obligation of providing condiments necessary for preparing meals, who appreciate the regularity of income provided by their small cereals fields.

[31]It is known that marriages are sometimes arranged over space to spread climatic risks (eg. Binswanger and McIntire, 1987, p.84). In the FSP sample at least one matrimonial alliance was made across the Gambian border, ostensibly to facilitate the introduction of cheaper Gambian products into Senegal. See also Lambert, 1989.

reduces the average burden of household chores.[32] First wives have a somewhat higher social status than subsequent wives, but this does not necessarily extend to economic and other spheres. Wives also do not wish to share their husbands with too many additional wives, and may encourage their sons to become autonomous soon after their own marriage; this labor withdrawal from the household head reduces his ability to take on a new wife. For the same reason, the household head may not want to provide his son(s) with large amounts of peanut seed; BCF (p.73) also suggest that acquisition of equipment by sons will hasten their emancipation, i.e., departure from the household. A high dowry--viewed as an economic exchange for the procreative ability of the female--can make the decision of whether the household head or his son obtains the next wife a source of conflict in the household (Diop, p.195).[33]

BCF (p.79) suggest that women are better off if they belong to large, fully equipped households and have sons who work their fields.[34] This can mean that the mother need not work agriculturally, while still benefitting from the output of her alloted field to meet her own needs and communal obligations. She may of course also receive transfers (gifts) from her sons' fields and future in-laws.

The difficulty of mobilizing rural deposits in Africa is well documented (von Pirschke et al., 1983; Binswanger and McIntire, 1987). Diop (p.170) describes the situation where young males aspiring to become household heads deposit part of their surpluses for safe-guarding with the household head (in which case the son receives an interest payment) or, when confidence is lacking, with a maternal uncle or the village

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[32]Polygamy, with no limit on the number of wives so long as each could be supported adequately and equally, existed prior to the introduction of Islam into Wolof society.

[33]The size of the dowry also discourages divorce, which is one manifestation of the breakdown of a household coalition.

[34]Obviously, there are also tangible economic benefits to having female off-spring.

chief. Similarly, dependent unmarried males can grow food which they deposit with their (older) married brothers or household head, and which is credited towards a future dowry payment made by the recipient on behalf of the depositor (BCF, p.48).

In addition to household production units one can define residential, consumption and accumulation units (translated from Gastellu, 1980, p.4):

1. a residential unit--the group of persons sharing the same living space, separated from others by a visible frontier;
2. a production unit--the group of persons contributing to the creation and provision of a product;
3. a consumption unit--the group of persons participating in the destruction of part of the product with the goal of regaining their ability to work;
4. an accumulation unit--the group of persons who collectivize the surplus left over after each individual's consumption.

While, in general and for practical purposes, the first three types of units are often the same, it has been observed among certain ethnic groups that independent households of a concession form a collective consumption unit during the rainy season. These ethnic groups include the Serer of Niakhar in Senegal's Peanut Basin (Lombard, 1987, p.474), and the Serer Safèn in the Ivory Coast (Gastellu, 1980, p.7). It is not obvious how this phenomenon would affect agricultural household analyses, where utility-maximizing production and consumption decisions are assumed to be made simultaneously by a single, well-defined and homeostatic unit.

Of more immediate interest is the phenomenon of an accumulation unit (AU) among the Serer of Mbayar in Senegal studied by Gastellu (1985, p.417). His analysis may have implications for the disinvestment behavior of households in case of droughts. AUs are composed of "uterine relatives" such as a household head and his brothers, or a mother and her offspring, who accumulate wealth in the form of livestock, agricultural

equipment and jewelry. Three purposes of this accumulation are to provide (1) productive capital; (2) a security stock; and (3) a means of ceremonial exchange between AUs (Gastellu, p.419).

More importantly, AUs are not neatly confined or localized within a household, but are spread across different households. This leads to an "institutionalized contradiction," since each individual has obligations relative to his or her production-consumption unit and a separate AU, which in turn prevents pronounced individual accumulation (Gastellu, p.417-8). In the two societies studied by Gastellu, the contribution of individuals to the AU remained recognizable and separable. With geographic dispersion, AUs may entail risk-spreading benefits, and affect the ability of different households to cope with climatic uncertainty.

In case of food production shortfalls, the household head can purchase food from his dependents using proceeds from his cash crop fields, or he can buy cereals from his wife with reimbursement at the next harvest, with the amount of interest charged by the wife depending on the degree of competition between wives (Diop, p.166). Various authors report that output from the collective field is allocated first to consumption in the subsequent rainy season, and the remainder (if any) is then consumed during the dry season. Diop (ibid.) writes that when the household head migrates in search of food, the wife may have to sell off personal belongings to feed remaining household members in the interim. The first wife is responsible for the household's upkeep when the head is absent, and also represents the other wives in front of the household head (Diop, p.189).

Diop (p.214) presents data showing that of 921 cases of litigation before courts in the Thies, Diourbel and Dagana regions during 1965-73, 36.4% involved household conflicts (including the effects of divorce) while 37.5% concerned divorces, or a breakdown of the coalition. Among reasons given for divorces, the inability of the household head to provide food was prominent (p.223). According to the same author (p.180) this

is also a common cause for dependent household heads to form their own independent household.

The labor benefit which the household head receives is the counterpart of a transaction requiring him to supply dependents with food, lodging, land and (variable) inputs. As Binswanger and McIntire (1986, p.83) point out, "labor incentives are clearly improved ... if all nuclear units, or even all members, are also allowed to have plots of their own." The inputs supplied to dependents may vary with the status of the dependent. BCF state (p.77):[35]

> [le chef d'exploitation] doit ... assurer les investissements nécessaires aux activités agricoles du foyer et pour ses propres parcelles les dépenses annuelles de culture: engrais, semences, etc.

Diop lists the responsibilities of the household head as (p.158):[36]

> Détenant seul le pouvoir économique, [le chef d'exploitation] a, en retour, l'entière responsabilité de l'entretien de la famille, dès l'instant que ses membres s'acquittent correctement des tâches - surtout agricoles - qui leur reviennent. Il doit fournir les instruments de travail, trouver des semences, s'il en manque, assurer la nourriture, même en période de soudure ou de disette.

The requirement of providing inputs and food to dependents may partially explain why one particularly successful and large-scale farmer had difficulty envisioning a doubling of his operation (suitable land was not a constraint). Household heads not able

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[35] Translation: The household head must ... assure the necessary investments for the agricultural activities of the household and the annual expenses for his own fields: fertilizer, seeds, etc.

[36] Translation: The sole holder of economic power, [the household head] in return has the entire responsibility for the upkeep of the family as soon as the other members have properly carried out their - mainly agricultural - tasks. He has to furnish tools, find seeds if they are lacking, and assure the supply of food even in periods of food shortage.

to meet their obligations face the threat of other members exiting from the coalition. For example, Diop states (p.159):[37]

> ([m]ême dans le passé,) des chefs de ménages quittaient la concession pour fonder la leur, non seulement quand la famille devenait trop grande ou que les terres manquaient, mais aussi lors-qu'ils mettaient en cause l'autorité du chef de concession qui abusait de son pouvoir ou manquait à ses responsibilités. Il y avait aussi une alternative pour les jeunes gens qui pouvaient rejoindre la maison de l'oncle maternel (emphasis added).

Further, (p.176)[38]

> [a]ujourd'hui, l'autorité du chef de famille dépend avant tout de sa puissance économique mise au service du groupe et de ses membres. Les Wolofs disent de lui: "S'il ne peut pas satisfaire leurs besoins, ils ne le respectent plus."

Discussing recent changes in intra-household relationships, Diop also argues that traditional surghas (dependents) are becoming more independent because of increased participation in the monetary economy, due primarily to the availability of peanut production (p.171):[39]

> [l]e père de famille ne peut s'y opposer, même s'il le voulait, en lui refusant la disposition d'un champ personnel par exemple. ... il risquerait de provoquer le départ du garçon - qui irait s'établir ailleurs, chez son oncle maternal - faisant perdre ainsi à la famille une force de travail appréciable. C'est une réaction qu'on pouvait noter, autrefois, en cas de conflits graves dans la concession.

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[37] Translation: (even in the past) dependent household heads would leave the household to create their own not only when the family became too large or land became a constraint, but also when they challenged the household heads authority if he abused his powers or failed to live up to his responsibilities. One alternative for the young individuals was to join the household of their mother's brother (emphasis added).

[38] Translation: Today, the household head's authority depends primarily on the economic strength he conveys to other household members. The Wolof say of him: "If he cannot satisfy their needs, they no longer respect him."

[39] Translation: The household head cannot oppose this behavior [of economic independence], even if he wanted to, for example, by refusing to provide him [the dependent] with a personal field. ... he risks provoking the departure of his son - who would settle elsewhere, with his mother's brother - thereby causing the family to lose a worker. This is a reaction noted earlier in the case of serious conflicts in the household.

The central role of peanuts in the household coalition is further stressed by Stomal-Weigel (p.28):[40]

> Grâce à la production de l'arachide, chaque individu peut réaliser ses propres objectifs indépendamment des objectifs de l'unité de production en tant que telle. Le chef de l'unité de production garde toujours le droit d'affectation de la terre parmi les invididus (sic) et selon les cultures; ce faisant, il doit cependant tenir compte des objectifs des différents groupes restreints et individus de son unité de production, au risque de perturber l'équilibre du système.

Finally, BCF (p.10) report an interesting consequence of the labor arrangements within households for the adoption of a new cultural practice. Plowing under plant residues of cereals at the end of the rainy season appears to appreciably affect yields in the subsequent season. However, household heads were found not to adopt this practice because once the short-cycle collective millet crop had been harvested, they no longer benefited from the labor services of dependents.

As a summary of the preceding discussion, Table 2-3 provides an overview of the objectives, rights and obligations of various members in Wolof households or coalitions. The principal objective of the household--survival--requires both a reproductive capacity and the ability to ensure adequate food availability. It is probably safe to argue that the table is more or less valid for other agriculturally sedentary ethnic groups of Senegal. Certainly among the Peulh of Senegal, the household head or jom galle is the central decision-maker (Ba, p.139), and vertical or horizontal integration are institutions also encountered in the southern research areas.[41]

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[40]Translation: Due to peanut production, each individual can achieve his or her objective independently of the objectives of the production unit (PU). The head of the PU retains the right of allocating land among individuals and crops; in so doing he must, however, take into account the objectives of the different groups and individuals of his PU so as to not perturb the equilibrium of the system.

[41]One southern village, for example, consisted of 11 households with only two family names: "MBallo" and "Balde". All the MBallos (6 households) had formed separate households while the Baldes (5 households) had organized themselves within a concession.

TABLE 2-3: OBJECTIVES, RIGHTS AND OBLIGATIONS IN THE WOLOF HOUSEHOLD/COALITION

	Head of Concession	Independent Household Head	Married Female	Young Active Female	Dependent Household Head	Dependent Unmarried Male	Young Active Boy
1. PRIMARY ECONOMIC OBJECTIVE	Assure survival of household &/or concession: Food Self-Suffic. Obtain cash inc. for personal needs Maximize the number of wives and workers (i.e. sons)	Assure survival of household: Food Self-Suffic. and/or equipment	Cash Income for personal & hhold needs & condiments Balanced nbr. of co-spouses		Some food crop Cash Income Capital stock: for ag. inputs (and spouse?)	Cash Income Capital stock: for spouse	
2. RIGHTS AND OBLIGATIONS							
2.1. Food	owns a granery (food stock) provides food for the members of his "kitchen" (ndieul)		prepares meal (duty rotates among wives) supplies condiments	assists her mother	<---------fed by the household head---------> provides wife with food when it is her turn to prepare meal		
2.2. Land	manages land of the: Concession Household		owns right to have a crop	no right to land	has the right to a crop; may own land if inherits it or clears it himself		no right to land
2.3. Crop	grows cash crop (peanuts, cotton cereals) for personal cash needs and agricultural inputs grows cereals for self-sufficiency		Grows cash crop for needs cited above (see obj.)	no crop	grows cash crop (peanuts, cotton cereals) for personal cash needs grows some food for family needs		no crop
2.4. Labor	works on his own crops/fields		manual labor on male fields	assists her mother	works on household head's field 4 out of 7 days		work for father mother, hhhead.
2.5. Equipment	own their own equipment (varies in FSP areas)		do not own or use equipment Males provide eqmt. service		<-------borrow/use hhhead's equipment-------> Beginning to equip himself		
2.6. Inputs*	provides all inputs to dependents						
2.7. Credit			Cannot receive credit w/o husband's consent				

Source: 1. is partially, 2.1-2.5. are entirely based on Benoit-Cattin and Faye (1982, p.76).
2.7. is based on observational evidence from the FSP research areas.
Note: * Inputs other than those already listed.

These observations in principle suggest that farm households in Senegal can be viewed analytically as coalitions of individuals with divergent interests: the household head, responsible for the long-term survival of the nuclear family is preoccupied with growing sufficient cereals (and presumably some cash crops to satisfy household cash needs), while wives, young sons and migrant workers are concerned with generating cash income. More specifically, the household head primarily seeks to maximize food production to ensure the survival of his household; the wife seeks cash income for personal and household needs as well as a balanced number of co-spouses; the married son seeks to accumulate sufficient capital (cash) to eventually form his own household; and the non-family worker, similarly, seeks to maximize the amount of cash received at harvest. Given the importance of cash income, it is interesting to speculate whether the cash-food crop dichotomy would ever have arisen in Senegal if food markets had historically been as reliable as cash crop markets continue to be to date.[42] A further general objective of the household is to support young children as well as elderly and infirm members of the household. This implicitly provides a form of intergenerational insurance.

The above problem can be stated more formally as follows.[43] Let $\{N\} = \{H,F,M,W\} = \{1,2,...,n\}$ denote a set of individuals capable of forming a household coalition. They may include a household head (H, or the manager of the coalition); females (F) who are old enough to be married; the household head's sons (M) who may or may not be married; and non-family laborers (W), where each group pursues a

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[42]Cash crops can always be sold to parastatals, although farmers may not receive officially announced prices due to opportunistic behavior at the scales. It is interesting to recall that peanuts were sold solely as a food crop at the turn of the century.

[43]The discussion is based on Staatz, 1983, who examines how costs should be shared among members of a cooperative so as to ensure its stability; his conclusions also hold in the present context.

different set of objectives. Further, let $C(q^m)$ measure the total cost facing members of subset M if they were to provide the amount q^m of a service to themselves, and $C(q^{h+f+m+w})$ denote the total cost at which H, F, M and W could together obtain $(q^h+q^f+q^m+q^w)$ of the service.[44] Then there are economies in jointly providing services to the members of the coalition, or subadditivity of the cost function is assured if, for any subsets H, F, M and $W \subseteq N$ and $H \cap F \cap M \cap W = \emptyset$,

$$C(q^{h+f+m+w}) \leq C(q^h) + C(q^f) + C(q^m) + C(q^w)$$

A member of group j can obtain q^j from the coalition or attempt to obtain that quantity elsewhere; for example, the married son may seek off-farm employment if he can thereby obtain (at least) q^j at a lower (or equal) cost. Obviously, the analysis assumes perfect certainty and foresight with respect to production outcomes. If the rains fail, so may the coalition to the extent that actual benefits received differ from those initially contracted for.[45]

Further following Staatz (pp.1085-6), a characteristic function $V(q^j)$ can be calculated, with knowledge of the cost j would incur if it were to obtain the service elsewhere, for each subset of members to reflect the minimum cost of providing q^j. Stability of the coalition is assured if $A(q^m) < V(q^m)$ for all $M \subseteq N$. Here $A(q^m)$ is the share of total (coalition) cost borne by subset M. We can also calculate the (net) benefit obtained by member M from participating in the coalition as (equation 5 in Staatz),

$$b_m = V(q^m) - \frac{C(q^n)}{q^n} q^m$$

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[44]For example, the "service" may be kilograms of peanuts harvested for sale to SONACOS.

[45]During 1987, non-family workers departed one research triad because of a (temporary) drought during the production season.

We may then ask which variables affect $A(q^m)$ or b_m in the context of Senegal (Table 2-4), and how they are in turn affected by agricultural policy. Obviously, any policy which increases the cost of peanut seeds, such as an elimination of the peanut seed credit program, can cause the coalition to collapse and lead to a reduced household

TABLE 2-4: ALLOCATION OF COSTS AND BENEFITS IN THE COALITION

Contributions (-) to and Benefits (+) from the Coalition	Household Head: H	Females F	[Married] Sons: M	Non-Family Labor: W
Land	$-(l_f+l_m+l_w)$	l_f	l_m	l_w
Draft Equipment & Animals	$-(d_f+d_m+d_w)$	d_f	d_m	d_w
Peanut Seeds	$-(p_f+p_m+p_w)$	p_f	p_m	p_w
Food Consumption	$-(f_f+f_m+f_w)$	f_f	f_m	f_w
Labor for HH Cereals Field	$c_f+c_m+c_w$	$-c_f$	$-c_m$	$-c_w$

labor force. The table shows who gets what from whom in the coalition. For example, l_f shows the amount of land females receive for growing their crops.

The idea that a coalition of individuals can produce a set of g goods (or services) less expensively than can g individuals on their own has of course existed for some time, and is central to the theory of cooperation (see also Olson, 1971; and Axelrod, 1984). The concept will be used again in discussing economies of scope in food and cash crop production.

2.4. SUMMARY AND CONCLUSION

Within the context of informing Senegal's New Agricultural Policy in general and the cash-food crop relationship on farms in particular, what do the concepts just presented suggest in terms of a useful line of inquiry and data analysis? First, while the concept of the household as a singular decision-making unit remains a valuable abstraction (and will be used extensively in this study), the notion of a household as a

coalition of individuals with divergent interests suggests it is important to identify what different types of household members get in terms of inputs, what they do in terms of production (i.e., what economic forces motivate them), and what difference the organization of a household makes for food production performance and the design of policies intended to raise food production levels. Also in terms of the NAP in general and the APS in particular, what are farmers' investment priorities and their perceptions of mineral fertilizer use? A related question is whether variables such as access or entitlements to cash crop parastatals help in "explaining" equipment ownership.

Second, if there is a market-based interdependency among inputs, a complementary rather than strictly competitive relationship may arise between cash and food crops. In particular, the peanut seed obtained on credit may allow the household to attract additional labor for work on the collective cereals field of the household. These input-related questions are addressed in Chapter III.

What difference does access to and the use of agricultural equipment make? From the farmer's viewpoint, which non-price factors constrain crop (especially maize) production, and which non-crop income generating strategies do farmers pursue? In addition, what can be learned from multi-product household cost function estimates about the consequences of inducing farmers to switch from cash to food crop production? These questions are examined in Ch. IV.

Given environmental constraints and tastes and opinions of farmers, how are the new policies likely to be received in rural areas and what is the likely potential for their success? How do the strategies identified in Chapter IV affect the food consumption security of households? Finally, can specific consequences of uncertainty and transactions costs for the marketing behavior of farmers be identified? Chapter V addresses this set of post-production issues.

CHAPTER III

HOUSEHOLD ORGANIZATION AND THE USE OF INPUTS

This chapter describes the organization of households and their 1986 resource inventories and use of inputs to provide baseline information for Senegal's New Agricultural Policy. Household heads' investment priorities at planting in 1987, and their anticipated responses to the new input distribution policy are listed, with particular attention given to concerns surrounding the use of mineral fertilizer on coarse grains. Issues involved in the privatization of input marketing are identified using survey results. Two econometric equations, designed to test for interdependencies among inputs (as discussed in Ch. II), are presented. Policy implications from this analysis for the privatization of agricultural input distribution functions in the context of Senegal's food self-sufficiency objective are briefly identified, and then will be expanded upon in Ch. VI (Section 6.1.1).

3.1. RESOURCE INVENTORIES

The structural organization of households and the amount of different types of labor available to household heads are described in this section, using a north-south sample stratification. Information on draft equipment ownership and use as well as chemical input and seed use in 1986 is presented. The current role of the private vs. the public sectors in assuring input supplies and enabling investments in equipment is also examined.

3.1.1. Structural Organization of Households and Labor Supply

The basic unit used to enumerate nuclear agricultural households is an exploitation (defined from the production side). Exploitations are generally independent decision making units which may or may not be organized within--or affiliated with--a concession. As discussed in Ch. II, the key factor uniting the otherwise independent

exploitations of a concession is the allocation of land among the exploitations (usually) by the father or oldest brother who heads the concession. It is also hypothesized that there are other bonds or linkages between such exploitations, for example in terms of food security strategies and access to resources such as equipment. Concessions thus consist of two or more horizontally integrated exploitations (cf. Ch. II). Table 3-1 shows the distribution of exploitations and concessions in the census sample.[1] For example, 73

TABLE 3-1: NUMBER OF EXPLOITATIONS PER CONCESSION

Number of Exploitations	Number of Concessions		
	North	South	Total
One	166	160	326
Two	25	25	50
Three	5	12	17
Four	1	4	5
Five		1	1
Total	197	202	399

Source: Expanded Census (1986)

concessions consisted of two or more exploitations, while one concession had five exploitations. There is no significant difference in this distribution by ethnicity. In the sample of 215 households used for subsequent in-depth surveys, 22% of the households were horizontally integrated (HI).

Household heads who retain their married sons within their households as dependents are heads of so-called vertically integrated households (VI). Of the households in the final sample, 19% were vertically integrated, while 9% were integrated in

[1]See Table 1-2 for a brief description of the census instrument.

both the horizontal and vertical senses (HI*VI).[2] Thus, one-half of the household heads were involved in some form of a coalition with their off-spring and/or siblings.

Another aspect of the coalition involves the use of non-family labor. Northern households were more likely to employ non-family labor (Table 3-2), possibly reflecting higher endowments of equipment, cash crop seeds (peanuts) and food. Non-family workers are comprised of surghas and nawetaans; the former have a stronger bond with the household head, residing in the household throughout the year. The latter are present during the rainy season (or nawet). Relative to their southern counterparts, northern households on average also had one more adult equivalent producer (AEP) at their disposal (Table 3-3). As discussed in Goetz and Holtzman, [GH henceforth] (April 1988, p.14-5), households in the southern areas on average gained .48 additional workers (concentrated in 36% of the households), while northern households gained .29 workers in 1987 relative to 1986. While the reasons for these gains are unknown, they may be related to higher expected rainfall following a good year (1986) and discouragement by

TABLE 3-2: HOUSEHOLD LABOR FORCE DISTRIBUTION

Labor Category	Percent of Households		Total	
	North	South	Nbr.	%
Female Labor	83	96	179	90
Young Males	62	56	115	58
Older Males	35	26	59	30
Married Sons	28	26	53	27
Non-Family Lab.	47	11	51	26

Source: ISRA/MSU FSP Surveys, 1986/7
Note: For a total of 198 households; based on FSP field surveys, 1986/7. See also definitions following Table 3-3. Standard errors are less than or equal to .06 (i.e., 6%) in all cells.

[2]The distribution is similar for the northern and southern areas.

TABLE 3-3: AVERAGE LABOR FORCE STRUCTURE[a]
(Standard Errors)

Category	North	South	Total
Household Head	.91	.94	.93
	(.02)	(.02)	(.02)
Females	1.72	1.89	1.82
	(.16)	(.12)	(.09)
Young Males	.78	.80	.79
	(.09)	(.10)	(.07)
Married Sons	.40	.40	.40
	(.08)	(.07)	(.06)
Older Males	.48	.30	.37
	(.09)	(.05)	(.05)
Non-Family	1.08	.14	.52
Labor	(.16)	(.04)	(.08)
Total Labor Force			
Mean	5.37	4.46	4.83
St. Error	.36	.23	.20
Minimum	1.00	1.00	1.00
Maximum	15.10	13.90	15.10
Valid N	81	117	198

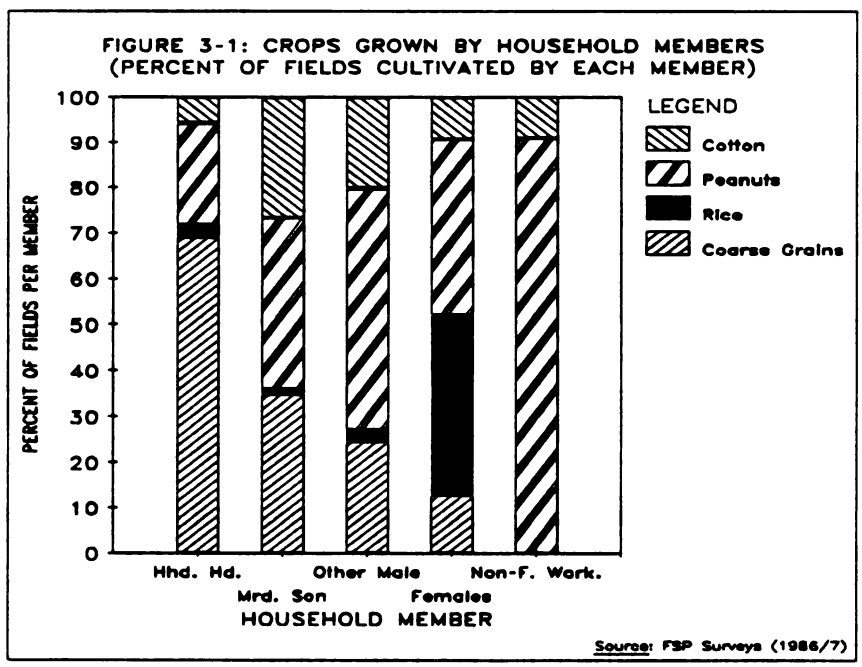
Source: ISRA/MSU FSP Surveys (1986).

a. Data are adult equivalent producers (AEPs), using weights: males 15-60 yrs = 1.0; females 15-60 = 0.8; boys 5-14=0.5; girls 5-14=0.25; individuals older than 60 = 0.5 adult-equivalents; only active individuals are included in calculations. "Young males" are 0-19 years, "older males" are 20 and older. The (agricultural labor) weight for females is less than that of males to reflect their preoccupation with non-agricultural domestic work. This variable is intended to measure the agricultural labor available in households.

job seekers with alternative income opportunities due to cutbacks in public sector employment.

Figure 3-1 illustrates the notion of a household as a coalition of individuals with different (cash and/or food crop) interests. Married sons allocated their land to cash crops more frequently than if they had headed their own household, while non-family workers exclusively grew cash crops.[3]

While Figure 3-1 suggests females play a major role in growing cash crops (especially peanuts), Table 3-4 shows the average quantity seeded by that group in the north is only one-tenth of that seeded by household heads, and about one-fifth that seeded by dependent married males. Similar relationships hold in the southern research area, where females on average also tend to produce more cotton than in the north. It



[3]Land area data were not collected due to measurement difficulties.

TABLE 3-4: DEPENDENCY STATUS AND KILOGRAMS OF SEED USED; BY REGION[a]

Study Area and Type of Seed	Household Heads	Dependents			
		Females (Wives)	Married Sons	Other Male Relatives	Non-Fam. Labor
	----------Kilograms of Seeds Planted----------				
North:					
Coarse Grain	31	0	2	0	0
Peanuts[b]	293	29	133	51	105
Cotton	5	1	3	1	2
Valid N	87	72	23	62	39
South:					
Coarse Grain	40	1	4	1	1
Rice	11	9	0	0	0
Peanuts[b]	88	14	27	15	24
Cotton	15	3	17	5	7
Valid N	124	119	32	83	13

Source: ISRA/MSU FSP Surveys, 1986/7
a. Data are per adult equivalent producer (see Table 3-3).
b. Unshelled peanuts.

is of interest to note that although households heads are responsible for growing coarse grains, they on average also seed the largest quantity of peanuts. Married sons grow the largest fields of cotton in the southern research areas. The question of seed inputs is examined again in Section 3.1.4.

3.1.2. Draft Equipment and Animals

Households in the northern research areas were more likely to be fully equipped and also owned more equipment per adult equivalent producer and per household (Table 3-5). This is to some extent a legacy of the Programme Agricole, an equipment distribution credit program in effect from 1960 to 1980, which was operative primarily in the Peanut Basin and the Lower Casamance (Havard, 1986a; see Ndoye, 1980 for details of the PA). The sources, means of payment, date of acquisition and condition of

TABLE 3-5: DRAFT EQUIPMENT AND ANIMAL OWNERSHIP
(Standard Error)

Item	North	South	Total
Percent of Households:			
Equipment Non-Users[a]	0%	22%	13%
Borrowers	13%	26%	21%
Owner/Borrowers	15%	24%	20%
Fully Equipped	72%	28%	46%
Mean FCFA[b] Value per Household of:			
Equipment[c]	25414	11541	17216
	(2262)	(1265	(1282)
Draft Animals[c]	18151	9269	12903
	(1765)	(1413)	(1144)
Total Value (FCFA)[b]:			
per household	43565	20809	30119
	(3729)	(2470)	(2251)
per AEP	8609	4395	6119
	(605)	(509)	(416)

Source: ISRA/MSU FSP Surveys (1986).

a. Equipment non-users neither own nor use a (draft) hoe or a plow. Borrowers do not own but use implements and draft animals. Owner-borrowers own either the animal or the implement, but not both; they use both by borrowing either the animal or the implement. Fully equipped households own both a hoe and/or a plow and a horse and/or oxen.

b. FCFA is the West African Currency Unit (50 FCFA = 1 French Franc; 300 FCFA = approximately 1 US$).

c. Equipment and draft animal (amortized) prices are from SODEFITEX and field surveys, respectively (see Appendix A-1).

the equipment are described in GH (April 1987).[4] Recent investments in draft equipment (in 1987) are described in GH (May 1988).

3.1.3. Chemical Products

Less than one-half of the farm households studied reported using mineral fertilizer in the period 1985-87 (Table 3-6), and 20% are estimated to have received 75% of the fertilizer distributed in 1986 (GH, April 1988, p.7).[5] In the south, 28.6% (4/14) of the households using herbicide do not use equipment, suggesting they may rely on herbicides as a substitute for mechanical weeding. At the same time, only 20% (4/20) of the households not using equipment in the south used herbicides.

TABLE 3-6: USE OF CHEMICAL PRODUCTS
(Standard Errors)

Product/Item	North	South	Total
Percent of HHs Using:			
Herbicides	2%	23%	15%
Insecticides	15%	38%	29%
Fungicides	57%	4%	26%
Fertilizer (NPK/Urea)	49%	46%	47%
Mean Value per HH of:			
Kgs. of N-P-K	69	91	82
	(12)	(14)	(10)
Kgs. of Urea	20	20	20
	(5)	(4)	(3)
Total Fert. Value (FCFA):[a]			
per Household	7186	9748	8958
	(1297)	(1522)	(1044)
per AEP	1560	2135	1900
	(255)	(315)	(214)

Source: ISRA/MSU FSP Surveys (1986).
a. Price used is 88 FCFA/kg for both N-P-K and urea.

[4]See also section 3.1.5.

[5]In the southern research areas, the estimate of the proportion of farmers using improved inputs tends to be upward-biased due to a small over-sampling of farmers working with SODEFITEX.

Table 3-7 shows the average distribution of chemical products among different members of the household. The relatively large quantity of mineral fertilizer used by married sons is likely to be related to their propensity to grow cotton (especially in the south). GH (May 1987 and April 1988) describe the use of chemical products on different crops in recent years.

TABLE 3-7: DEPENDENCY STATUS AND CHEMICAL PRODUCT USAGE[a]

Chemical Product	Household Head	Dependents				Hhlds.	
		Female (Wife)	Married Son	Other Male Relative	Non-Fam. Labor	Nbr.	%
N-P-K (kg)	119.7	12.3	46.7	18.2	0.0	89	44
Urea (kg)	64.0	3.3	13.0	5.7	0.0	51	26
Insect. (kg)	4.9	0.8	3.4	2.1	0.0	59	29
Herbicide (l)	3.6	0.3	1.0	0.4	0.0	30	15
Fungicide (kg)	0.5	0.0	0.0	0.7	0.0	49	26

Source: ISRA/MSU FSP Surveys, 1986/7
a. Data are per adult-producer-equivalent.

The relative importance of public and private sources of fertilizer is discussed in Section 3.1.5. Section 3.2. discusses farmer perceptions of mineral fertilizer, their anticipated reaction to USAID's Agricultural Production Support (APS) project, and general issues involved in privatizing input distribution, while Section 3.3. examines factors affecting the use of mineral fertilizer at the household level.

3.1.4. Seeds

Millet and maize are of equal importance among coarse grains seeded in the north, while maize dominates sorghum in the southern areas (Table 3-8). The large quantity of peanuts seeded in the north relative to the south is noteworthy. Higher precipitation in the south offers more opportunities for cotton cultivation as an alternative to peanuts. Heads of horizontally and/or vertically integrated households were on

TABLE 3-8: HOUSEHOLD SEED USAGE[a]
(Standard Errors)

Kilograms and Value[b]	North	South	Total
Millet	13.9	2.2	7.0
	(1.6)	(.50)	(.82)
Sorghum	3.2	13.6	9.3
	(.75)	(1.6)	(1.0)
Maize	13.9	18.2	16.4
	(1.5)	(1.8)	(1.2)
Total Coarse Grains	31.0	34.0	32.7
	(2.6)	(2.8)	(2.0)
Per AEP	6.3	8.7	7.7
	(.52)	(.71)	(.47)
Rice	0.1	31.3	18.5
	(.05)	(4.5)	(2.8)
Total Cereals (FCFA)	3101	7471	5683
	(262)	(697)	(451)
Cereals (FCFA)/AEP	634	1731	1282
	(51)	(119)	(83)
Peanuts (unshelled)	590	136	322
	(61)	(19)	(32)
Cotton	7.3	33.7	22.9
	(2.4)	(62)	(3.6)
Total Cash Crop (FCFA)	71681	20321	41332
	(7351)	(2407)	(3772)
Cash Crop (FCFA)/AEP	13148	4534	8058
	(999)	(491)	(584)

Source: ISRA/MSU FSP Surveys (1986).
a. See Chapter IV for a description of crop mixes.
b. Prices used in calculations are: Coarse grains=100 FCFA/kg (observed market price at planting in 1986); rice=130 FCFA/kg; peanuts=120 FCFA/kg; cotton=120 FCFA/kg.

average able to muster larger total quantities of peanut seed, enabling them to provide members of their household with a similar amount of seeds as did farmers heading single families (Table 3-9). Households heads hiring non-family workers not only laid claim to more total peanut seeds, but in the north on average also offered significantly (at the 5% level) more seeds per worker.

In the southern areas these relationships are not as straightforward, but the results generally suggest that household heads who attract additional workers acquire more peanut seeds.[6] The relationship between household organization and labor use and coarse grain seeds is examined in detail in Section 3.3.

Table 3-9 illustrates the importance of SONACOS in providing peanut seed. This raises the question, if SONACOS discontinues its peanut seed credit program, and no viable alternative system is developed, will household heads be able to carry-over enough of their own seed to attract additional workers? Cotton is a poor substitute for peanuts in the drier climate of the Peanut Basin, and coarse grains are not likely to become a viable alternative unless food markets become more profitable, reliable and predictable (see also the discussion in Ch. IV on this subject).

3.1.5. Factors Associated with Equipment Ownership

Given the apparent importance, demonstrated in the next chapter, of agricultural draft equipment in raising crop production levels of households, Table 3-10 shows select

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[6]Peanut seed stocks are difficult to maintain since the seed is expensive (relative to low cash balances of households at planting); seed requirements per hectare are high (ca. 120 kgs/ha); and the peanut seed-output conversion ratio is low (approximately 1:10 in the Peanut Basin, see Gaye, 1987). In contrast, cotton has a low per hectare seed ratio and is distributed gratis as part of the input package provided by SODEFITEX.

TABLE 3-9: CASH CROP SEEDS (KGS) AS LABOR INCENTIVES
(Standard Errors)

Household Organization and Labor Use	North				South			
	Peanut Seed		Cotton Seed		Peanut Seed		Cotton Seed	
	Total	/Wkr.	Total	/Wkr.	Total	/Wkr.	Total	/Wkr.
	----------Kilograms of Seed Planted----------							
Single Family	461	116	5.5	1.4	101	28	19	4.8
	(54)	(13)	(2.3)	(.70)	(16)	(4.1)	(5.3)	(1.2)
Horizontal Int.	562	101	9.6	3.3	154	41	23	8.1
	(175)	(17)	(6.9)	(2.1)	(46)	(13)	(7.8)	(2.7)
Vertical Integ.	786	96	8.9	1.8	205	31	83	12.8
	(145)	(17)	(6.6)	(1.4)	(88)	(14)	(23)	(3.5)
Both (HI*VI)	995	106	7.0	1.4	178	23	55	6.5
	(229)	(27)	(7.0)	(1.4)	(51)	(6.6)	(24)	(2.7)
Use Non-Fam. Lab.	880	134	4.9	1.2	172	32	30	7.2
	(101)	(14)	(2.4)	(.72)	(69)	(8.5)	(17)	(3.8)
Family Lab. only	334	84	9.4	2.5	131	31	34	6.8
	(47)	(9)	(4.1)	(1.1)	(20)	(4.5)	(6.1)	(1.1)
With Parastatal[a]	719	123	39.4	10.3	196	41	93	19.0
	(96)	(12)	(9.7)	(2.7)	(31)	(5.9)	(11)	(1.9)
Not with Parast.	436	90	0.0	0.0	61	18	1.5	0.0
	(64)	(10)	(0.0)	(0.0)	(15)	(5.1)	(1.0)	(.0)

Source: ISRA/MSU FSP Surveys, 1986/7
a. Parastatal is SONACOS for peanut seed, SODEFITEX for cotton.

TABLE 3-10: VARIABLES ASSOCIATED WITH EQUIPMENT OWNERSHIP

	Equipment Value per Worker (FCFA)					
	North		South		Total	
Variable	Mean	StErr	Mean	StErr	Mean	StErr
Age of Household Head: 20-39 yrs	23151	3258	11070	2200	16104	2007
40-54 yrs	26595	4773	9928	1711	16056	2264
55-90 yrs	26286	3730	13742	2645	19297	2321
Nbr. of Wives: 0	9347	5809	4788	4788	7275	3726
1	19355	2319	8618	1562	12723	1403
2	33571	3367	15810	2380	23704	2242
Non-Fulani	26438	2834	7605	1946	20076	2237
Fulani	23845	3775	12610	1505	15510	1538
Nuclear Family	19052	1861	9427	1591	13107	1294
Horizont. Integ.	20925	5040	8544	2379	14015	2728
Vertically Inte.	38169	6116	17662	3761	27916	3940
Both (HI*VI)	46172	6535	19448	4325	27308	4635
Fam. Lab. Only	18246	2461	10693	1299	12903	1197
Use Nonfam. Lab.	33525	3530	18318	4366	29649	2986
Land=Constraint	36881	4488	14693	7428	34734	4262
Not a constraint	19356	2113	11458	1288	13964	1138
'85 Stcks < 9 mth	17463	3041	8728	1368	10821	1318
> 9 months	28567	2829	16207	2340	23235	1986
Cattle Owner	33598	5257	16932	1992	22281	2313
Non-Owner	18856	2923	5947	1126	10197	1387
Not w/ SODEFITEX	26300	2724	9363	1509	17050	1655
With SODEFITEX	23038	4058	14902	2148	17534	1996
Not w/ SODEVA	24038	2383	11541	1265	15960	1252
With SODEVA	30594	5970	.	.	30594	5970
Not w/ SONACOS	24966	3221	7819	1784	14947	1911
With SONACOS	25790	3197	14518	1698	19068	1716
No Off-Farm Inc.	30331	4219	13459	2666	21604	2681
Off-Farm Income	22816	2603	10879	1434	15398	1411
No Borrowing	25232	2900	12640	1538	17057	1512
Borrowed Cash	25665	3653	8353	2037	17550	2407

(continued)

TABLE 3-10: Continued

	Equipment Value per Worker (FCFA)					
	North		South		Total	
Variable	Mean	StErr	Mean	StErr	Mean	StErr
Age of Household Head: 20-39 yrs	6260	872	3192	611	4471	541
40-54 yrs	4599	535	2152	357	3052	330
55-90 yrs	4200	499	2091	414	3025	341
Nbr. of Wives: 0	3713	2146	1127	1127	2537	1286
1	5185	631	2337	399	3426	370
2	4946	383	2740	403	3721	308
Non-Fulani	5042	493	1576	388	3871	399
Fulani	4831	596	2679	317	3234	292
Nuclear Family	5450	646	2366	373	3545	367
Horizont. Integ.	4116	733	2383	632	3149	491
Vertically Inte.	4783	555	2564	512	3674	417
Both (HI*VI)	4965	470	2787	914	3428	695
Fam. Lab. Only	4865	547	2280	280	3036	272
Use Nonfam. Lab.	5065	521	3748	768	4729	439
Land=Constraint	5559	465	2250	1359	5239	468
Not a constraint	4642	520	2448	271	3144	259
'85 Stcks < 9 mt	3583	522	1770	298	2204	269
> 9 months	5504	468	3560	461	4665	344
Cattle Owner	5925	848	3423	407	4226	406
Non-Owner	3980	565	1389	265	2242	289
Not w/ SODEFITEX	5171	458	2011	319	3445	304
With SODEFITEX	4390	652	3110	448	3524	374
Not w/ SODEVA	4586	370	2443	265	3201	228
With SODEVA	6363	1102	.	.	6363	1102
Not w/ SONACOS	5521	666	1848	435	3375	420
With SONACOS	4486	405	2919	318	3552	260
No Off-Farm Income	5749	570	3328	580	4497	434
Off-Farm Income	4541	486	2138	291	3048	275
No Borrowing	5103	460	2752	328	3576	283
Borrowed Cash	4760	643	1548	371	3254	431

Source: ISRA/MSU FSP Surveys, 1986/7

variables hypothesized[7] to be associated with different levels of equipment ownership, without necessarily implying causality between the variables. Households headed by younger individuals[8]; facing a land constraint; having food stocks out of 1985 production which lasted 9 months or longer[9]; and households owning cattle had more equipment at their disposal, regardless of where they resided (i.e., north or south).

In contrast, households which pursued an off-farm activity, or had borrowed cash during the 1986 hungry season, owned less equipment. This partial analysis, and this data set, therefore suggest that households do not necessarily have to pursue off-farm activities to maintain equipment ownership over time. Participation in SODEFITEX's crop production program made a noticeable difference only in the south; this reflects more recent sales (of ex-ONCAD equipment stocks) by SODEFITEX in the Casamance, and the effects of the Programme Agricole in the northern research areas. The receipt of peanut seed from SONACOS seems to facilitate equipment ownership in the south[10], but not in the north.

To examine more precisely the role of parastatals in facilitating equipment ownership, Table 3-11 shows the status of households with respect to equipment ownership, borrowing and non-use as it relates to participation in parastatal The table provides some support for the assertion that parastatals make a difference in terms of which households own equipment, but there are exceptions to this rule. It is of course

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[7]These variables are demographic characteristics of the household and entitlements, which in Chapter II were argued to affect the performance (including equipment ownership) of the household.

[8]It is not clear that this results from increased risk-taking behavior of younger males. It is also conceivable that some of the young males in the sample had just "inherited" the equipment of the household.

[9]Higher food stocks may have been made possible by equipment ownership, and at the same time made equipment ownership possible by obviating forced equipment sales, as may have occurred in other households.

[10]Again, it is not possible to establish causality here.

TABLE 3-11: EQUIPMENT STATUS[a] AS A FUNCTION OF PARASTATAL AFFILIATION OF THE HOUSEHOLD
Percent of households responding

Parastatal Affiliation	North			South			
	BO	OB	FE	NU	BO	OB	FE
None	43%	25%	21%	38%	48%	13%	22%
SODEFITEX[b]	33%	23%	27%	27%	23%	52%	51%
SONACOS	44%	69%	53%	27%	45%	66%	74%
SODEVA	11%	8%	25%	--	--	--	--
Sample Size:[c]	9	13	59	22	31	29	35
SONACOS**[d]	33%	60%	47%	25%	38%	71%	65%
Sample Size:	6	10	43	16	24	14	17

Source: ISRA/MSU FSP Surveys, 1986/7
a. NU=equipment non-user; BO=borrower (non-owner); OB=owner/borrow (partial owner); FE=fully equipped.
b. Maize and/or cotton programs.
c. For the sample working with a parastatal.
d. For the sample not working with SODEFITEX programs.

plausible that some of the fully equipped households worked with one or more of the parastatals in the past, and dropped their affiliation once the equipment had been paid off. Another important feature of equipment ownership is that fully equipped households on average have significantly larger labor forces than borrowing and non-using households (i.e., 5.7 vs. 4.5, 3.0 and 3.0 adult-equivalent producers in fully equipped, owner/borrowing, borrowing and non-using households, respectively. This may suggest a minimum size labor force is necessary to profitably use equipment; at the same time, it may be easier to attract other workers (family and non-family) the larger the stock of equipment.

Table 3-10 also showed that the total value of equipment owned rises dramatically from nuclear families to horizontally (HI), vertically (VI) and horizontally-and-vertically (HI*VI) integrated households in the northern areas. The same relationship

does not hold on a per worker basis however, or in the southern areas, except that households that are integrated in both senses in the south on average own the largest amount of total equipment. A hypothesis raised earlier was that the sharing of equipment constituted one of the benefits of being a member of a concession (i.e., horizontal integration). Table 3-12 provides some (weak) support for this hypothesis, with horizontally integrated households showing the largest proportion of borrowers for each of the equipment types and animals listed in 5 out of 8 cases in the north (with one tie of 11% for plows) and 3 out of 7 cases in the south (peanut plant lifters are not owned in the south). In the north, 47.4% of the horizontally integrated households are equipment and/or draft animal borrowers, as compared with 25.6%, 11.2% and 20% of the nuclear families, vertically integrated and HI*VI households, respectively. In the southern area these percentages are 45.8%, 58.7%, 55.6% and 16.7%. Table 3-12 also shows that HI*VI households on average had the largest labor force of all households. Finally, in the north 58% of the HI households work with parastatals, as compared to 21%, 28% and 20% of the nuclear, VI and HI*VI households.

3.1.6. Private versus Public Involvement in Input Markets

Parastatals (especially SODEFITEX) were the primary source of chemical and cash crop inputs for farmers in 1985-87, with the private sector taking on a limited role even in 1987, when it is estimated to have sold only 4% of the total fertilizer used (GH, April 1988).[11] Improved inputs are sold on a credit basis by parastatals. Given the predominance of parastatals in the marketing of technical inputs, it would be useful to examine parastatal's procedures for identifying farmers with whom they work, and to analyze their (negative and positive) experiences with credit granted to different kinds of farmers.

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[11]The participation of households in parastatal crop production programs is described in Diagana and Goetz (December, 1987).

TABLE 3-12: EQUIPMENT BORROWING AND SIZE OF LABOR FORCE ACCORDING TO HOUSEHOLD ORGANIZATION[a] AND REGION
(Standard Errors)

	North				South			
Equipment	Nucl.	VI	HI	HI*VI	Nucl.	VI	HI	HI*VI
	----------Percent of Households per Stratum----------							
Hoes	15 (6)	6 (6)	26 (10)	0	21 (5)	17 (9)	25 (9)	8 (8)
Plows	3 (3)	11 (8)	11 (7)	0	21 (5)	17 (9)	17 (8)	0
Soule-veuse[b]	15 (6)	6 (6)	16 (9)	0	Not Owned			
Seeders	15 (6)	11 (8)	32 11	0	30 (6)	6 (6)	33 (10)	17 (11)
Cart	46 (8)	22 (10)	21 (10)	0	41 (6)	33 (11)	46 (10)	8 (8)
Oxen	3 (3)	6 (6)	11 (7)	0	22 (5)	39 (12)	33 (10)	8 (8)
Horse	10 (5)	0	21 (10)	0	5 (3)	0	4 (4)	0
Donkey	3 (3)	6 (6)	5 (5)	0	14 (4)	22 (10)	21 (8)	0
Workers (AEPs)	4.1 (.3)	7.9 (.8)	4.4 (.6)	9.8 (1.8)	3.6 (.2)	6.6 (.5)	3.5 (.3)	7.9 (.7)
Valid N	39	18	19	5	63	18	24	12

Source: ISRA/MSU FSP Surveys, 1986/7
a. Nucl.=nuclear household, VI=vertically, HI=horizontally integrated.
b. A peanut plant-lifting implement designed to facilitate the harvesting of peanuts.

In the scant instances where credit is granted by private traders, it tends to be used mainly for consumption purposes (GH, May 1987). Gaye (1987) argues that the historical prominence of SONACOS in the peanut credit market has broken the production credit ties sometimes observed between traders and producers in other countries. Farmers sampled did purchase fungicides, draft equipment, draft animals and peanut seed from private (non-cereal) traders during the 1987 dry season, suggesting a willingness of some individuals to handle certain agricultural inputs (the durables may have represented former collateral from other transactions).

As of 1986, about one-half of the agricultural equipment (hoes, plows and seeders) owned by farmers had been obtained from a parastatal (on credit), while other producers supplied implements in roughly one-third of the cases. These latter transactions largely reflect distress sales of (used) equipment, since farmers are not known to manufacture equipment.

Most cereals seed were obtained from carry-over stocks, cotton seed from SODEFITEX, and peanuts were obtained from SONACOS as well as carry-over stocks. Given these results on the "manifest behavior" of farmers, we are now ready to turn to their "potential behavior". After reviewing farmers' opinions and anticipated responses to input market reforms in the next section, section 3.2.6. discusses issues involved in the privatization of input delivery.

3.2. INVESTMENT PRIORITIES, EXPECTATIONS AND THE NEW INPUT DISTRIBUTION POLICY

This section presents results on what farmers say they would have done in the 1987 season if they had had more cash; what levels of returns they expect from investments in their crops; and their perceptions and knowledge of mineral fertilizer use. The question of whether or not they have better investment alternatives than using fertilizer on maize is examined, and their opinions of the new input distribution policy are

discussed. Asking farmers how they feel about new technologies and market reforms (Chapter V), and why, is a useful starting point in providing feedback to policy makers contemplating programs designed to increase the productivity of producers.

3.2.1. Investment Priorities at the Beginning of the 1987 Season

To determine their investment/cash expenditure priorities at the beginning of the 1987 agricultural season, household heads were asked how they would have spent 15,000 FCFA (see notes to Table 3-13 for the formulation of the question), such as may have been obtained in kind through the APS. Two follow-up questions enquired how the funds would have been used as second and third priorities if the respective previous need had already been met (Table 3-13).[12]

Table 3-13 shows that farmers would have used credit to buy food as an important first priority--following a not-so-bad cereals crop in 1986--as well as peanut seed, agricultural equipment or labor. Gaye (1986) argues peanut price policy changes during 1984 and 1985 translated into a perceived--and guaranteed--price increase of 80% for farmers (from 50 to 90 FCFA/kg) due to changes in the credit retention procedure; in comparison, announced coarse grain floor prices were raised from 60 to 70 FCFA/kg in the same period (a 17% change); this may explain the strong preference for peanut seed.

As indicated earlier (and tested in Section 3.3.), Kelly and Gaye (1986) argue that to attract seasonal labor, and to retain sons in the household, household heads need to provide these workers with cash crop opportunities.[13] Most household heads (99%) surveyed in this study believe it is their responsibility to supply other household members with peanut seeds. Consequently, those citing peanut purchases as a first priority probably not only perceive this crop to be more profitable, but would also use the seed

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[12]This question was originally addressed to farmers in the Peanut Basin by Kelly and Gaye (1986).

[13]See also the discussion in Kelly (1988c).

TABLE 3-13: FARMER PRIORITY USES OF 15,000 FCFA;[a] BEGINNING OF 1987 SEASON
Number and Percent of Households Reporting

	North		South		Total	
First Priority						
Buy Food.....	41	47%	68	55%	109	52%
Buy Peanut Seed.....	27	31%	17	14%	44	21%
Buy/Repair Equipment...	14	16%	10	8%	24	11%
Hire Agr. Labor.....	0	0%	19	15%	19	9%
Buy Fertilizer.....	3	3%	1	1%	4	2%
Other[b]	2	2%	9	8%	11	5%
Second Priority						
Buy Peanut Seed.....	33	38%	17	14%	50	24%
Buy Food.....	12	14%	28	23%	40	19%
Buy/Repair Equipment...	17	20%	4	3%	21	10%
Hire Agr. Labor.....	1	1%	20	16%	21	10%
Buy Fertilizer.....	11	13%	3	2%	14	7%
Other[b]	23	27%	53	43%	64	31%
Third Priority						
Buy/Repair Equipment...	17	20%	9	7%	26	12%
Buy Food.....	12	14%	11	9%	23	11%
Buy Fertilizer.....	15	17%	6	5%	21	10%
Buy Peanut Seed.....	2	2%	17	14%	19	9%
Hire Agr. Labor.....	4	5%	14	11%	18	9%
Other[b]	37	41%	66	54%	103	49%

Source: ISRA/MSU FSP Surveys, 1986/7

a. Following Kelly and Gaye (1986) farmers were asked how they would have invested an additional 15,000 FCFA prior to the beginning of the rainy season (open-ended question format). Two follow-up questions asked what they would have done with 15,000 FCFA if the previously cited need had already been met. It is conceivable that equipment purchases were rarely cited because most pieces cost more than 15,000 FCFA. The same may be true of large ruminants.

b. Includes save the money; other agricultural and non-agricultural use; purchase/trade in livestock; purchase of draft animals.

to attract additional labor to the household (see also the discussion in 4.1.5.). The same may be true for those who would have bought food, since this serves as a partial payment for seasonal workers.[14]

While fertilizer purchases (in retrospect) did not rank highly among stated priority uses of funds at the beginning of the 1987 rainy season, 44% of the household heads who had not received fertilizer as of June 1987 indicated the that they planned to buy it if it were available on credit (Table 3-14).[15]

TABLE 3-14: PURCHASE INTENTIONS FOR FARMERS NOT HAVING RECEIVED FERTILIZER AS OF JUNE 1987, BY REGION
Number and Percent of Households Responding

Region	Do Not Plan To Buy		Plan to Buy if on Credit		Plan to Buy Credit or Cash		Not Yet Decided	
	N	%	N	%	N	%	N	%
North	28	36%	38	49%	12	15%	0	0%
South	28	30%	37	40%	9	10%	19	20%
Total	56	33%	75	44%	21	12%	19	11%

Source: ISRA/MSU FSP Surveys, 1986/7
Note: Data for the 80% of households in the sample not having received fertilizer as of June, 1987.

Since many household heads responded that they would have bought food with additional funds at the beginning of the 1987 season, there may be a tendency to resell fertilizer obtained on credit to purchase food. The decision to resell improved inputs received through the APS may depend on two factors: a) the urgency to resell, which will

[14]In fact, it is not possible to attract seasonal farm labor unless one can provide food during the growing season.

[15]The final survey in September/October 1987 shows less than half of the households sampled acquired fertilizer in 1987 (most of it obtained on credit). The results suggest most farmers will buy fertilizer on credit but not use [their own] cash to buy it. This may be related to the belief that if crops receiving fertilizer fail (eg. due to drought) someone else should share the loss with the farmer (see also section 5.1.6).

be higher for household heads with a precarious food situation and b) relative prices of the traded goods. For example, farmers re-selling fertilizer to buy peanut seed will put downward pressure on fertilizer prices until it is no longer profitable to sell it in exchange for peanuts. This will happen sooner the larger the quantity of improved inputs that becomes available in a given area.

In the southern area a large number of respondents would have saved additional funds, if their first need had already been met. The following section offers hints as to why these farmers may have preferred not to commit further funds to agriculture.

3.2.2. Expectations for Returns on Crop Investments

To develop an idea of their expected gross benefit-cost ratios, interviewees were asked what level of returns they would expect if they invested 5,000 and 20,000 FCFA in an agricultural crop. The question initially confounded farmers, who tend to believe returns to investments depend on Allah and are not for mortals to guess at. Another problem arose from the fact that some farmers anticipated if they were to invest 5000 FCFA, e.g., for additional manual weeding in their peanut fields, an increase in yields would raise labor costs for harvesting and transporting. Since it was not possible to control for this effect, some of the data in Table 3-15 reflect "true" gross returns, taking into account secondary costs associated with the investment, while others exclude such costs.

The gross benefit/cost ratio distribution ranges from 1.16 to 8.00 for the 5,000 FCFA investment, and exhibits both a mode and median of 2.00. Two key insights may be gained from Table 3-15:

a. Farmers in the south are on average less optimistic about returns from agricultural crop activities, despite the alleged high potential of this area.

b. Farmers in both areas on average report diminishing marginal returns to capital investments.

TABLE 3-15: FCFA RETURNS EXPECTED BY FARMERS FOR TWO INVESTMENTS IN AN AGRICULTURAL CROP ACTIVITY
(Standard Error)

	Net Return @ 5000		Net return @ 20000		Gross Benefit-Cost Ratio	
	Mean	Range	Mean	Range	@5000	@20000
North	8194 (1039)	800-35000	27286 (3301)	3200-140000	2.64	2.34
South	5429 (365)	1000-25000	18945 (1064)	1700-50000	2.09	1.95
Total	6351 (434)	800-35000	21726 (1340)	3200-140000	2.27	2.09

Source: ISRA/MSU FSP Surveys, 1986/7
Note: 52/211 household heads were not able or willing to advance a return. Both the mode and the median are 5000 FCFA for the 5000 FCFA investment (both regions); the mode is 20000 FCFA for the 20000 FCFA investment in both regions; the median is 20000 FCFA in the north, 18000 FCFA in the south.

In the northern areas, fully-equipped farmers on average reported a higher expected return for the 5,000 FCFA investment (8,766 FCFA). In contrast, fully-equipped southern farmers expected a 15% lower return (4,625 FCFA) than the average. A plausible explanation is as follows. When asked toward the end of the 1987 growing season which crop they would have grown more of if they had been able to, 83% of the southern farmers responded with coarse grains; half of the northern farmers responded with peanuts. If farmers were thinking of these crops when responding to the investment question (posed at the beginning of the season), this would explain why northern farmers were on average more optimistic about expected returns. For both areas, those who would have grown more peanuts in 1987 reported a higher expected gross benefit (2.96) than those who would have expanded into cereals production (2.03).[16]

[16]The null-hypothesis of equality of the two means is rejected at the 1% level of significance.

3.2.3 Farmers' Knowledge and Perceptions of Fertilizer

Most farm households in the research areas have used fertilizer at some point in the past.[17] Nevertheless, many respondents did not believe they were better able to assess the quantitative fertilizer needs of their cereals fields than an extension agent (Table 3-16). Farmers participating in SODEFITEX's cotton and/or maize program in 1986 were more likely to answer this question affirmatively than those who were not.

TABLE 3-16: RESPONSES TO THE QUESTION "DO YOU BELIEVE YOU KNOW THE QUANTITATIVE FERTILIZER NEEDS OF YOUR CEREALS FIELDS BETTER THAN AN EXTENSION AGENT?"
Number and Percent of Households Responding

Response	North		South		Total	
No	44	52%	71	58%	115	56%
Yes	39	46%	50	41%	89	43%
Don't Know	2	2%	1	1%	3	1%

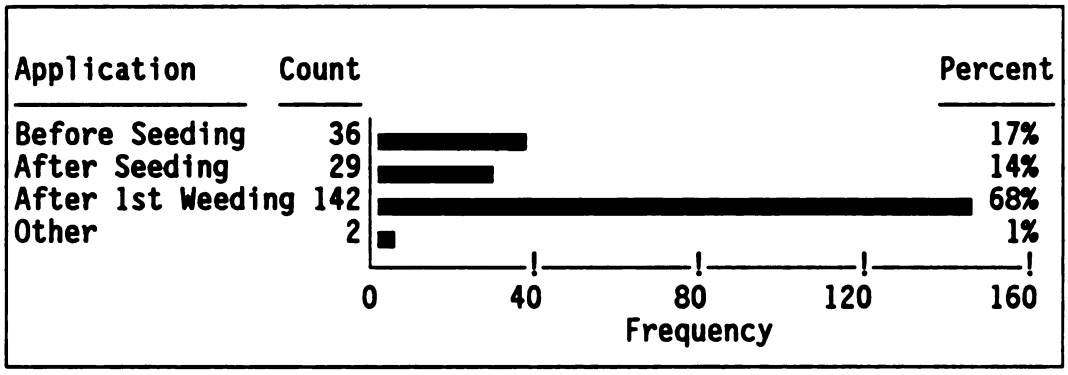
Source: ISRA/MSU FSP Surveys, 1986/7

Agronomists, including SODEFITEX researchers in Tambacounda, recommend two separate applications of fertilizer to maize: prior to land preparation and after the first weeding.[18] In contrast, Figure 3-2 shows most farmers would apply fertilizer only once, after the first weeding, when the plant population is well-established. This confirms the existence of a rule of thumb alluded to by Kelly and Gaye (1986), that farmers tend not to apply fertilizer unless rains are satisfactory and they have "seen the plant" grow. Farmers working with SODEFITEX in the south (1986), were more likely to respond they would apply fertilizer after tne first weeding than those in the south not

[17]See Goetz and Holtzman (May, 1987).

[18]See, e.g., Martin (1988). SODEFITEX information was obtained through personal communication (1987). SODEFITEX does not recommend use of fertilizer on (unimproved) millet and sorghum, since this was found to be uneconomical.

FIGURE 3-2: TIME IN THE CROP CYCLE AT WHICH FARMERS WOULD APPLY FERTILIZER



Source: ISRA/MSU FSP Surveys, 1986/7

working with this parastatal. Furthermore, southern farmers more frequently (72 vs. 62%) responded with this date of application than northern farmers, suggesting many worry about stronger weed growth due to early fertilizer use (this was confirmed in informal interviews).

It is plausible that the strategy of applying fertilizer only after plant emergence has a higher average pay-off than applying fertilizer twice (as on experiment stations), given the uncertainty of rains in Senegal. The results also suggest provisions should be made for distributing weed-control equipment and chemicals along with the fertilizer under the APS. Surveys of village chiefs in the areas reveal they are generally aware of the benefits (and potential toxic effects on humans and livestock) of using herbicides; their experience with this chemical stems mainly from cash crops (cotton). We have little information on the perceived profitability of herbicides applied to cereals, since it is not widely used. However, of 12 farmers applying herbicide to maize in 1985 or 1986, 11 were convinced its use is "worthwhile".[19] A partial budget in Appendix A-2 shows some

[19]All southern farmers using it were convinced herbicide use was worthwhile. For the overall sample, 11 out of 17 northern and 82 out of 121 southern farmers claiming to be able to assess the benefit of herbicide relative to its cost reported it to be "worthwhile".

of the costs and benefits involved in herbicide use on maize for one representative SODEFITEX farmer.

One question for Senegal's NAP is how farmers perceive of mineral as compared to organic fertilizers (manure) when applied to cereals.[20] Farmers who are strongly convinced manure is superior (Table 3-17) may convert mineral fertilizer received on credit into livestock holdings. In this case full benefits would accrue only after a period of years, making it more difficult to repay a one-season production credit. As will become evident below, not all the responses shown in Table 3-17 refer to the agronomic efficacy of the two types of fertilizers.

TABLE 3-17: FARMERS' PERCEPTIONS ABOUT THE RELATIVE EFFICACY OF MANURE AND MINERAL FERTILIZER APPLIED TO MAIZE[a]
Number and Percent of Households

Perception	North		South		Total	
No difference	10	12%	4	3%	14	7%
Manure better	33	41%	37	30%	70	34%
Fert. better	38	47%	82	67%	120	59%
Total	81	100%	123	100%	204	100%

Source: ISRA/MSU FSP Surveys, 1986/7
a. Similar results were obtained for millet and sorghum.

Regional averages tend to mask important differences among triads. In Ndoga, for example, most farmers believed manure is "better" for cereals, while in Diega more than 80% stated mineral fertilizer is better. It is plausible that perceptions depend on how effectively manure and fertilizer interact with the predominant soils of a given area, suggesting more site-specific agronomic research is needed to improve the effectiveness of fertilizer (Kelly, 1988a, reports widely different responses to fertilizer, depending on

[20] A survey of village chiefs showed the practice of applying manure and mineral fertilizer together is rare. See also note c in Table 3-18, however.

the area). Nevertheless, the larger proportion of southern farmers favoring mineral fertilizer is likely to reflect the beneficial interaction between fertilizer and higher rainfall. Table 3-18 shows responses as to why farmers believe mineral or organic fertilizer is more effective.

Using a base of 10 sacks of cereals harvested in a field without fertilizer and animal manure under 1987 rainfall conditions, household heads were then asked how many sacks they would expect to harvest if they had applied "sufficient" amounts of mineral fertilizer (see Table 3-19). Parallel questions covered situations of poor and abundant rainfall.[21]

Virtually all farmers believe mineral fertilizer can augment yields of cereals.[22] For 1987, the average expected response was highest for field maize in the southern, and highest for sorghum--not maize--in the northern area. Lower expectations for maize may reflect temporary drought conditions during the 1987 growing season. In both areas expected yield averages for home maize were consistently higher than for field maize, presumably reflecting the higher organic matter content of soils near the home.

A cross-tabulation of average expected maize yields under 1987 rainfall conditions with fertilizer revealed similar results regardless of whether or not the farmer believed he could better assess the quantitative fertilizer needs of his cereals fields, and whether or not he believed manure was superior to mineral fertilizer. Farmers who had participated in SODEFITEX's maize program in 1986 on average advanced yield expectations similar to those who had not (2% lower in the north, 4% lower in the south),

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[21]Some farmers indicated expected yields would not change under conditions of abundant rainfall as in the distant past, for example for millet, since it does not demand much moisture. Others advanced identical yield expectations for the abundant and 1987 rainfall scenario since "too much rain washes away the fertilizer".

[22]Two farmers in Ndoga pose an exception, responding they would only be able to increase yields with higher rainfall; this may be related to the drought during the 1987 growing season.

TABLE 3-18: REASONS GIVEN BY FARMERS FOR PREFERRING ORGANIC OR MINERAL FERTILIZER, APPLIED TO MAIZE[a]
Number and Percent of Households Responding

ORGANIC FERTILIZER BETTER	N	S	T	%
1. Manure lasts in the soil for multiple years...	17	14	31	46%
2. Increases yields more than fertilizer	13	14	27	40%
3. Cattle urine acts as an herbicide	0	5	5	7%
4. Other[b]	3	1	4	6%
Total:	33	34	67	100%

MINERAL FERTILIZER BETTER	N	S	T	%
1. Increases yields more than manure (stronger plants and larger ears)	14	50	64	53%
2. Fixes roots solidly in the ground	0	17	17	14%
3. Spreading is easier (manure difficult to distribute evenly over the field).....	6	8	14	12%
4. Helps crops during droughts	9	0	9	8%
5. Less herbs than with manure (parkage) and/or fertilizer kills weeds (Silo/striga)	6	3	9	8%
6. Immediate result in comparison to manure	0	3	3	3%
7. Other[c]	3	1	4	4%
Total:	38	82	120	100%

Source: ISRA/MSU FSP Surveys, 1986/7

a. Similar percentages were obtained for millet and sorghum. N=North, S=South, T=Sample, % = percent of responses by category.

b. "Other" responses are: Fixes stems firmly in the soil; helps crop during drought; prevents soil degradation; does not cost anything (the latter three responses are for the North).

c. "Other" responses are: Stems turn yellow if too much manure; Manure (cattle urine) prevents seeds from germinating; I have seen others put fertilizer in fields which had already been manured (parkage)--the latter three are from the North.

TABLE 3-19: FARMERS' FERTILIZER YIELD RESPONSE PERCEPTIONS (100=BASE YIELD WITHOUT FERTILIZER AND 1987 RAINFALL)

	Millet			Sorghum			Field Maize		
	North	South	Total	North	South	Total	North	South	Total
1987 Rain w/Fert.									
Mean	156	191	171	166	188	183	158	194	177
Valid N	87	62	149	37	116	153	86	95	181
Poor Rain w/Fert.									
Mean	92	92	92	45	94	86	84	84	84
Valid N	34	26	60	10	52	62	22	39	61
Poor Rain w/o Fert.									
Mean	45	49	47	29	54	49	32	42	39
Valid N	34	26	60	12	51	63	22	39	61

Source: ISRA/MSU FSP Surveys, 1986/7
Note: The sample size for the poor rain situation was reduced because of enumerator illness.

while those who reported they would apply fertilizer early in the rainy season rather than wait until the plant was established tended to have marginally higher yield expectations. Finally, among farmers using fertilizer on cereals in 1987, average yield expectations were marginally higher (4%) in the northern area, but lower in the southern area (8%).

The data therefore do not permit us to conclude that farmers not using fertilizer in 1987 had lower expectations about the yield effect of fertilizer. In the next section farmers' yield expectations are used to construct gross benefit-cost ratios for using fertilizer. These are compared to ratios listed in the APS document, as well as expected gross benefits advanced by farmers for returns to their investments to assess the relative profitability of investing in mineral fertilizer for cereals.

3.2.4. Fertilizer B-C Ratios Based on Farmers' Expectations

Average gross benefit-cost ratios calculated using farmers' cereals yield response perceptions under 1987 rainfall conditions are shown in Appendix A-3. These estimated

ratios are based on official prices, official 1986 yield estimates in pertinent arrondissements, and they assume the use of traditional rather than improved seeds. Excepting sorghum in Senegal Oriental, field maize on average yields the highest ratio, while millet lies below 1.9 in the northern triads. If one assumes farmers cut back on fertilizer application rates under poor rainfall conditions (by one-half), fertilizer on maize performs better than on the other two cereals. However, if farmers do not cut back on application rates under poor rainfall conditions, only fertilizer on millet in the Sine Saloum remains "profitable" (Appendix A-3).

Gross benefit-cost ratios calculated using farmers' perceptions tend to concord well with those presented in the APS document. However, these ratios are calculated using official prices, which are often irrelevant at the farm level. Table 3-20 illustrates the sensitivity of the results to alternative assumptions about input/output price ratios for maize.

TABLE 3-20: SENSITIVITY OF BENEFIT-COST RATIOS FOR FERTILIZER USE ON MAIZE TO ALTERNATIVE ASSUMPTIONS ABOUT INPUT-OUTPUT PRICES (Using 1987 Rainfall conditions, Official 1986 Yields)

	Sine Saloum			Senegal Oriental			Casamance	
Assumption	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)
FCFA/kg P_x	84	109	87[a]	87	113	68[b]	90	117
FCFA/kg P_y	70	61	61	70	56	56	70	60
P_x/P_y	1.2	1.8	1.4	1.2	2.0	1.2	1.3	1.9
NB ('000)	29	16	21	20	5	16	60	39
BCR	2.4	1.6	2.0	1.9	1.2	2.0	3.5	2.3

Source: ISRA/MSU FSP Surveys, 1986/7
P_x=weighted fertilizer price; P_y=price of maize; NB=net benefit ('000 FCFA). BCR=benefit-cost ratio. Note: a=20% subsidy on the final price, b=40% subsidy (see text).

Scenario (1) is the basic situation, using official prices; (2) is a "worst-case" situation, using average cereals prices observed in southeastern Senegal during 1987, and

adding a 30% mark-up to the price of fertilizer reflecting trader margins.[23] In this case the expected gross benefit cost ratio remains above 2.0 only in the Casamance. Using these same assumptions, scenario (3) shows what prices of fertilizer delivered to farmers in the northern areas would have to be to raise the ratio to 2.0; in terms of a subsidy on fertilizer, this amounts to 20% and 40% on the final price charged by traders.

If one compares, finally, the distribution of benefit-cost ratios from using fertilizer on maize, and the ratio advanced by farmers for their 20,000 FCFA investment alternative, more southern (84%) than northern (47%) farmers would be better off using fertilizer on maize (Figure 3-3). This may reflect both the higher profitability of fertilizer use in the south and a lack of competitive investment alternative. However, because maize matures more rapidly than other crops, it is more prone to attacks by natural predators and pests, a factor cited by many southern farmers as an impediment to expanded field maize production (see also Ch. IV). One option may be to encourage farmers to continue to grow maize around the compound as a "hungry season crop", but to delay the seeding of field maize--as a cash crop--so that it matures at the same time as the other crops (this would also allow the farmer to assess whether or not the pattern of rainfall is adequate to warrant the application of fertilizer). Further analysis would be required to assess the effect of such a shift on seasonal labor constraints of the household.

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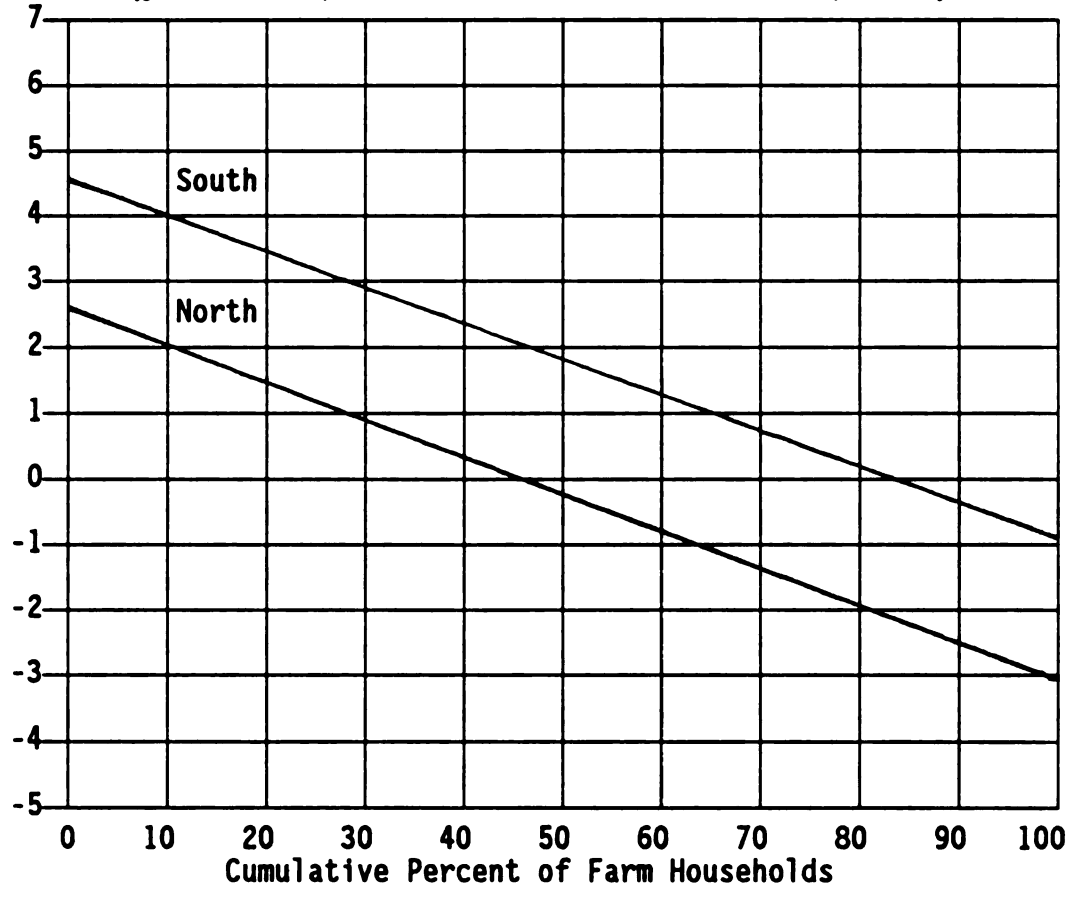
[23]The 30% rate was elicited in trader surveys. It incorporates traders' time, management and costs associated with physical distribution (storage, transport) as well as a premium for being held responsible for non-reimbursements of credit by farmers; it does not take into account the interest charged on loans to farmers, which could add another 15-20%.

FIGURE 3-3: DIFFERENCES IN GROSS BENEFIT-COST RATIOS EXPECTED BY FARMERS FOR RETURNS TO USING FERTILIZER ON MAIZE UNDER 1987 RAINFALL CONDITIONS AND THEIR OWN 20,000 FCFA CASH INVESTMENT
(y-axis=GBCR/Fertilizer on Maize minus GBCR/20000)



Source: ISRA/MSU FSP Surveys, 1986/7
Note: Points on the (smoothed) line shows the difference in the return an individual farmer expects from using mineral fertilizer on maize, both valued at official prices, and from his own (unspecified) 20000 FCFA cash investment (see summary statistics in Table 3-15). Hence the graph is intended to capture the profitability of using fertilizer relative to other investment opportunities.

3.2.5. Willingness to Use Selected Seeds and Fertilizer

As indicated above, there was no evidence of substantive changes in the input distribution system in southeastern Senegal at the time of the surveys (GH, March 1988). To anticipate farmers' responses to the APS, hypothetical questions were used together with information on perceptions, stated responses and observed behavior.

Essentially all household heads responded they would be interested in adopting the fertilizer/improved seed package to be promoted under the APS.[24] However, 51 % of the northern (=44/87) and 15 % of the southern (=18/124) household heads stated they were unwilling to use both inputs at a cash price of 100 F/kg of fertilizer and 210 F/kg of improved seeds (the numbers drop to 42 and 11 households for credit sales in the two regions). Responses in the northern area tend to reflect the lower price of fertilizer available from the Gambia. Cash constraints were a particular concern in the southern area, where many respondents reminded the interviewer they would only buy the inputs with cash if they had sufficient funds.

Some farmers were curious to know why they were expected to pay 210 FCFA/kg for (improved) cereals seed if they only received 70 FCFA/kg for their own production. In the case of peanut seed, Gaye (1986, p.6) reports that farmers tend to perceive of the Government as a simple speculateur when it resells (indistinguishable, improved) peanut seed to farmers at a price (110-120 FCFA/Kg) above the producer output price (90 FCFA/Kg).[25] Since cereals are a subsistence food--farmers may indeed consume rather than plant improved seeds--and since the input/output price difference is threefold, it is important to explain to farmers why the improved seeds are more

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[24]Some reluctance was expressed in Ndoga, where farmers have had poor experiences with improved millet seed distributed by SODEFITEX (apparently it was particularly well-liked by birds).

[25]Kelly (1988b) mentions a similar "confusion" for fertilizer which, although fabricated in Dakar, is sold at lower (subsidized) prices in the Gambia.

expensive. This is critical given attitudes among some farmers that traders are exploitative (see also Ch. V).

Household heads not willing to buy the inputs at official prices, on average proposed cash prices roughly 50% lower (Table 3-21), with insignificant regional differences.[26] These farmers are on average willing to pay a 15% premium for the benefit of

TABLE 3-21: IMPROVED INPUT PRICES "ACCEPTABLE" TO FARMERS[a]

	FCFA Cash Price			FCFA Credit Price		
Input	Mean	Range	N	Mean	Range	N
Improved Seeds	102	50-200	41	119	60-200	36
Fertilizer	57	10-80	62	65	20-90	50

Source: ISRA/MSU FSP Surveys, 1986/7
a. For the subsample not willing to acquire at prices of 210 FCFA/Kg for seeds and 100 FCFA/Kg for fertilizer. This kind of data is merely indicative and should be interpreted with caution.

receiving the inputs on credit. Assuming a six-month loan period (July-December) the premium is equivalent to a 30% annual interest rate, not unlike that paid by farmers on private loans (GH, May 1987). Given the uncertainty of agricultural production, and the associated credit repayment ability of producers, traders may charge similar interest rates for loans provided to farmers under the APS.

In comparison, approximate official historical fertilizer prices and input/output ratios are shown in Table 3-22. In view of these fluctuations one is hard-pressed to explain how farmers can keep up with annual assessments of whether or not fertilizer use is worthwhile (add to that the uncertainty of climate and actual output prices for cereals).

[26]Farmers in Ndiapto tended to advance slightly higher prices than farmers in Ndoga.

TABLE 3-22: RECENT OFFICIAL FERTILIZER, PEANUT AND CEREALS PRICES

Years	Fertilizer Price (FCFA/kg)	Percent Change	Price of Peanuts (FCFA/kg)	Pnt./Fert Price Ratio	Price of Cereals[a] (FCFA/kg)	Cer./Fert Price Ratio
1976-82	25		42-60	1.7-2.4	35-50	1.4-2.0
1983	50	100%	50	1.00	55	1.10
1984	90	80%	60	0.67	60	0.67
1985[b]	105	17%	90	0.86	60	0.57
1986[c]	64	- 39%	90	1.41	60	0.94
1987	72	13%	90	1.25	70	0.97
1988	80	11%	70	0.88	70	0.88
1989	88	10%	70	0.80	70	0.80

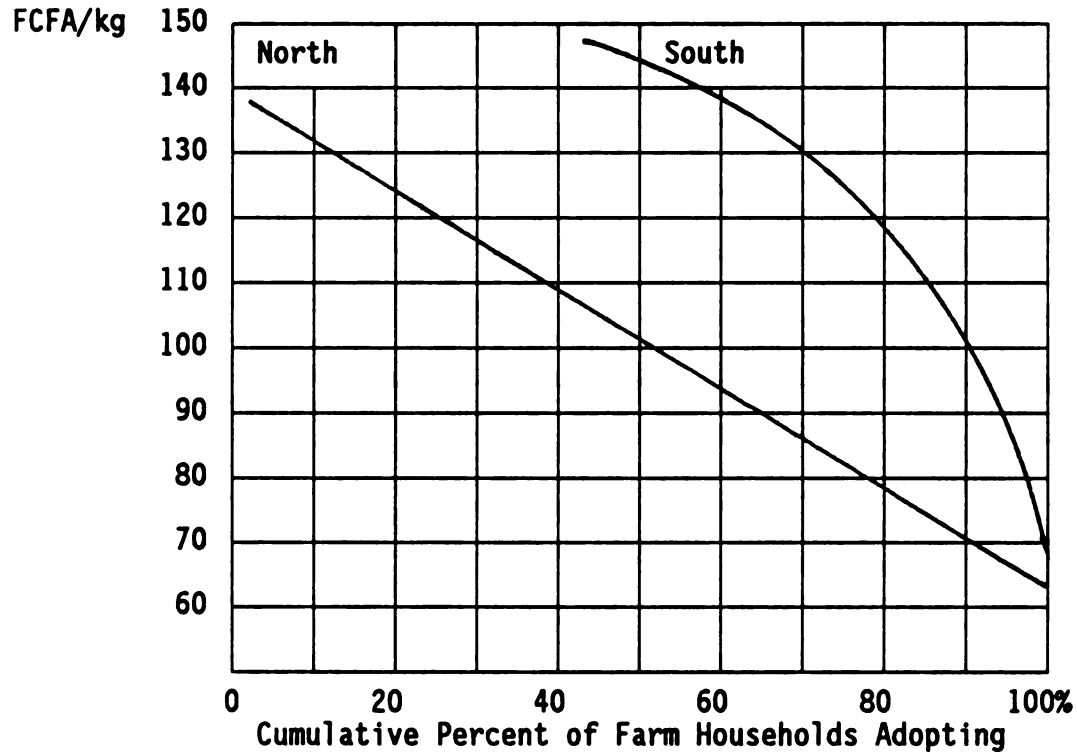
Source: Kelly (1988b, p.16), with additional calculations and recent updates from Le Soleil. Pre-1984 data are estimates based on various official sources.
a. Coarse grains (millet, sorghum and maize).
b. Based on the retenue system.
c. Prices in 1986 through 1989 reflect USAID's declining fertilizer subsidy of 24, 16 and 8 FCFA/kg.

If one argues the adoption of fertilizer involves a "yes-no" decision, rather than how much fertilizer to use on a given crop to maximize expected profits, the above information for fertilizer (i.e., excluding farmers not willing to use improved seeds at 210 FCFA/kg) can be used to estimate fertilizer adoption rates at alternative prices (Figure 3-4). The graph suggests most household heads would use fertilizer if it cost 65 FCFA/kg. In comparison, cereals traders sampled believed they could double fertilizer volumes sold if prices were lowered from 90 to 60 FCFA/kg.

If cash sales of improved inputs are to be encouraged under the APS, fertilizer should be made available during the cash crop marketing period, when rural liquidity levels are high (Figure 3-5).[27] In 1987 fertilizer was made available only prior to planting in the research areas (May-June), and the historical experience is that fertilizer more often than not arrives too late at the farm-level to be utilized prior to seeding (see

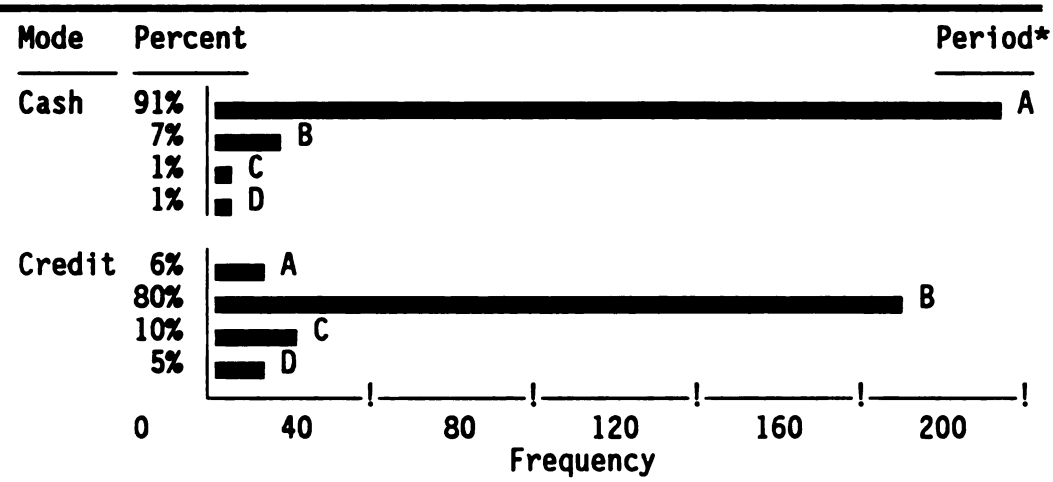
[27]Virtually identical results are reported in Crawford et al., (1987).

FIGURE 3-4: PREDICTED FERTILIZER ADOPTION RATES AT ALTERNATIVE FERTILIZER PRICES



Source: ISRA/MSU FSP Surveys, 1986/7
Note: Based on the percent of households willing to use fertilizer at alternative prices; assumes an output price of 70 FCFA/kg.

FIGURE 3-5: WHEN FARMERS WOULD PREFER TO PURCHASE FERTILIZER AND IMPROVED SEEDS, ACCORDING TO MODE OF PAYMENT



*Code for Periods: A = Peanut/Cotton marketing period (Jan-Mar)
B = After A, before C (i.e., April)
C = Beginning of rainy season (May-June)
D = Indifferent/throughout the year

Source: ISRA/MSU FSP Surveys, 1986/7

Crawford et al., 1987, for an assessment in 1984; this study did not examine the performance of SODEFITEX, however). Given the rule of thumb used by farmers discussed earlier, however, the fertilizer was not "late" if it arrived prior to the emergence of plants.

3.2.6. Issues Involved in Privatizing Input Distribution

The data suggest that physical access to fertilizer, and credit to obtain it, are as important as its perceived profitability (confirming findings reported by Kelly, 1988a); farmers not using fertilizer did not advance a significantly lower yield response expectation, although they may have been contemplating alternative cereals output prices and/or degrees of riskiness. Private trader surveys reveal that an important issue is the initially high price of fertilizer distributed by private traders, which we estimate will exceed the

current price of approximately 90 FCFA/kg by 20-30%, depending on the extent to which private traders are held responsible for the non-repayment of loans.[28]

With a higher price of fertilizer, (a) the fertilizer benefit-cost ratio falls below that calculated officially; (b) farmers will have increasingly superior investment alternatives (Figure 3-3); and (c) they can be expected to not only use less fertilizer per unit of land but cease to use it entirely (Figure 3-4). As a consequence we may expect the already unequal distribution of fertilizer to become more unequal, and geographically isolated and agronomically marginal areas not to receive fertilizer at all. The issue for national policy then is, to what extent should fertilizer use be promoted on marginal land and remote areas of Senegal?

It does not appear that SODEFITEX and SONACOS will reduce their activities in southeastern Senegal in the foreseeable future, making it even more difficult for private traders to establish themselves. One strategy could involve encouraging private traders to form a market parallel to that provided by the parastatals, delivering fertilizer early in the post-harvest period and buying up surpluses of cereals at the same time. Delivering inputs and buying outputs in one rather than two visits to rural areas would reduce marketing costs, but would require that farmers learn--and have facilities--to store fertilizer correctly.[29]

This raises the broader question, how are the rights of different input suppliers (plant geneticists, breeders, cereals assemblers, wholesalers, retailers and parastatals) to

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[28]Nearly one-quarter of the farmers surveyed felt they were not required to repay fertilizer loans when the crop which had received the fertilizer failed, for example, due to drought.

[29]Gaye (op. cit.) alludes to farmers' concerns about toxic effects of urea on ruminants and children, a concern seconded by village chiefs in the FSP sample. Furthermore, urea has a propensity to become compact under humid conditions, making storage more difficult (see also Crawford et al, 1987).

be defined and structured so that conflict (opportunistic behavior)[30] is minimized and the transition to a more productive system completed as quickly as possible? Two related issues include: (a) to the extent that the adoption of draft equipment is possible primarily by tying it to a cash crop and an entity that is sufficiently large to absorb debt losses through transfers from other areas of its operation (such as output marketing or processing); (b) can traders achieve sufficient scales of operation, without becoming monopolists or monopsonists, to act effectively as agents of technological change? What are the knowledge needs of traders, and who is to provide them with that knowledge so that the learning curve may be compressed? We will return to some of these issues in the concluding chapter.

3.3. INTERDEPENDENCIES AMONG INPUTS

Earlier in this chapter the organization of rural households and their access to non-family labor was argued (and seen) to depend strongly on the peanut seed economy. The purpose of this section is to answer the question, "what difference does the organization of households make for cereals production performance and the adoption of mineral fertilizer?" Answers to these questions will reveal some of the consequences of scaling down the official peanut seed credit program.

3.3.1. Model Specification

To test the hypothesis that households with additional laborers seed and, implicitly, produce more coarse grains than are needed to meet the food requirements of those laborers, equation [1] was estimated using an instrumental variables (IV) estimator. The regressors include household structural variables and identifying variables such as the household head's age, the value of agricultural draft equipment per active worker, the quantity of rice seeded and participation with parastatal crop production programs.

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[30]Many farmers were not aware of the basic price and interest they were paying for certain improved inputs received on credit.

Since decisions about the two latter variables are unlikely to be made independently of the quantity of coarse grains seeded, predicted values from two auxiliary regression equations (using predetermined variables in the system) are used in equation [1]. It is assumed that decisions related to labor use and household organization are made based on the amount of peanut seed offered by the household head and other economic considerations such as equipment availability and sharing arrangements. Hence these decisions are independent of, but affect, the quantity of coarse grains seeded. Prices of coarse grain seed are excluded due to a lack of geographic price variation during the planting season.

$$[1] \quad CGSEED = \alpha_0 + \alpha_1 VILAB + \alpha_2 COND + \alpha_3 HIVI + \alpha_4 COREM + \alpha_5 COREF + \alpha_6 NFML + \alpha_7 HAGE + \alpha_8 EQMT + \alpha_9 STCK + \alpha_{10} \hat{RIZS} + \alpha_{11} \hat{PARA} + \epsilon_1$$

The following are variable definitions and expected signs () for the parameter estimates α_i:

CGSEED = kgs of coarse grain seed used (millet, sorghum and/or maize);

VILAB(+) = vertically integrated labor (i.e., that associated with married sons and their dependents living in the household), expressed in adult-equivalent producers (AEPs); this variable measures vertical integration (VI);

COND(?) = 1 if the household is horizontally integrated (HI), i.e., associated with a concession, 0 otherwise;

HIVI(?) = the interaction between VILAB and COND, i.e., HIVI > 0 for households that are both vertically and horizontally integrated; 0 otherwise;

COREM(+) = core labor force--includes the household head's labor and that of his immediate male relatives, measured as AEPs;

COREF(+) = the core female labor force of the household, measured as AEPs;

NFML(+) = non-family workers and their family members, expressed in AEPs;

HAGE(-) = the age of the household head--the sign is negative to reflect experience;

EQMT(+) = the value of equipment owned by the household per AEP;

STCK(?) = 1 if food stocks out of the preceding year's production lasted less than 10 months, zero otherwise; the sign of this coefficient will be negative if insufficient carry-over of seed reduces quantities seeded and positive if households strive to not run out of food stocks in the subsequent year;

RIZS(-) = kilograms of rice seeded--this variable is predicted based on a separate regression (see note below Table 3-24); to the extent that coarse grains and rice are substitutes in the household's cereals budget the sign will be negative.

PARA(+) = 1 if the household participates in SODEFITEX's cotton and/or maize program, SODEVA's maize production program, and/or SODAGRI's rice production program, and 0 otherwise; this is also the predicted value from a separate regression on predetermined variables.

The error term ϵ_1 is assumed to be independently and identically distributed as $N(0,\sigma_1)$.

Equation [2] relates the value of NPK and urea fertilizer (FERT) used by households to the same regressors as in [1] except for the quantity of rice seeded, and with the additional variables listed below.

$$[2] \quad FERT = \beta_0 + \beta_1 VILAB + \beta_2 COND + \beta_3 HIVI + \beta_4 CORE + \beta_5 FEML + \beta_6 NFML + \beta_7 HAGE + \beta_8 EQMT + \beta_9 LCON + \beta_{10} OFFY + \beta_{11} FULN + \beta_{12} STCK + \beta_{13} \hat{SCOT} + \beta_{14} \hat{SMAZ} + \beta_{15} \hat{SEVA} + \epsilon_2$$

The following additional variables are included in the fertilizer equation.

LCON(+) = measures whether or not the household faces a land constraint--LCON(+) = 1 if the household faces a constraint, 0 otherwise (determined from Table 4.3. in Chapter IV);

OFFY(+) = 1 if the household has off-farm income which can serve as a buffer to repay loans in the case of harvest failure, 0 otherwise;

FULN(-) = 1 if the household is of the traditional livestock herder's ethnic group (Fulani), which may prefer to use manure instead of mineral fertilizer on crops, 0 otherwise;

SCOT(+); (SMAZ(+)); and [SEVA(+)] = 1 if the household is affiliated with SODEFITEX's cotton, (SODEFITEX's maize) and/or [SODEVA's maize] production program, and 0 otherwise; it is difficult to grow cotton and maize without mineral fertilizer, so these three variables serves as identifying variables. Since there is also a possibility of a simultaneous equations bias, the instrumental variables technique was also used on these variables and their predicted values entered into equation [2].

Since about 50% of the households surveyed did not use mineral fertilizer, the tobit method is required to estimate [2]. Since this estimator assumes, however, that the same set of variables affects both the probability and quantity of fertilizer use, two separate equations are estimated. The first is a standard probit model predicting the probability (yes or no) of fertilizer. The second equation is estimated on the set of households using fertilizer, and the error term is assumed to be truncated at zero. The latter equation pertains to fertilizer quantities used conditional upon use. Both of these are compared with standard tobit results in Table 3-25.

3.3.2. Results and Discussion

A key question to be answered here is whether or not additional workers allow the household to produce an additional amount of food that at least equals the consumption requirements of the workers and their non-working dependents. Table 3-23 shows the mean number of workers in the different categories as well as the dependency ratios associated with each of the categories. Clearly, additional food requirements are

TABLE 3-23: LABOR CATEGORY SIZE AND EFFICIENCY MEASURES

Category/Measure	Region		Sample Total
	North	South	
Core Labor			
Mean	3.60	3.57	3.58
StErr	.18	.17	.13
Dependency Ratio[a]			
Mean	1.62	1.63	1.62
StErr	.05	.03	.03
Valid N	81	117	198
VI Labor[b]			
Mean	2.51	3.00	2.79
StErr	.35	.30	.23
Dependency Ratio[a]			
Mean	1.42	1.45	1.44
StErr	.08	.07	.05
Valid N	23	30	53
Non-Family Labor			
Mean	2.30	1.25	2.05
StErr	.22	.18	.18
Dependency Ratio[a]			
Mean	.67	.96	.74
StErr	.06	.12	.06
Valid N	38	12	50

Source: ISRA/MSU FSP Surveys, 1986/7
Note: a. Ratio of adult equivalent consumers to producers.
b. Vertically integrated labor force.

lower for non-family workers (with a dependency ratio of only 0.74). Nawetaans, for example, remain in the household for less than 5 months per year.

Table 3-24 presents coefficient estimates for the coarse grain seed equation. With the exception of female labor, all coefficients estimates for household labor structure variables are significant at the 10% level or lower. The relatively low R-square value suggests much of the variation in the quantity of coarse grains seeded remains "unexplained". Assuming an average seed-output conversion ratio of 1:100 for coarse grains[31], the results show households with one more adult equivalent producer belonging to the married son (VI) category grow an additional 332 kgs of coarse grains, while an additional non-family worker adds 364 kilograms. Given per capita (milled) coarse grain requirements of 200 kgs/annum, which is roughly equivalent to 200 kgs of unmilled coarse grains per adult-equivalent-consumer (i.e., the definition used here),[32] these additional workers allow the household to produce a surplus of food above the needs of these workers. In the case of married sons the surplus is (332 - 1.44*200 =) 44 kgs/AEC,[33] while in the case of non-family labor it is (364 - .74*200 =) 216 kgs/AEC. Horizontally integrated households (HI) produce 800 kgs less coarse grains, ceteris paribus, suggesting that membership in a concession leads to disincentive effects with respect to food production. On the other hand, households that are both horizontally and vertically integrated produce about two-thirds of a metric ton of coarse grains more relative to other households (HI*VI variable).

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[31]See Martin, 1988. Estimates for the FSP sample suggest this seed conversion ratio was attained in the northern, but not in the southern research area.

[32]The rate of converting unmilled to milled coarse grains is assumed to be 78% (FAO, 1984). At the same time, there are an average of 0.75 adult equivalent consumers per person in the households sampled.

[33]The break-even seed-to-output conversion ratio required for this category is (200/3.32=) 1:60.

TABLE 3-24: COEFFICIENT ESTIMATES FOR FACTORS AFFECTING THE QUANTITY OF COARSE GRAINS SEEDED
Dependent Variable = Kgs of Coarse Grains Seeded
(Absolute t-statistic)

Independent Variables	IV Estimator
Constant	11.8
	(1.49)
VI Labor (VI)	3.32**
	(2.08)
Concession (HI)	-8.05*
	(1.71)
Interaction (HI*VI)	6.60**
	(2.67)
Core Labor: Male	3.05*
	(1.59)
Core Labor: Female	.753
	(.296)
Non-Family Labor	3.64*
	(1.77)
Household Head Age	.134
	(.942)
Equipment Value/Worker (1000 FCFA)	.720**
	(2.00)
1985 Stocks < 10 Months	7.31*
	(1.83)
Parastatal Member@	7.64
	(1.22)
Kgs of Rice Seeded@	.0531
	(.316)
Number of Households	195
Adjusted R-square	24.1
F-Value (11,183)	6.61**

*(**) = Significant at 10% (5%) or lower.
@: Predicted values of the variables. The set of instruments includes all of the predetermined variables shown here.

It is not clear at this point why these results are obtained. Presumably one explanation is related to different food production risk-sharing arrangements across and within different households and concessions, as alluded to above and as discussed in Binswanger et al. (1987). For example, household heads in horizontally integrated households may rely on each other and/or the concession head in the case of field-specific production failures, thus creating a moral hazard[34] problem (or social trap). This does not explain, however, why households that are both vertically and horizontally integrated seed significantly more coarse grains than the other households.

The results in general support the hypothesis stated earlier: household heads who are able to retain married sons in their households and/or attract non-family workers seed significantly larger quantities of coarse grains than those unable to do so, and the increased output in principle exceeds the consumption requirements of the additional workers.

Table 3-25 presents results for the equations relating household structure to the use of fertilizer. Many of the regressors are statistically insignificant, and the probit equation appears to have difficulty predicting the probability of fertilizer use. There are two labor variables significantly affecting the probability of fertilizer use: 1) married sons (VI labor), suggesting that vertically integrated households are more likely to use fertilizer (independently of whether or not they grow cotton and/or maize); and 2) HI*VI interaction. Households that are both vertically and horizontally integrated are significantly less likely to use fertilizer. The tobit coefficient estimate suggests households with one more core female worker are both more likely to use fertilizer and, conditional upon using fertilizer, use a larger quantity of fertilizer. Households with non-family workers

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[34]Layard and Walters (1978, p.383) provide the following definition: "There is a problem of moral hazard whenever the liability of the insurance company is affected by actions of the insured party about which the insurance company has incomplete information; the state of nature is thus unobservable by the insurance company." (in the present discussion the concession head represents the insurance company).

TABLE 3-25: MAXIMUM LIKELIHOOD ESTIMATES FOR FACTORS AFFECTING THE USE OF FERTILIZER
Dependent Variable = FCFA Value of Fertilizer Used
(Absolute t-statistic)

	Estimator		
Independent Variables	Tobit	Probit	Trunc
Constant	-13834	-.2582	-51412**
	(1.38)	(.483)	(1.87)
VI Labor (Vertically Integrated)	3068**	.1743**	1103
	(1.93)	(1.92)	(.390)
Concession (Horizontally Integ.)	54.2	.180	-10165
	(.012)	(.722)	(.964)
Interaction (HI*VI)	-3738*	-.342***	267
	(1.48)	(2.19)	(.071)
Core Labor: Male	1605	.103	428
	(.865)	(.967)	(.111)
Core Labor: Female	2978**	.141	2233
	(1.61)	(1.37)	(.593)
Non-Family Labor	178	.0628	-1159
	(.101)	(.627)	(.369)
Household Head Age	-61.2	-.0126*	732***
	(.411)	(1.58)	(2.02)
Equipment Value/Worker	520*	.0137	1.09*
(1000 FCFA)	(1.44)	(.678)	(1.48)
Land Constraint	4764	.161	8038
	(.867)	(.533)	(.768)
Non-Agricultural Income	1817	.307	-9330
	(.406)	(1.26)	(-1.03)
Fulani Ethnic Group	-4561	-.306	5066
	(1.07)	(1.36)	(.558)
1985 Stocks < 10 Months	-1757	.0443	-10910
	(.417)	(.197)	(1.13)
SODEFITEX Cotton@	27730***	1.62***	19402
	(3.68)	(3.20)	(1.38)
SODEFITEX Maize@	18974**	.514	37113***
	(1.81)	(.768)	(2.19)
SODEVA Maize@	-4805	.122	-17876
	(.262)	(.124)	(.502)
Number of Households	198	198	94
Log-Likelihood Value	1131	118	1002
Prediction Success: p=0 [p=1]		71% [57%]	

*(**)[***] = Significant at 15% (10%) [5%] or lower. @: Predicted values of the variables. See note for Table 3-24.

are not more likely to use fertilizer (the coefficient estimate in the truncated regression is in fact negative). We may also note, finally, that the married sons and core labor variables do not significantly affect the quantity of fertilizer used, conditional on using fertilizer, for this sample.

Older household heads and members of the Fulani ethnic group are less likely to use fertilizer, although households with older heads use a significantly larger quantity of fertilizer once they have decided to use it. In the specification shown, the sign on the non-agricultural income variable is positive in the probit model, but negative in the truncated version. As hypothesized earlier, a household's ability to draw on non-agricultural revenues to repay production credits in the event of crop failure may make it more willing to invest in fertilizer, while using less--once it has decided to use fertilizer--relative to households without off-farm income that use mineral fertilizer. In summary, the coefficient estimates in Table 3-25 suggest relative input/output prices are not the only factors affecting the use of mineral fertilizer by farm households in Senegal (see also Kelly, 1988a).

3.4. SUMMARY AND CONCLUSION

There is a considerable diversity of resource ownership among farm households in southeastern Senegal. While relaxing cash constraints is important--especially in the pre-planting period as envisioned under the APS--not all households will necessarily be best served with fertilizer and improved coarse grain seed inputs. Access to cash crop seed (peanuts) appears to be important in attracting workers and/or retaining them in the household, which leads to a larger quantity of coarse grains planted. The ability to retain married sons also appears to affect the willingness of households to use fertilizer (controlling for the growing of cotton and maize, which require fertilizer), but no such relationship was found in the case of non-family labor. Access to and affiliation with parastatals is of some importance in "explaining" equipment ownership and use, which is

also interdependent with the size of the household's labor force and, to some extent, its structural organization.

While more work is needed on the determinants of household structure and the relationship between household structure and performance, the results presented here suggest that viewing households as a coalition of individuals with different interests may lead to a more solid microeconomic foundation for understanding the organization of Sahelian agriculture, where markets commonly do not conform to neoclassical assumptions and intra-household trade can become a substitute for conventional market exchange. For more immediate purposes, the results suggest that, under current conditions of coarse grain market uncertainty, the "cash-versus-food" crop issue poses less of a dilemma than previously imagined. This results from the linkage between cash crop seeds and additional laborers attracted with the seeds, who in turn also work on the collective cereals field of the household. Complete government withdrawal from peanut seed distribution, without the development of an effective private sector replacement distribution system that can offer seed on credit, may well lead to lower rather than higher national food production and self-sufficiency levels, by inducing smaller labor forces in rural households.

CHAPTER IV

HOUSEHOLD PRODUCTION BEHAVIOR AND POSSIBILITIES

This chapter describes the crop and non-crop production activities of households sampled; their anticipated responses to the NAP; prospects for expanded maize production; and recent changes in the crop mix grown by households. In this chapter a set of feasible production strategies is identified and an evaluation is made of the "trade-off" between two key strategies, namely food crop and cash crop production. This is done by means of an estimated cost function, which is used to calculate economies of scope and scale in producing the two types of crops. The next chapter examines the relationship of the strategies identified here to the food security performance of individual households. The final chapter draws implications of the results presented in this chapter for national crop research priorities and strategies.

4.1. CROP PRODUCTION GOALS, STRATEGIES AND RECENT DYNAMICS

Section 4.1. examines crop mixes and production levels of households in south-eastern Senegal (using official and survey data), factors correlated with different crop production levels, and primary constraints to expanding areas cultivated advanced by household heads. Given the importance of maize in Senegal's new food strategy, section 4.1.4. reports maize production problems reported by farmers. The section concludes by presenting crop mix changes in 1987 relative to 1986 along with reasons given by farmers for these changes, and evidence related to their crop production decision-making.

4.1.1. Crop Mixes and Production Levels

Most households (98%) grew millet, sorghum and/or maize in 1986, while over two-thirds of the households in the south also grew low-land rice (Figure 4-1). Figure 4-2 suggests that in comparison to all of Senegal, farmers in the southern part of the study zone allocate their land to a greater variety of crops. To a large extent this reflects

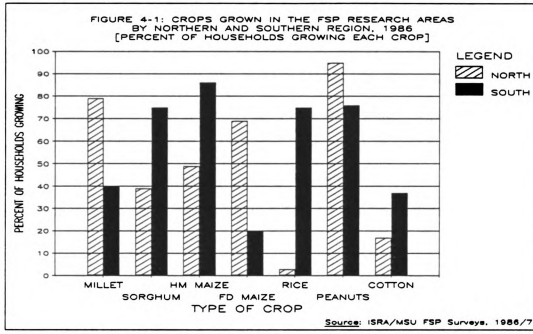
FIGURE 4-1: CROPS GROWN IN THE FSP RESEARCH AREAS
BY NORTHERN AND SOUTHERN REGION, 1986
[PERCENT OF HOUSEHOLDS GROWING EACH CROP]
PERCENT OF HOUSEHOLDS GROWING
100
90
80
70
60
50
40
30
20
10
0
LEGEND
NORTH
SOUTH
MILLET
SORGHUM
HM MAIZE
FD MAIZE
RICE
PEANUTS
COTTON
TYPE OF CROP
Source: ISRA/MSU FSP Surveys, 1986/7

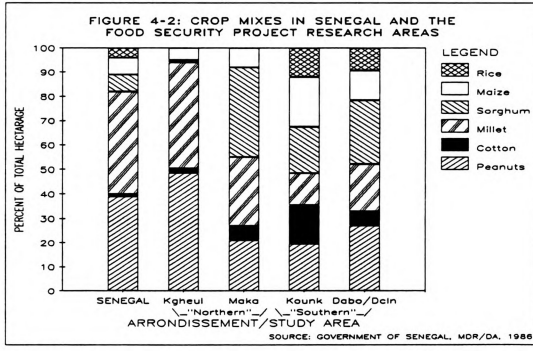
FIGURE 4-2: CROP MIXES IN SENEGAL AND THE
FOOD SECURITY PROJECT RESEARCH AREAS
PERCENT OF TOTAL HECTARAGE
100
90
80
70
60
50
40
30
20
10
0
LEGEND
Rice
Maize
Sorghum
Millet
Cotton
Peanuts
SENEGAL
Kgheul
Maka
Kounk
Dabo/Dcin
"Northern"
"Southern"
ARRONDISSEMENT/STUDY AREA
SOURCE: GOVERNMENT OF SENEGAL, MDR/DA, 1986

increased production opportunities owing to higher rainfall; the cultivation of sorghum, for example, is possible only in the relatively rain-abundant southeastern areas of the country (the role of tastes is examined in Chapter V, Section 5.1.4.).

Table 4-1 shows crop production levels in the two survey regions. Valued at official 1987 prices,[1] the gross market value of total crops produced per AEP was 60% higher in the north (106,000 FCFA/AEP) than in the south (66,500 FCFA/AEP). One-quarter of the households produced 47% of all coarse grains in the north, and 60% of all coarse grains in the south. This appears to reflect the somewhat more even distribution of equipment in the north (see Chapter III).

In a year of adequate rainfall 66% of the households in the south failed to produce sufficient quantities of millet-sorghum-maize (estimated at 200 kg per adult-equivalent consumer, AEC[2]) to carry them through until the subsequent harvest (Figure 4-3). Adding rice production reduces this percentage only marginally (to 60%). In comparison, only 20% of the northern households produced less than 200 kgs of cereals per AEC. Information obtained for the 1987 crop year suggests the food situation observed in 1986 was not unique: sixty-four percent of the southern household heads reported they had not seeded enough cereals (millet, sorghum and maize) in 1987 to satisfy household consumption needs. Thirty-six percent indicated they had seeded enough (30%) or more than enough (6%). In comparison, only 11% of the northern household heads reported they had not seeded enough, while 34% indicated they had seeded enough to meet household needs and 54% responded they had seeded enough to produce a surplus of cereals.

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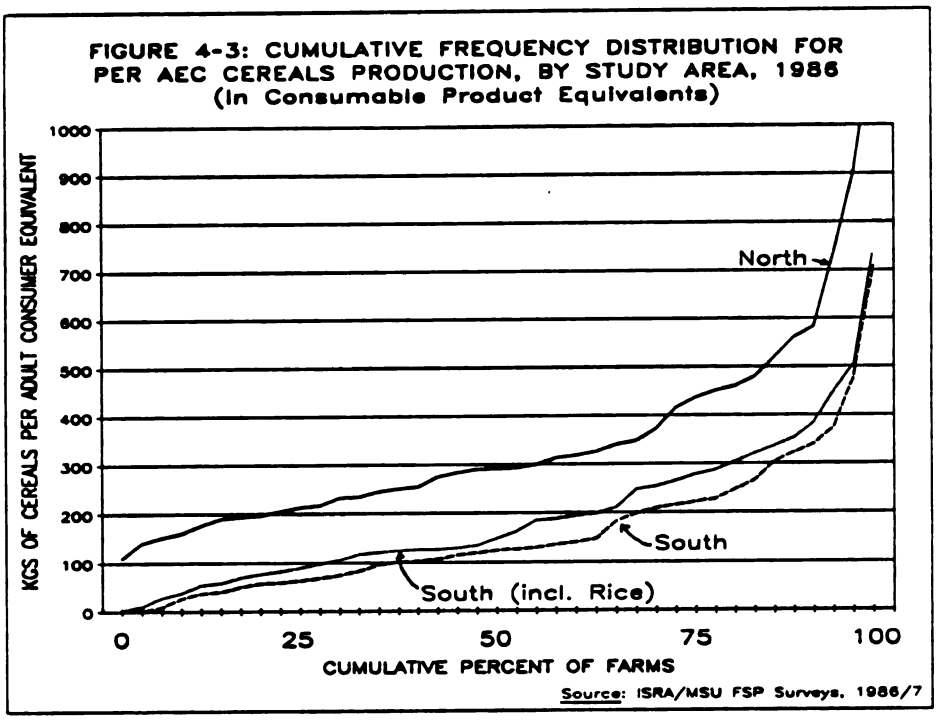
[1]These are cereals = 70 FCFA/kg, peanuts = 90 FCFA/kg, cotton = 100 FCFA/kg and rice = 150 FCFA/kg. The latter is an estimate representing a mix of official and unofficial rice and paddy rice prices.

[2]See also the discussion in Chapter III on the use of consumption requirement standards (Section 3.3).

TABLE 4-1: MEAN ANNUAL HOUSEHOLD CROP PRODUCTION, BY STUDY REGION, 1986[a]
(Standard Error)

Study Region	Production (Kgs)				Total '000 FCFA Value[e]
	Coarse Grains	Rice[c]	Peanuts	Cotton[d]	
North					
Total	2978	1	3175	169	514.6
	(230)	(1)	(455)	(80)	(54)
Per AEP[b]	676	0	605	56	106.1
	(55)	(0)	(75)	(31)	(9)
South					
Total	1317	213	896	536	255.3
	(146)	(27)	(126)	(101)	(25)
Per AEP	326	52	248	139	66.4
	(32)	(6)	(34)	(25)	(5)

Source: ISRA/MSU FSP Surveys, 1986/7
Notes:
a. Minor crops such as fonio, cowpeas and cassava are excluded. According to official 1986 estimates, these crops occupy less than 1% of the land in the research areas.
b. See Table 3-3 for definitions of AEPs.
c. Paddy rice is converted assuming a 65% transformation rate.
d. In Thioubouk (Kounkane, Velingara) 8 fully equipped households produced an average of 2,950 kg of cotton each (equivalent to 640 kg/AEP).
e. Prices used are: Coarse grains = 70 F/kg; rice = 150 F/kg; peanuts = 90 F/kg; cotton=100 F/kg.



Virtually all household heads believe it is preferable to grow enough cereals to meet home consumption needs rather than buying staples, mainly because cereals markets are perceived as unreliable during years of food production shortfalls (see also Chapter VI). Over 90% of the household heads reported cereals consumption needs were the first factor taken into consideration in determining the area seeded to cereals (see Goetz, July 1988 and the discussion in Section 5.1.5.). This raises the question why many households nevertheless failed to produce sufficient cereals in two consecutive years to meet estimated household food needs.

The following hypotheses are offered at this point to explain why per adult consumer equivalent cereals production is low in the southern areas. (1) The lack of equipment, combined with relatively abundant rains leading to rapid weed growth, entails a severe peak labor demand which reduces the total area cultivated per worker.[3]

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[3]Herbicides are not widely used (see Chapter III).

(2) The lack of equipment tends to be interdependent with a relatively low supply of labor at the farm level: a minimum number of active workers is required to profitably use a given set of agricultural implements, but in households without equipment young sons are more likely to migrate and/or seek off-farm sources of income. (3) Pursuing off-farm activities (including seasonal labor migration, petty trading and raising of livestock) is on average more profitable than growing cereals. (4) Cotton and peanut crops are preferred because they have secure market outlets at known prices. These crops--in contrast to cereals--also tend to be less prone to attacks by wildlife.

Given insignificant differences in average crop yields between the two areas (according to official estimates), Table 4-2 suggests that household crop production per AEP is related to the level of equipment use, although the value of the output does differ significantly between non-users and borrowers in the south. Differences between borrowers and fully equipped households are less pronounced in the north, presumably

TABLE 4-2: ANNUAL CROP PRODUCTION PER AEP AND EQUIPMENT USE[a]
(Standard Errors)

Study Region and Equipment Use[b]	Production per AEP (Kgs)				Total '000 FCFA Value
	Coarse Grains	Rice[c]	Peanuts	Cotton[d]	
North					
Borrower	712	0	359	148	84.4
	(182)		(150)	(137)	(21)
Fully Eq	661	0	665	32	110.3
	(55		(86)	(12)	(10)
South					
Non-User	196	64	309	50	54.8
	(44)	(9)	(105)	(31)	(12)
Borrower	261	46	193	103	53.8
	(26)	(8)	(35)	(27)	(5)
Fully Eq	551	53	293	273	98.6
	(83)	(15)	(62)	(66)	(13)

Source: ISRA/MSU FSP Surveys, 1986/7
a. See Table 3-3 for definition of AEPs;
b. Table 3-5 for equipment definitions.

due to the greater availability of equipment even for borrowers (note the large standard error associated with that category, however).

In both research areas households (a) of the Fulani ethnic group; (b) not facing a land constraint; and (c) whose 1985 cereals production had lasted nine months or longer produced more coarse grains per active worker (Table 4-3). In the north (where land is becoming more of a constraint relative to the south) it appears that farmers shift into (possibly intensified) production of higher-valued peanuts rather than coarse grains, when land becomes a constraint and once food needs have been met (see also the discussion in 4.1.5.).

In the north the following households produced more coarse grains per worker: households headed by younger individuals; those that were not integrated; those using only family labor; and those not participating with SODEFITEX. In contrast, southern households that produced more coarse grains per worker were: those which were integrated in some sense; those owning cattle; those who participated with SODEFITEX and/or SONACOS and did not pursue off-farm activities. Consequently, there are considerable differences between the northern and southern areas, as will be further confirmed in the following section.

A further analysis, useful also for issues examined in the following chapter, is carried out by classifying households into three "production-security" categories according to the amount of all cereals (milled coarse grain equivalents[4] and rice) produced per adult equivalent consumer (AEP). The categories selected were:

1. Low producers: 0-160 kgs per AEP, who are considered to be food deficit;

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[4]A 78% conversion ratio from unmilled to milled coarse grains is assumed (FAO, 1984).

TABLE 4-3: VARIABLES ASSOCIATED WITH PER WORKER PRODUCTION

	Coarse Grains (Kgs) North		Coarse Grains (Kgs) South		Rice (Kgs) South	
Variables	Mean	StErr	Mean	StErr	Mean	StErr
Age of Household Head: 20-39 yrs	744	107	355	71	62	15
40-54 yrs	629	81	270	38	30	6
55-90 yrs	570	65	351	61	59	10
Nmbr of Wives: 0	873	178	105	69	46	35
1	725	90	358	46	37	7
2	513	48	315	56	63	12
3	723	216	209	87	78	25
Ethnic=Fulani	794	107	363	39	48	7
Ethnic=Other	580	52	162	29	51	11
Single Family	729	78	289	34	51	9
Vertical Integ.	549	68	394	112	36	13
Horizontal Int.	642	117	364	99	52	12
HI*VI	437	42	339	106	46	9
Family Lab. only	713	66	323	36	47	6
Use Non-Fm. Lab.	564	74	315	70	64	22
No land constr.	690	69	323	33	49	6
Land constraint	563	61	261		31	
'85 stck < 9 mth	534	86	286	42	47	8
GE 9 mths	689	60	380	51	52	10
Cattle Owner	697	80	466	58	54	11
Non-owner	639	88	205	26	49	8
w/ SODEFITEX	531	62	387	61	33	9
not w/SODEFIT.	694	65	281	36	58	8
w/ SODEVA	592	82	.	.	.	.
not w SODEVA	665	61	322	32	49	6
w/ SONACOS	631	72	366	40	57	9
not w/ SONACOS	661	70	273	52	40	8
Off-farm Income	633	64	291	33	57	8
None	668	82	395	74	32	8
Borrowed Cash	634	75	334	72	54	12
No borrowing	657	68	319	37	47	7

TABLE 4-3: Continued

Variable	Peanuts (Kgs) North Mean	Peanuts (Kgs) North StErr	Peanuts (Kgs) South Mean	Peanuts (Kgs) South StErr	Cotton (Kgs) North Mean	Cotton (Kgs) North StErr	Cotton (Kgs) South Mean	Cotton (Kgs) South StErr
Age 20-39 yrs	601	137	203	45	89	77	195	57
of 40-54 yrs	830	167	247	57	44	28	97	32
Head 55-90 yrs	431	83	260	54	29	14	123	44
Nbr of wives: 0	344	265	124	113	101	75		
1	607	124	256	42	81	58	165	37
2	580	86	221	53	14	7	121	42
3	1220	461	257	98	43	43	47	47
Fulani	472	107	227	35	26	14	164	31
Non-fulani	654	96	276	65	68	41	34	24
Single Family	712	133	255	37	48	21	105	29
Vertically Int.	558	164	198	113	6	6	190	77
Horizontal Int.	459	101	282	82	109	89	210	78
HI*VI	593	195	103	28	7	7	88	38
Fam. Lab. Only	541	96	225	32	79	48	138	28
Use Non-Fam Lb.	661	115	337	102	22	16	121	63
Non Land Const.	466	81	239	31	69	39	137	26
Land Constraint	857	135	96		20	12		
'85 Stock<9mths	311	65	205	36	110	85	127	32
GE 9 months	713	96	293	54	29	12	151	42
Cattle Owner	789	155	235	41	1	1	215	47
Non-Owner	513	115	223	45	111	80	69	23
w/SODEFITEX	475	88	99	18	167	80	336	50
Not w/ SOD.	652	100	321	44			16	8
w/SODEVA	532	135	.	.	28	16	.	.
Not w/ SODEVA	614	88	238	30	61	35	136	25
w/SONACOS	640	102	296	43	84	50	160	35
Not w/ SONACOS	547	108	173	41	19	9	109	37
Off-Farm Inc.	581	97	225	34	70	41	82	20
None	617	112	267	63	21	11	258	64
Borrowed Cash	578	115	333	85	69	54	56	30
No Borrowing	609	96	208	29	38	17	161	32

Source: ISRA/MSU FSP Surveys, 1986/7

2. Medium producers: 161-300 kgs per AEP, who are considered food production secure; and

3. High producers: 301+ kgs per AEP, who are considered food production surplus.

In the sample, 32% of the households are estimated to be food-production insecure, while 31% (mostly in the north) produced enough cereals to last them 18 months or longer (Table 4-4). Food production-insecure households in the south on average produced proportionally more rice than the food production secure and surplus households, possibly reflecting different labor constraints. Households in the "low" category produced less cash crops per worker, and they had fewer workers than those in the medium category and a slightly higher ratio of consumers per active worker (1.64 vs. 1.58 and 1.50 in the "medium" and "high" categories). The significant and sizeable differences in equipment owned per active worker across the three strata are noteworthy. Nevertheless, 22% of the food production-insecure households were also fully equipped, while one-quarter of the households in the "high" category were able to produce a surplus without being fully equipped. Some of the production-insecure households also used non-family labor, and they were not significantly more or less likely to be integrated (either vertically or horizontally). At the same time, 27% of the integrated households were in the "low" category, while 29% were in the "high" category.

Households in the food production surplus category were more likely to own cattle (relative to households in the low category), and most had also produced at least enough food to last them 9 months or longer in the preceding year. A fairly large proportion of households in the low category also were working with SODEFITEX. This may partially reflect the fact that many of the households in the low category are in the south, and it is unclear whether they work with the parastatal because they produce

TABLE 4-4: PRODUCTION VARIABLES ASSOCIATED WITH HOUSEHOLDS' FOOD PRODUCTION SUFFICIENCY STATUS

Variable	Kilograms of all Cereals[a] produced per Consumer: Low 0-160	Medium 161-300	High 301+	Total
Households: No.	45	53	44	142
Percent	32%	37%	31%	100%
All Cereals (kgs) Produced/Worker	157	366	718	409
	(12)	(15)	(48)	(25)
Rice as a % of Cereals (South)	24	18	13	20
	(5)	(2)	(4)	(2)
FCFA Cash Crops Produced/Worker	23929	41385	70064	44739
	(3275)	(5459)	(8839)	(3868)
Number of Workers in AEPs	4.1	5.0	4.3	4.5
	(.4)	(.4)	(.4)	(.2)
FCFA Equipment Owned per Worker	1036	2787	4571	2785
	(229)	(367)	(477)	(243)
Percent Fully Equipped	22	51	75	49
	(6)	(7)	(7)	(4)
Percent Using Non-Family Labor	12	24	35	24
	(5)	(6)	(7)	(4)
Percent Integrated [HI or VI or HIVI]	40	58	43	48
	(8)	(7)	(8)	(4)
Percent Owning Cattle	30	54	58	47
	(7)	(7)	(8)	(4)
1985 Food Prodn. lasted 9 mths +	33	48	77	52
	(7)	(7)	(6)	(4)
Percent Working w/ SODEFITEX[b]	42	26	36	35
	(7)	(6)	(7)	(4)
Percent Working w/ SODEVA (North only)	33	28	19	24
	(21)	(9)	(6)	(6)

Source: ISRA/MSU FSP Surveys, 1986/7

a. All coarse grain figures are converted into milled equivalents assuming a 78% transformation rate. b. Cotton and/or maize production programs.

insufficient amounts of food, or whether they produce insufficient amounts of food because they work with the parastatal.

4.1.2. Perceived Constraints to Extensification

This section reports interviewees' responses to shed light on the following questions: which factors reportedly prevented household heads from expanding areas cultivated in 1986; to what extent are they influenced by cereals price policies; and how would they react to a reduction in peanut prices?

Household heads in the north of the study area responded that a lack of labor, peanut seed and land were principal factors preventing crop extensification in 1986 (Table 4-5). In the south a lack of equipment and labor were cited as the main reasons, even by respondents in "fully equipped" households. While some households invested in labor-saving draft equipment prior to the 1987 season, this was not sufficiently widespread to have made a substantial difference for agricultural production in 1987 (see GH, March 1988).

TABLE 4-5: PRIMARY CONSTRAINTS TO EXPANDING AREA CULTIVATED IN 1986
Percent of Households Responding

	Constraint				
Region	Land	Labor	Equipment	Seed[a]	Other
North	35[b]	26	5	35	
South	11[b]	30	40	15	4

Source: ISRA/MSU FSP Surveys, 1986/7
a. This is peanut seed in the north, cereals seed in the south.
b. In most of these cases the land is perceived as being "too remote to be worth cultivating".

The results therefore suggest that credit for purchasing inputs, and not the unprofitability of production opportunities alone, was a primary constraint to extensification (note that the question asked which general factor prevented expansion, i.e., allowance was made for price or profitability factors). This does not mean, however, that simply providing more cash to farmers would allow them to expand production, since it is not clear that input supplies (labor, equipment and/or seed) would readily be forthcoming in any given area. The data in Table 4-5 also suggest that most farmers would not be forced to intensify agricultural production (increase the amount of inputs used per unit of land) because they lack suitable land.

As discussed in Chapter III, household heads were also asked which crop they would have grown more of in 1987 if they had been able to expand production. One-half of the respondents in the north answered they would have grown more peanuts, while most (83%) southern respondents would have grown more millet, sorghum and/or field maize. This indicates the more food-secure northern farmers view peanut production as more profitable than cereals production at current relative input and output prices (see also Kelly, 1988a and GH, May 1987), while southern household heads would attempt to make up the food production deficit rather than commit additional resources to cash crop production.

Most northern household heads responded they would not change their cereals areas seeded if the floor price were reduced or eliminated, while one-quarter responded they would not change the area seeded if the price were increased (see also the more detailed results in Section 5.1.6.[i]; observations for the southern areas have to be interpreted with caution since farmers have no experience with effective coarse grain floor prices; evidently, some of the northern respondents may have been considering a change in the use of inputs per unit of land). The responses suggest it is difficult for some household heads--as buyers or sellers--to conceive of cereals as a "true" cash crop.

Three plausible explanations are (a) the historical role of peanuts and cotton (with assured input delivery and output markets), and possibly livestock, as a source of cash revenue, combined with the only recently granted right to trade cereals freely and at a supported price; (b) relative input and output prices are such that it is more profitable to grow peanuts, even though cereals prices have recently been rising more rapidly than peanut prices; (c) the "ghost of past famines" (as recent as 1984/5) which, combined with the unreliability of markets as a source of cereals, makes selling of staple cereals unthinkable for some household heads.[5]

If (a) above is the principal explanation, household heads are likely to adjust their perceptions of cereals as a cash crop over time. In fact, sizeable sales of sorghum in 1987 in Maka (Figure 5-3 in Chapter V) and sales of all cereals in the Medina Yoro Foulah area (Kolda) in 1987 illustrate this adjustment may already be underway. As an indirect and partial test of explanation (b), farmers were asked how they would react if official peanut prices were reduced from 90 to 70 FCFA/kg (this policy was actually implemented in 1988). One-half (38/78) of the northern household heads reported they would seed more peanuts, while 28% would not change the area seeded to peanuts. In the south most farmers responded they would seed less (39% = 42/108) or the same (41%) amount of peanuts.

In the north most household heads (67%) responding they would seed more peanuts also indicated they would not change the area cultivated to other crops. They may have excess productive capacity and would grow more peanuts but not more cereals

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[5]This may be related to a cultural norm which stipulates that if a household sold coarse grains one year, and then had insufficient food supplies the next (for whatever reason), it was the household that got itself into trouble by selling food and therefore did not deserve any assistance from other households.

to meet target cash needs.[6] Those who would seed less peanuts indicated they would switch mainly to millet and/or sorghum (55%) and maize (35%). In the south some household heads would reduce millet-sorghum (30%) and maize areas (23%), if they were to increase the size of their peanut fields. Most (89%) of those responding they would reduce their peanut areas answered they would instead grow cereals.

Taken together, the results imply that most farmers in southeastern Senegal face resource and/or credit constraints, and that simply raising cereals prices is unlikely to have a significant impact on output. In fact, we will see in Chapter V that households relying on cereals markets to purchase food already face higher cereals prices than households selling cereals, so that they in the short-run may be adversely affected by a higher cereals floor price.

To conclude this section, examining household heads' opinions of--and stated responses to--current and future agricultural policies in Senegal is a useful starting point for informing political decision-makers about the anticipated consequences of those policies in different regions of the country. Additional information on opinions is examined in Chapter V. The following section presents results pertaining specifically to the APS.

4.1.3. Considerations of Cereals Output Response under the APS

On average, household heads indicated they would be willing to replace 67% of their traditional coarse grain seeds with the improved seeds (range = 10% to 100%; proportions are slightly higher for maize than for millet and sorghum).[7] This average is

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[6] These farmers may also plan to purchase more peanut seeds at the lower price, still finding peanuts more profitable than cereals at the lower (but nevertheless certain) price. Given the low output per seed ratio of peanuts, seed is an important cost of producing peanuts (see Section 3.1.4. and Gaye, 1986). More peanut seed would also allow them to attract more workers.

[7] Results include all farmers, assuming those not willing to pay official prices get the inputs at their proposed prices.

high, given the importance of assuring cereals self-sufficiency and, from the farmer's point of view, the untested nature of the seeds.

After presenting respondents with per hectare seed and fertilizer application rates proposed under the APS (e.g., 4 kgs of millet seed for every 150 kgs of NPK and 50 kgs of urea per hectare, and the expected output achievable with these inputs), they were asked how many hectares they would cultivate to improved cereals (Table 4-6). At proposed application rates these areas correspond to an average of 730 kgs of fertilizer

TABLE 4-6: HECTARES WHICH FARMERS WOULD REPORTEDLY CULTIVATE TO IMPROVED MILLET/SORGHUM AND MAIZE; ASSUMES CASH SALES[a]

Study Region	Millet/Sorghum			Maize			Totals
	Mean	Range	N	Mean	Range	N	
North	1.9	.5-5.0	82	1.4	.3-4.0	83	3.3
South	1.2	.3-5.5	120	0.9	.3-6.5	122	2.1
Total	1.5	.5-5.5	202	1.1	.3-6.5	205	2.6

Source: ISRA/MSU FSP Surveys, 1986/7
a. Responses for credit sales: millet/sorghum N=2.3, S=1.4; maize N=1.6, S=1.

per northern and 465 kgs per southern household, considerably above historical levels received by households.[8] For most farmers--particularly in the southern areas--the use of improved seeds and fertilizer would entail an increase in the total area cultivated to cereals (Table 4-7). It is unclear to what extent this increase would reflect cultivation of new land or a reduction in land allocated to peanuts and cotton.

Table 4-7 confirms the earlier finding that the availability of cereals seed is one important factor determining hectares grown to cereals in the southern area, especially

[8]See, e.g., Crawford et al. (1987), and other FSP reports on input use. The calculations assume actual application rates of 250 kg/ha on maize and 200 kg/ha on millet.

TABLE 4-7: HOW FARMERS WOULD CHANGE TOTAL AREA SEEDED TO CEREALS, CONCURRENT WITH RECEIPT OF IMPROVED SEEDS UNDER THE APS
Number and Percent of Households Sampled

Area Change	Study Region North		Study Region South		Total	
Increase	54	62%	110	89%	164	78%
Decrease	3	3%			3	1%
No Change	30	34%	14	11%	44	21%
Total	87	100%	124	100%	211	100%

Source: ISRA/MSU FSP Surveys, 1986/7

in Sandio and Diega, where 98 % and 93 % of household heads said they would increase areas cultivated to cereals if they obtained cereals seed under the APS.[9] Consequently, distribution of the improved inputs may, depending on the region, lead to both a yield and an area expansion effect for cereals.

From the above information approximate average coarse grains yields and hectares cultivated by households in 1987 can be calculated. The 3.3 and 2.1 hectares cultivated using improved seeds (Table 4-6) are in fact the estimated areas grown in 1987, since they represent 67% of all cereals seeded in the northern and southern areas; assuming identical seeding rates for improved and traditional seeds, the total area cultivated per household would therefore be 4.9 and 3.1 hectares, 33% of which represents an increase attributable to the APS. Assuming no change in yields and average areas cultivated to cereals in 1987 relative to 1986,[10] this gives a yield estimate of 905 kg/ha for northern and 630 kg/ha for southern households.

[9] In part this may also reflect the higher expected profitability of the cereals, however, rather than only a relaxed input constraint.

[10] Production data for 1987 were not collected.

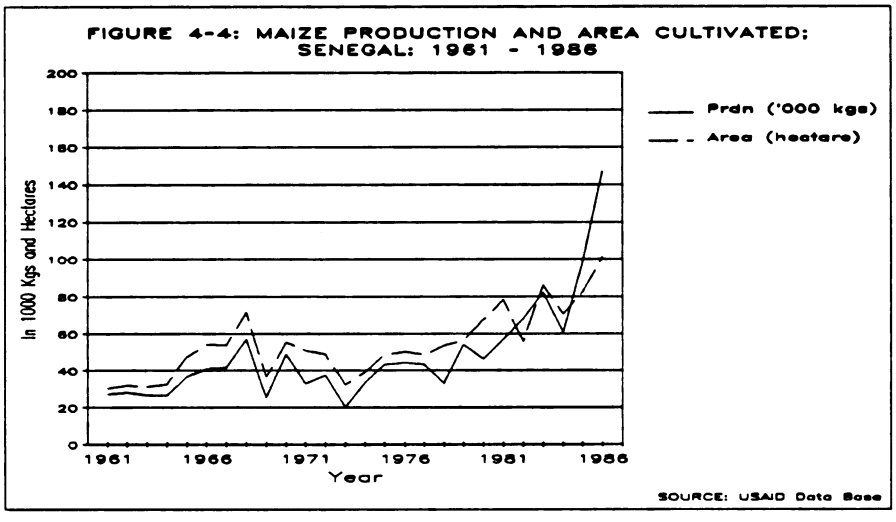
The yield estimate for the northern area is close to official 1986 estimates while the southern estimate is below these estimates. In part the discrepancy may be explained by a) yields and areas cultivated did change between 1986 and 1987, b) farmers have a more difficult time visualizing crop area changes in the south and/or c) the lower southern yield reflects higher crop damages by predators and pests and/or increased weeding problems.

Not all farmers are likely to adopt the entire technological package. In particular, an estimated 14% of the household heads will adopt only fertilizer or improved seeds, but not both at the same time, regardless of whether sales are on a cash or credit basis.

4.1.4. Prospects for Expanded Maize Production

Since maize is especially targeted under the APS, it is worth examining reasons given by farmers for growing maize as well as factors currently affecting maize production, to see if maize supplies are likely to increase in response to price incentives. At the national level, according to official statistics, the area and production of maize has increased since 1980 (Figure 4-4). As discussed briefly in Chapter I, a shift-share analysis for the period 1961-85 reveals that the share of the Peanut Basin in total national maize production is increasing, while the shares of Senegal Oriental and the Casamance are declining, despite their higher rainfall (Goetz with Dieng, March 1987, p.11). To some extent this may reflect a response to the recent drought since the newer, early-maturing maize varieties appear to serve as a food security crop during the hungry season.

In 1987, over 95% of the households sampled grew maize in the traditional field around the compound or as field maize. Due primarily to land pressure, there is a tendency to grow maize further away from the home in the northern areas. Farmers generally believed they could have increased yields in their home maize field (56%), but



not expanded the area cultivated (69%). Most farmers either did not plan to use fertilizer on their field maize (52%), or had not acquired it at the time of the survey (July, 1987). Nevertheless, fertilizer was identified as an important input into maize production. Maize grown around the compound usually benefits from animal manure and "night soil" and therefore does not require commercial fertilizer.

Most farmers grow field maize as a food crop, destined for own-consumption and not for cash sales (Table 4-8).[11] Farmers not growing field maize cited, as main reasons, a lack of fertilizer in the northern, and problems with natural predators in the southern areas. Potential output marketing constraints and ways of reducing these to stimulate the production of maize are explored in subsequent chapters.

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[11]Household preferences among different cereals, and storage and transformation constraints, are discussed in Chapter V.

TABLE 4-8: REASONS FOR AND AGAINST GROWING FIELD MAIZE
Percent of Households Responding

Responses	Study Region		Total
	North	South	
Reason for Growing			
Serves as our Food.....	36%	73%	56%
Gives Good Yields.....	7%	24%	16%
Home Maize is not Sufficient.....	17%	2%	9%
Lack Land for Home Maize.	14%	2%	8%
Sells Easily.....	17%	0%	8%
Other Reason.....	10%	0%	4%
Reason for not Growing			
Monkey/Warthog problem...	0%	58%	36%
Lack Fertilizer.....	50%	0%	19%
Lack Labor.....	19%	23%	21%
Lack Suitable land.....	12%	6%	8%
Lack of Market Outlet....	5%	6%	5%
Other Reason.....	14%	7%	10%

Source: ISRA/MSU Food Security Project Survey, 1987
Note: The question allowed only for the one most important reason for growing or not growing field maize. This does not mean, for example, that soil fertility is not a concern in the southern research areas (see also Table 4-9).

Attacks by natural predators, high fertility needs and high labor demands were listed as the main general problems with producing field maize by those growing the crop (Appendix A-4). High moisture requirements of existing varieties were cited as a concern in the northern but not in the southern areas. Labor and tools for land preparation along with a lack of fertilizer constituted principal constraints to expanding the area cultivated to maize in 1987 (Table 4-9).

One goal of the NPA is to induce farmers to substitute maize for millet and sorghum (allegedly less fertilizer-responsive). Those farmers not willing to make the reduction indicated that millet and sorghum were their principal staple, maize production

TABLE 4-9: FACTORS PREVENTING EXPANSION OF FIELD MAIZE CROPS
Percent of Households Responding

Factors	Study Region		
	North	South	Total
First Reason			
Labor/Field Work.....	32%	43%	38%
Lack Fertilizer/Manure.....	38%	6%	22%
Lack Equipment/Animals.....	12%	25%	19%
Lack Suitable Land.....	12%	8%	10%
Lack of maize seeds.....	2%	8%	5%
Labor/Crop protection.....	0%	6%	3%
Lack Land in general.....	2%	2%	2%
Rainfall Insufficient.....	2%	2%	2%
Second Reason			
Lack Equipment/Animals.....	46%	22%	32%
Labor/Crop protection.....	3%	39%	23%
Labor/Field Work.....	18%	18%	18%
Lack Fertilizer/Manure.....	15%	8%	11%
Lack of maize seeds.....	0%	10%	6%
Rainfall Insufficient.....	8%	2%	4%
Lack Suitable Land.....	3%	0%	1%
Lack Land in general.....	3%	0%	1%
Other Reason.....	5%	2%	3%
Third Reason			
Rainfall Insufficient.....	19%	29%	26%
Labor/Field Work.....	19%	17%	17%
Lack Fertilizer/Manure.....	24%	17%	19%
Lack Equipment/Animals.....	19%	8%	12%
Lack of maize seeds.....	5%	13%	10%
Labor/Crop protection.....	0%	13%	9%
Lack Suitable Land.....	5%	2%	3%
Lack Land in general.....	0%	2%	1%
Other Reason.....	10%	0%	3%

Source: ISRA/MSU Food Security Project Survey, 1987

is "too risky", and that the land currently cultivated to millet was not suitable for maize (Table 4-10). Farmers willing to substitute maize for millet and sorghum, would do so if they had more fertilizer (especially in the North), if the price of maize rose relative to that of millet and sorghum, and if they had more maize seeds (Table 4-10).

TABLE 4-10: WILLINGNESS TO SUBSTITUTE MILLET/SORGHUM FOR MAIZE
Percent of Households Responding

	Study Region		
Willingness	North	South	Total
A. Not willing to Substitute because...			
Mil/Sorghum is our essential staple.....	65%	36%	44%
Maize is too risky.....	8%	40%	31%
Land not suitable.....	15%	11%	13%
Insufficient labor/equipment.....	0%	10%	7%
Other.....	12%	3%	5%
B. Willing to substitute if...			
Had (more) Fertilizer.....	60%	35%	51%
Relative price rises.....	33%	6%	22%
Had more maize seeds.....	4%	35%	16%
Less predators.....	0%	12%	4%
Other.....	4%	12%	7%

Source: ISRA/MSU Food Security Project Survey, 1987

In summary, the following conclusions can be drawn regarding the prospect of expanded maize production in southeastern Senegal. (1) The potential for expanding maize production in traditional fields around the compound is limited. Substantial gains are likely to be possible only by promoting field maize, but this has to be accompanied by a sound technological package to help farmers overcome production constraints. (2) Soil fertility is a principal constraint to growing field maize in the northern research

areas. This is followed by higher labor demands (relative to millet and sorghum) as well as a higher susceptibility to droughts. (3) Natural predators, insects and high labor/equipment demands constrain the expansion of maize production in the southern research areas. Similar wildlife and agricultural resource management issues have of course existed for some time in countries such as Kenya, which depend heavily on rural tourism. Finally, marketing problems pose potentially important further constraints. They are discussed in Chapter V.

4.1.5. Recent Crop Mix Changes, Reasons Given by Farmers and Evidence Relating to Farmer Decision-Making

Farmers in the survey areas by and large increased areas cultivated to crops in 1987 over 1986, as far as can be seen from qualitative responses, and the number of households adding crops to their crop mixes outweighed the number reducing the extent (or scope) of their crop mix (see GH, May 1987; and GH, March 1988 for changes over the period 1984-6). The proportion of increases was somewhat biased in favor of food crops, with maize production expanding noticeably (Table 4-11): On net, 7% or 14/203

TABLE 4-11 : ABSOLUTE AND RELATIVE CROP MIX CHANGES IN 1987 OVER 1986
Number and Percent of Households Responding

	Number of Households Concerned						As a Percent of		Number of HHs Growing
	Crop was:			Area Cultivated was:			Growers:		
Crop	Added A	Dropped D	Net (A-D)	Incrs. I	Reduc. R	Net (I-D)	A-D	I-D	Crop in 1986
Millet	6	14	-8	46	9	37	-7%	31%	120
Sorghum	9	11	-2	50	15	35	-2%	27%	130
Home Maize	0	2	-2	7	8	-1	-1%	-1%	153
Field Maize	23	9	14	31	12	19	16%	22%	86
Rice	1	5	-4	9	2	7	-4%	7%	99
Cotton	13	6	7	14	1	13	11%	21%	62
Peanuts	17	7	10	75	22	55	6%	31%	180

Source: ISRA/MSU FSP Surveys, 1986/7
Note: Sample size is 203 households.

of the households--added field maize to their crop mix while 22% of the households already growing maize expanded the area allocated to that crop. At least in the northern areas, where the floor price policy was in effect during the 1987 marketing season, this raises the question whether that policy or another reason motivated the change.

The availability (cost) of peanut seed (37%), labor (21%), land[12] (7%) and fertilizer (4%) were common reasons advanced for changes in areas cultivated in the north, along with the desire to meet household food (15%) and cash (3%) needs (see GH, March 1988 for responses by crop).[13] The producer floor price for cereals was not evoked as a reason. In the southern areas, reasons given for increases in area cultivated included the desire to meet household food (30%) and cash (14%) needs, increased availability of labor and equipment (23%) and peanut (16%) and cereals (11%) seed.

All northern and most (93%) southern household heads indicated household food needs were the first factor taken into account in deciding how much land to seed to cereals. The expected relative price of cereals and cash crops was the second most important factor for 39% (62/160) of farmers in both areas. Among southern farmers giving a third factor, 43% (49/113) responded cereal seed available affected the area seeded to cereals.

The evidence presented earlier in Table 3-13 (Chapter III) yields further insights into how farmers approach crop production decisions.[14] Most farmers are unlikely to invest in inputs such as fertilizer and agricultural equipment unless they are first able to satisfy anticipated household food needs during the rainy season (GH, May 1987; Table

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[12]This represents land previously lent to or borrowed from other farmers.

[13]Similar responses were given for crop area decreases and changes in the crop mix.

[14]This section is extracted from GH, May 1987.

15 and Figures 2 and 3). Once these needs are met, most farmers in the north (31%) would invest in peanut rather than cereals production. This supports the hypothesis that many farmers, particularly in the arid north, would rather invest in additional peanut seed before intensifying cereals production (see also Kelly, 1988a), and the hypothesized peanut seed-labor linkage. In the south, hiring of labor constitutes an important use of additional funds, followed by saving rather than investing of funds.

Thus, while formal-sector lenders tend to regard loans for food consumption as unproductive, expanded food consumption during the hungry season can increase labor productivity and availability. Some farmers reported they were unable to profit fully from the good rains in the 1985-86 cropping season, because they lacked the energy to expand area cropped and complete arduous cropping activities. By investing in higher food consumption during the growing season, farm households are able to put more land area under cultivation and achieve higher yields through more careful land preparation and weeding. They are also able to attract more laborers to work in collective cereals fields, using additional food as a labor payment. Making loans available for food deficit households to purchase cereals could be an essential element in breaking low income rural households out of a cycle of low productivity, poverty and indebtedness.

Household heads in the south preferring to invest 15,000 FCFA in peanut seed on average had larger cereals and lower peanut stocks than those who would have bought food (Table 4-12). In the north, households heads preferring to buy peanut seed with incremental funds had lower cereals (and peanut) stocks than households which would have bought food. This lends further credence to the peanut seed-labor linkage. In particular, the finding that some household heads would invest in peanut seed (and fertilizer) before buying food suggests their decision-making is complex, and that trade-offs are evaluated in an intertemporal context. The household head organizes and manages cultivation of collective household grain fields (see Goetz and Diagana with

TABLE 4-12: HOUSEHOLD LEVEL STOCKS OF CEREALS AND PEANUTS, STRATIFIED BY FIRST INVESTMENT PREFERENCE FOR 15,000 FCFA

	Stocks (July 1987) in Kilograms[a]			
	North		South	
First Choice	Cereals	Peanuts	Cereals	Peanuts
Buy Peanuts	69	26	67	4
Buy Food	94	38	33	17

Source: ISRA/MSU FSP Surveys, 1986/7
a. Peanuts are per 1986 adult producer equivalent, cereals per 1986 adult consumer equivalent.

Diallo, 1987; also Benoit-Cattin and Faye, 1982, and Chapter II), relying on family and non-family labor. The more workers he can attract as dependents by providing peanut seed, the more collective land can be put under cereals cultivation. By foregoing immediate food consumption and buying peanut seed, household heads are indirectly investing in greater food security for the coming year. This balance of productive investment and consumption requires careful management. When grain supplies are not adequate to meet food requirements, assets such as livestock or equipment must be liquidated, or income needs to be tapped from other sources.

4.2. AUXILIARY INCOME-GENERATING STRATEGIES

Since agricultural households rely not only on revenues from crop production to survive, it is important to identify at least the qualitative significance of non-crop production activities and their role in providing non-production entitlements for food access. Livestock ownership and off-farm income activities are described in this section.

4.2.1. Livestock

Table 4-13 suggests most households in the survey areas own some form of livestock. Not surprisingly, members of the traditional livestock-herding ethnic group

(Peulh or Fulani) are more likely to own larger cattle herds. Livestock transactions and their role in assuring food security are examined in Section 5.1.3.

TABLE 4-13: OWNERSHIP OF LIVESTOCK IN THE STUDY AREAS
% of Households; excludes draft animals

Number of Animals	Cattle		Goats/Sheep		Poultry	
	North	South	North	South	North	South
0	55	51	24	51	29	12
1-10	39	27	61	40	56	53
11-30	0	15	12	8	15	33
30+	6	7	3	1	0	2
	Peulh	Other	Peulh	Other	Peulh	Other
0	41	67	43	34	16	21
1-10	38	28	44	56	54	53
11-30	13	1	11	7	29	25
30+	8	4	2	3	1	1

Source: ISRA/MSU FSP Surveys, 1986/7

4.2.2. Off-Farm Income

Nearly two-thirds of the households sampled have at least one member who pursued an off-farm activity during the 1986/87 agricultural season.[15] The proportion of households with off-farm activities is higher in the southern than the northern areas and tends to be larger among households borrowing or not using agricultural draft equipment. The data reveal a small net decline in the number of households in which household heads pursued off-farm activities in 1987 relative to 1986. The decline may be related to higher levels of coarse grain production in 1986, relative to 1985, which in turn

[15]This section is based on Goetz (June, 1988), "A Note on Off-Farm Activities and Food Security in Southeastern Senegal", which provides more details. An off-farm activity is defined as any activity not related to own-crop production providing cash, including trade in livestock but excluding disinvestment of livestock.

suggests that off-farm income is one important means of recuperating from crop failure (1984-85 for these farmers). In other words, the household head may be forced to pursue off-farm activities temporarily in order to allow his household to recuperate from crop failures.

The household head was most frequently counted as the person pursuing the off-farm activity (71% of the cases) followed by male (18%) and female relatives (11%). In 33% of the cases household heads engage in small-scale commerce (banabana). Most of the activities are carried out all year--possibly competing with own-crop production, see Ch. II--or during the dry season, with some regional differences (Table 4-14). Obviously, the volume of the off-farm activity may also vary seasonally.

TABLE 4-14: TIMING OF THE OFF-FARM ACTIVITY
Number and Percent of Households Responding

	Study Region					
Timing	North		South		Total	
All Year	22	32%	65	50%	87	44%
Dry Season	32	46%	55	42%	87	44%
Cash Crop Season	11	16%	2	2%	13	7%
Rainy Season/Harvest	4	6%	8	6%	12	6%
Total	69	100%	130	100%	199	100%

Source: ISRA/MSU Food Security Project Surveys (1986/87)

Small-scale commerce (banabana) was the most frequently cited off-farm activity, followed by artisinal and livestock-related pursuits (e.g., herding and trade, Table 4-15). The blacksmith/bicycle repair activity was cited by only one northern farmer, suggesting more specialization in the northern area, which is conceivably related to higher equipment endowments. Only household heads engage in salaried labor and construction (wells, huts), and most of the religious and livestock-related activities are carried out by household heads. In contrast to findings from Mali (D'Agostino and Sundberg, 1990),

TABLE 4-15: OFF-FARM ACTIVITY FREQUENCY COUNTS
(All Household Members)
Number and Percent of Households

Activity	Study Region: North		Study Region: South		Total	
Commerce/BanaBana	33	48%	41	32%	74	37%
Artisinal	12	17%	26	20%	38	19%
Livestock	8	12%	17	13%	25	13%
Religious/Marabout	3	4%	13	10%	16	8%
Food Services	6	9%	8	6%	14	7%
Blacksmith/ Bicycle Repair	1	1%	8	6%	9	5%
Other[a]	6	8%	17	13%	23	13%
Total	69	100%	130	100%	199	100%

Source: ISRA/MSU Food Security Project Surveys (1986/87)
a. Includes construction (3%), salaried labor (3%), working for other farmers (3%) and miscellaneous (4%).

these results suggest that off-farm activities pursued by farmers are not necessarily more diverse and numerous in the more arid region (North); indeed, the institutional environment (better market integration, etc.) may compensate for a climatic deficit.

In three-quarters of the cases, the activity has been carried out for more than three years (Table 4-16). The data imply more "dynamism" in the northern areas,

TABLE 4-16: BEGINNING OF OFF-FARM ACTIVITY
Number and Percent of Households

Beginning	Study Region: North		Study Region: South		Total	
1986/87	11	16%	5	4%	16	8%
Two years ago	10	14%	6	5%	16	8%
Three years ago	7	10%	12	10%	19	10%
More than 3 yrs. ago	41	59%	103	82%	144	74%
Total	69	100%	126	100%	195	100%

Source: ISRA/MSU Food Security Project Surveys (1986/87)

possibly due to opportunities granted by recently liberalized cereals markets in 1986/87 combined with higher coarse grain surpluses. Commerce was cited most frequently as having been started this past year, while construction and livestock-related activities are more stable in the sense that they generally have been carried out for more than three years.

Having described the multidimensional production behavior and possibilities of agricultural households in southeastern Senegal, we now turn to estimating a cost function to determine if the technology available to households is such that there are economies of scope in producing food and cash crop within the same household.[16] The effects of ethnicity and off-farm incomes on the coarse grain marketing behavior of households is examined in Chapter V.

4.3. COST FUNCTION ESTIMATION

4.3.1. Introduction

The purpose of this section is to estimate a household cost function, incorporating the multi-product nature of households, to determine the quantitative significance of non-congested inputs. Labor may constitute one such input, since (for example) the harvest periods of cash and food crops differ. From the estimated cost function, various cost measures are calculated to examine where farmers are currently operating on their cost curves. "Economies of scope", defined as the proportional cost reduction achievable by producing food and cash crops in one rather than two specialized households, are one such cost measure. Another is the economies of scale specific to one product in a firm producing multiple products.

One of the explicit policy instruments the GOS has chosen to achieve its cereals self-sufficiency objective is the substitution of coarse grains for peanut production in

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[16]Livestock is excluded from the cost function owing to a lack of reliable production data in 1986.

southeastern Senegal. The instrument is implemented by reducing sales of peanut seed on credit and establishing a producer floor price for cereals. The question then arises, why do most rural households in Senegal produce both food and cash crops? There are two plausible answers to this question.[17]

First, uncertain food markets create incentives for households to produce both cash and food crops if they are to meet both cash and food needs of the household (Ch. II). A second explanation involves the existence of a non-congested or public input, which makes it less costly to produce food and cash crops in one household rather than in two specialized (separate) households. Non-congestion means that there is slack for one or more inputs with regard to its use on a particular crop, and that growing both types of crops within the same firm (household) leads to a fuller utilization of the input at any given point in time. If, alternatively, there were sizeable economies of scale in growing food and cash crops (separately), one could expect two or more households to form an agreement or contract to specialize in the production of one or another of the crops, and to trade outputs at harvest. For a small enough number of households, transactions costs could be sufficiently small (i.e., close to zero) so that the gains from specialization exceed the costs of agreeing to and enforcing the contract. This form of complete specialization across households, however, is not observed in Senegal.[18] One reason may be that costs of enforcing contracts between households are high given the uncertain environment.

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[17]A third possible explanation, the peanut seed-labor linkage, was examined in Chapter III.

[18]One can argue that specialization among different crops takes case within households when coalitions are formed (see Ch. II). It is not clear whether this occurs because of gains from specialization as such or because low profitability and market uncertainty, for example, in food markets, leads non-family workers to almost exclusively grow cash crops. This may imply that contract enforcement is less costly within than between households.

The remainder of this section is organized as follows. Section 4.3.2. more precisely defines economies of scope and various cost measures associated with multiple output firms. Section 4.3.3. discusses the translog cost function used for estimation purposes, and section 4.3.4. presents the empirical results and interpretation of the findings.

4.3.2. Cost Measures for Multiproduct Firms

Following Panzar and Willig (1981), let $Y=(Y_1,...,Y_n)$ represent the firm's vector of output levels produced out of the product set $N=\{1,...,n\}$, and Y_s an n-dimensional vector, the elements of which equal those of Y if the product is produced (i.e., for $i\in S \subset N$) and 0 otherwise (i.e., for $i\notin S$). $C(Y,W)$ measures the (minimal) cost of producing Y given input prices W, while $C(Y_s,W)$ reflects the cost of producing output vector Y_s.

Definition (Panzar and Willig, p.268-7): Let $T=\{T_1,...,T_k\}$ denote a non-trivial partition of $S \subseteq N$. That is, $\cup_i T_i = S$, $T_i \cap T_j = \emptyset$ for $i \neq j$, $T_i \neq \emptyset$, and $k>1$. There are economies of scope at Y_s and at factor prices W with respect to the partition T if

$$(1) \qquad \sum_{i=1}^{k} C(Y_{Ti},W) > C(Y_s,W).$$

Using the convention that $Y_i=(0,...0,y_i,0,...0)$ denotes a non-negative orthogonal vector, while Y represents a vector of all Y_i vectors, an equivalent condition for the existence of economies of scale is (suppressing W),

$$(2) \qquad (EOS > 0) \Leftrightarrow \frac{\Sigma_i C(Y_i) - C(Y)}{C(Y)} > 0$$

This means it is cheaper to produce n products in one single firm rather than producing only one distinct product in any of n separate firms, if the technology is such that it exhibits economies of scope.

Product-specific economies of scale are calculated as

(3) $PSE_i = AIC(Y_i)/MC(Y_i) = AIC(Y_i)/(\delta C(Y)/\delta y_i)$,

where MC is the marginal cost of producing Y_i, and AIC is average incremental cost, or

(4) $AIC(Y_i) = IC(Y_i)/y_i$,

where y_i represents the (scalar) quantity of Y_i produced, and $IC(Y_i)$ the incremental cost of producing Y_i, defined as

(5) $IC(Y_i) = C(Y) - C(Y - Y_i)$.

Multiproduct scale economies can be calculated as

(6) $MPSE = 1 - \Sigma_i \delta \ln C(Y)/\delta \ln y_i$.

Multiproduct scale economies exist if MPSE > 0, while the existence of product-specific scale economies requires PSE > 1. These measures are discussed in more detail in Baumol, Panzar and Willig (1982); Willig (1979); and Panzar and Willig (1977). For a recent application to retail-level fertilizer firms see Akridge and Hertel (1986).

4.3.3. The Translog Cost Function

The translog cost function can serve as a local second-order approximation to any arbitrary cost function (see e.g., Varian, 1984; or Binswanger, 1974 for a derivation of the associated Taylor series expansion); with appropriate restrictions (see below), the function satisfies linear homogeneity in input prices and with respect to outputs (in the multiproduct case); and it is relatively parsimonious in terms of the parameters to be estimated (Caves, Cristensen and Tretheway, 1980). One drawback of the function is that it does not permit zero quantities since the regressors enter in logarithmic form. In the estimation this problem is circumvented by replacing $Y_i = 0$ with the value 0.10.[19] To facilitate the interpretation of the coefficients, and following common practice, the

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[19] Caves et al. (1980, p.479) suggest using the Box-Cox metric $f_i(Y_i) = (Y_i^{\tau} - 1)/\tau$ for $\tau \to 0$ to circumvent this problem.

exogenous variables are normalized around their geometric means (Akridge and Hertel; Kim and Ben-Zion, 1989).

Given the quantities,

Y = a vector of n outputs;

W = a vector of p variable input prices;

F = a vector of r fixed factors; and total variable costs

$C(Y,W,F) = \Sigma_p w_p x_p$,

where x_p is the p-th variable input, the translog variable cost function is written as

$$(7)\quad \ln C(Y,W,F) = \alpha_o + \Sigma_n \alpha_n \ln Y_n + \Sigma_p \beta_p \ln W_p + \Sigma_r \mu_r \ln F_r +$$
$$\tfrac{1}{2}[\Sigma_n \Sigma_m A_{nm} \ln Y_n \ln Y_m + \Sigma_p \Sigma_q B_{pq} \ln W_p \ln W_q + \Sigma_r \Sigma_s C_{rs} \ln F_r \ln F_s] +$$
$$\Sigma_n \Sigma_p D_{np} \ln Y_n \ln W_p + \Sigma_n \Sigma_r E_{nr} \ln Y_n \ln F_r + \Sigma_p \Sigma_r G_{pr} \ln W_p \ln F_r + \epsilon$$

As discussed in Brown, Caves and Christensen (1979, p.259), linear homogeneity in factor prices is imposed with the restrictions

$$(8)\quad \Sigma_p \beta_p = 1; \quad \Sigma B_{qp} = 0; \quad \text{for } p=1,\ldots,n \text{ and } q=1,\ldots,m$$
$$\Sigma_q D_{pq} = 0.$$

To ensure linear homogeneity in outputs and fixed factors, similar restrictions (some redundant with (8)) are imposed on the following coefficients:

$$(9)\quad \Sigma_n A_{nm} = \Sigma_n D_{np} = \Sigma_n E_{nr} = 0.$$

4.3.4. Estimation, Results and Discussion

Two outputs (Y_1,Y_2), one variable input price (W) and one fixed factor (F) were used in the estimation (Table 4-17). The calculations for these variables are shown in Appendix A-5. Since it is not possible to treat the outputs as strictly exogenous, a two-stage estimation method was applied and predicted values of (Y_1,Y_2) were used in estimating the cost function.

TABLE 4-17: COST FUNCTION STATISTICS FOR AGRICULTURAL HOUSEHOLDS

Variable[a]	Mean	Standard Deviation	Minimum[b]	Maximum	Geometric Mean
			in FCFA		
Variable Costs	331,186	205,510	55,100	1,108,512	278,097
Food Crop Output[c]	157,875	102,543	25,123	518,234	128,700
Cash Crop Output[c]	210,034	219,097	.10	1,292,813	111,848
Wage Rate[d]	396	83	257	534	387
Fixed Capital	30,955	34,679	.10	165,367	756

Source: ISRA/MSU FSP Surveys, 1986/7
Number of Observations = 145.00
a. All values expressed in FCFA; see Appendix A-5 for calculations.
b. Zero values recoded as 0.100 to compute logarithm.
c. Predicted values from another regression.
d. Per unit of four hours.

Coefficient estimates for the cost function are presented in Table 4-18. As expected, both α_i values are positive and statistically significant, indicating total variable costs would increase with increases in the production of either crop (as expected). Short-run average cost curves are U-shaped since the positive (albeit statistically insignificant at the 5% level) A_{ii} values imply $\delta MC_i/\delta y_i > 0$ at the geometric means; the positive β shows the cost function monotonically increases in input prices; while the negative sign of μ (although the parameter estimate is insignificant at the 5% level) suggests households are in long-run equilibrium with respect to the use of fixed factors (see also Akridge and Hertel, 1986). Hence for this sample the coefficient estimates of A_{ii} and μ are of the expected sign but not statistically different from zero.

Producing both food and cash crops in the same household results in a 22.3% cost saving relative to producing the same quantities in two separate (specialized) households (Table 4-19). The average incremental cost of food production are less than marginal costs of food production, while average incremental costs of cash crop production exceed marginal costs of producing cash crops. This implies that for the average

TABLE 4-18: OLS COEFFICIENT ESTIMATES FOR THE TRANSLOG COST FUNCTION

Variable[a]		Parameter Estimate[b]	t-statistic
Intercept		12.387	61.050**
$\ln Y_1$	α_1	.640	5.081**
$\ln Y_2$	α_2	.128	2.311*
$\ln P^2$	B	1.029	5.419**
$\ln F$	μ	-.00277	-.074
$\ln Y_1 \ln Y_1$	A_{11}	.138	.481
$\ln Y_1 \ln Y_2$	A_{12}	-.146	-.493
$\ln Y_2 \ln Y_2$	A_{22}	.00784	.588
$\ln P \ln P$	B	.134	.096
$\ln C \ln C$	C	.00567	.481
$\ln Y_1 \ln P$	D_1	1.011	3.817**
$\ln Y_2 \ln P$	D_2	-1.011	-3.817**
$\ln Y_1 \ln F$	E_1	.00593	.720
$\ln Y_2 \ln F$	E_1	-.00593	-.720
$\ln P \ln F$	G	-.0310	-.997
Number of observations			145
R Square			.594
Adjusted R Square			.561
Standard Error			.397
F =			17.702**

a. Y_1=food crop output; Y_2=cash crop output; P=labor wage rate; F=value of fixed capital.

b. *=significant at 5%; ** at 1 % or lower.

TABLE 4-19: COST MEASURES FOR HOUSEHOLD CASH AND FOOD CROP PRODUCTION
Cost Data are Measured in FCFA

Measure	Symbol	Product		Aggregate Output
		Food	Cash	
Stand-alone production cost	$C_v(Y_i)$	180,413	121,407	301,820
Joint production cost	$C_v(Y)$			246,732
Economies of scope	EOS			22.3%
Incremental cost	$IC(Y_i)$	125,325	63,319	
Average incremental cost	$AIC(Y_i)$	0.974	0.566	
Marginal cost	$MC(Y_i)$	1.227	0.283	
Product-specific economies	$PSE(Y_i)$	0.794	2.000	
Multiproduct scale economies	MPSE			0.231

Source: Tables 4-17 and 4-18.

household, reducing food production below and increasing cash crop production beyond the geometric mean would reduce average incremental costs of production (see also the estimates of the product-specific economies of scale). Conversely, inducing households to substitute food for cash crop production, as planned in the NAP, would lead to higher marginal costs of food production; equality of (observed) marginal revenue and cost would in that case require a higher output price. It is of course plausible that high transaction costs in risky markets mean that the observed market price of food does not adequately reflect the insurance value of food. The PSE estimates also show households are operating in the region of diseconomies of scale for food production, but economies of scale for cash crop production. Finally, the existence of multiproduct economies of scale (MPSE = 0.231 > 0) suggests a proportional increase in food and cash crop production would entail a less-than proportional increase in total variable costs.

4.4. SUMMARY AND CONCLUSION

A variety of crop and non-crop production strategies--beyond own-food production--are available to and pursued by households in southeastern Senegal. Not surprisingly, given the diversity of entitlements and resource ownership and use levels reported in Chapter III, there is considerable diversity in terms of household crop production levels. The use of animal draft technology appears to explain much of this difference, particularly in the southern study areas. Policies designed to raise rural welfare will have to take into account the diversity of resource ownership and the different food security strategies that households pursue as a result. The following chapter, for example, explores the potential for and the anticipated consequences of a floor price policy in view of the finding that nearly one-quarter of the households sampled produced insufficient quantities of coarse grains (and rice) to last them until the subsequent harvest. That chapter also attempts to discern how the different strategies contribute to household food security.

An examination of household cost functions yielded two important insights. First, estimates of marginal and average cost of production suggest that households are already producing "too much" food relative to cash crops, given observed relative prices and the structure of their cost functions. Encouraging them to grow more food crops--and less cash crops--would further distort this relationship. A plausible explanation given for this phenomenon is that recorded market prices of food (and cash) crops do not adequately reflect the insurance value to the household of having its own supply of food. Second, there are certain non-congested inputs on rural farms, and economies of scope are realized by producing both food and cash crops within the same household. These cost savings to households (and the nation) would be lost if they were somehow forced or induced to grow only food crops.

CHAPTER V

HOUSEHOLD MARKETING BEHAVIOR

Given the GOS's objective of stimulating marketed surpluses of coarse grains in southeastern Senegal, it is imperative to identify variables affecting the behavior of households in coarse grain markets, and their opinions of planned market reforms. This chapter describes the transactions behavior of households and examines post-production issues (consumption preferences, transformation or processing constraints, etc.) in Section 5.1., while Section 5.2 presents an improved method of estimating reduced form marketed surplus equations to explain household behavior in coarse grain cash markets in the presence of uncertainty and transactions costs. Section 5.3. summarizes the research findings.

5.1. TRANSACTIONS BEHAVIOR OF HOUSEHOLDS

Using survey data on both manifest and potential behavior, tabular analysis is used to describe households' behavior in coarse grain cash markets; to determine the food security situation of households before and after transfers; and to assess the uses and quantitative importance of revenues from cash crop and livestock sales, as well as off-farm activities, in assuring household food security. The data show households pursue a variety of strategies beyond own-production of food to achieve food security, "a fact that belies the conventional image of Sahelian peasants as autarkic agriculturalists" (Reardon et al., 1988, p. 1065). Since consumption preferences, perceived storage and processing problems may influence the cereals consumption mix of households, data are also presented on this subject, with a special focus on maize.

The special role of rice imported unofficially from the Gambia is examined, and an attempt is made to determine whether rice is a food security or a status good. Finally, opinion questions about market reform and potential responses are used both to

verify manifest behavioral data, and to inform policy makers about households' anticipated responses to output market reform.

5.1.1. Households' Coarse Grain Cash Market Position

As reported, many households failed to produce sufficient quantities of cereals to last them until the subsequent harvest (Ch. IV). The shortfall in production induced as many as 30% of the households to enter coarse grain markets as net buyers in the 10 month period following the 1986 harvest (Table 5-1). Nearly 40% of the households failed to participate in coarse grain cash markets altogether.[1] In contrast, most households (79%) purchased rice, most of which was imported privately from the Gambia (originating in Asia). Also, 42% of the households with food production shortfalls did not enter cash markets to purchase coarse grains. As argued in Section 5.2., this phenomenon is largely explained by prohibitive (transactions) costs, especially in the more isolated southern areas, involved in articulating supply and demand of individual

TABLE 5-1: COARSE GRAIN MARKET PARTICIPATION PROFILE
(Standard Error)

Study Region and Rainfall	Percent of Households and Avg. Quan. Net Buyer %	Net Buyer kgs	Not in the Market %	Net Seller %	Net Seller kgs	Percent of Production Marketed %
North/550mm	20	243 (95)	21	59	339 (57)	8
South/900mm	38	332 (67)	53	9	279 (118)	2
Total	32	308 (55)	40	29	327 (51)	5

Source: ISRA/MSU Food Security Project Surveys (1986/87).

[1] In one triad (Sare Yoba Diega), where livestock sales are important, virtually no cash transactions were observed in coarse grain markets.

households for coarse grains through cash market transactions.[2] On average only a small percentage (5% for the overall sample) of total production found its way into rural cash markets.

Market sales were concentrated in a small proportion of households, with 50%, 70% and 80% of total sales by volume effected by 7, 11 and 15% of all households. The short run implication of these findings for food price policy is obvious. An effective higher cereals floor price would have only narrow distributional benefits, and would likely impose substantial costs on rural households relying on markets to purchase food.

Table 5-2 presents the unambiguous buy-sell market position of households during the transaction period surveyed, and also displays information about selected household characteristics of the various groups. In particular, instead of looking at only net positions, households are divided into those that only bought (26% of the sample), only sold (24%), did not participate in coarse grain markets (40%), and those that both bought and sold coarse grains (10%). Thus from the group of net buyers (32% of the sample) and net sellers (29%) identified in Table 5-1 we can "extract" those that only bought, and those that both bought and sold but on net were nevertheless net buyers. The results show households only buying coarse grains during the 1987 dry season (period a, see Ch. II) lived in market areas (triads) where they on average faced a 10 FCFA/kg higher price than did selling households in their market areas. This price was 3 FCFA above the floor price, which raises the possibility that buying households already face higher buying prices than do selling households, and that they may at least in the short run have difficulty responding to a higher floor price offered as a production incentive. In fact, it is not known whether these buying households also expected to face higher prices, and the results have to be viewed with caution since only aggregate prices

[2]It is nevertheless surprising that even transactions within villages were absent in the Sare Yoba Diega triad.

TABLE 5-2: FARM HOUSEHOLD CHARACTERISTICS AND COARSE GRAIN[a] CASH MARKET POSITION: 1986/7; 10 MONTHS
(Standard Errors)

Household Characteristic	Coarse Grain Market Position: Buy Only	Not in Market	Sell Only	Sell & Buy
Households (%)	26	40	24	10
Quantity of per capita CG sold [bought]; in kgs	[42]	--	64	8
	(7)		(16)	(10)
Average coarse grain market price; in FCFA/kg	73	66	63	64
	(3)	(2)	(1)	(2)
Average rice market price; in FCFA/kg	169	168	149	152
	(2)	(2)	(3)	(4)
Percent Fully equipped[c]	40	40	66	71
	(8)	(7)	(8)	(13)
Value of equipment per active worker; in FCFA	2160	2870	3130	3300
	(447)	(438)	(440)	(652)
Fulani Ethnic Group; in percent[c]	76	60	46	36
	(7)	(7)	(9)	(13)
Mechanical transformation technology available[c]	5	9	26	0
	(4)	(4)	(7)	(0)
Per capita Coarse Grains produced/1986; in kgs	145	240	374	247
	(18)	(26)	(43)	(30)
Per capita cash crop produced/1986; in '000 FCFA	17	36	29	36
	(3)	(5)	(5)	(8)
Coarse grains stocks/capita as of July 1987; in kgs	22	46	64	45
	(4)	(7)	(11)	(9)
Estimated utilization[d] of cereals/capita; kgs	181	166	190	205
	(13)	(12)	(15)	(21)
1985 CG production lasted < 9 months [%][c]	68	51	29	29
	(8)	(7)	(8)	(13)
1987 CG area seeded < HH consumption needs [%][c]	66	48	11	27
	(8)	(7)	(5)	(12)

Source: ISRA/MSU FSP Surveys, 1986/7
Notes: a. Coarse Grains are millet, sorghum and maize
b. Number of households is 39; 61; 36; 15, respectively.
c. Percentages refer to the percent of households per stratum.
d. See Table 5-4, note (6), for calculations.

from five market areas are available in this study. Nevertheless, the findings tend to support the assertion that some households in southeastern Senegal will have difficulty responding to floor price incentives in the short run.[3] More applied research that generates transaction-level prices would be required to confirm or refute this assertion. Households selling coarse grains were also exposed to lower rice prices than buying households (on average 20 FCFA/kg lower), suggesting they were selling coarse grains to purchase rice as a preferred staple.

Examining the information in Table 5-2 about other household characteristics, it is not clear whether or not draft equipment ownership, or the value of equipment per active worker affects a household's market position. The data do suggest, however, that selling households are somewhat more likely to be fully equipped and to own more equipment per active worker. Since fully equipped households grow more cash crops (Ch. IV), they may not have to enter coarse grain cash markets to meet cash needs. In contrast, households borrowing equipment may enter these markets to repay debts from borrowing equipment.

Members of the Fulani ethnic group are more likely to buy coarse grains, indicating that traditional livestock herders were liquidating livestock holdings to purchase coarse grains (Section 5.1.3.). Households selling coarse grains are more likely to live in villages with access to mechanical coarse grain processing facilities (within a 10 kilometers radius). Availability of this threshing machines, which may reduce the cost of threshing coarse grains relative to manual methods, is potentially important since cereals

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[3]Agricultural credit is limited so that households are generally unable to capitalize higher future food prices into current period inputs; since buying households also rely on markets to buy food, a higher buying price could set off a vicious circle from which it is difficult to escape. Private credit taken out during the growing season is used primarily for short-term consumption purposes, and thus serving to increase labor productivity, but not to increase non-labor inputs. Thus higher coarse grain prices would make it more expensive to increase production because of the increased cost of labor paid for in the form of food.

enter cash markets in threshed form (early harvested "green" maize, eaten on the husk during the hungry season is an exception).[4]

Results in Table 5-2 also show that the average quantity of coarse grains produced per capita was lowest among households only buying coarse grains. Similarly, ending stocks of coarse grains, including seed, tended to be lowest for households only buying coarse grains. The estimated per capita availability of all cereals (including rice) was similar for buying and selling households, but lower for households not participating in the market.

The last two rows in Table 5-2 provide further potential insights into the ability of households to adjust to a floor price incentive. Households which sell only--i.e., those able to benefit from a higher floor price if and when it was effective--were apparently able to increase their area seeded to coarse grains over the period 1985-87, with the proportion of households not producing enough food to meet their consumption needs in that category dropping from 29 to 11% (in contrast, these proportions remained fairly stable among households in the other market position categories). This may reflect investments in coarse grain production facilitated by the floor price, which prevailed to different degrees of effectiveness in the northern areas (the group of sellers on average nevertheless faced a price 7 FCFA/kg below the official price of 70 FCFA/kg in 1987).

An often-mentioned phenomenon in African agriculture is the selling of food at depressed prices soon after harvest to generate cash, which is used in turn to pay off debts incurred during the hungry season and/or to meet other cash needs. More often than not, households following this strategy are said to have to buy back food later on in the season (perhaps using income earned during the dry season) at a higher price which reflects storage costs. The results shown in Table 5-2 make it clear that this

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[4]See also Holtzman (1989).

phenomenon pertains at most to only a small group of households. The 10% of the sample (15 households) that both sold and bought coarse grains during the survey period, were scrutinized to determine whether they were pursuing this strategy of "forced" sales, or whether they were responding to NAP incentives of liberalized cereals trade and becoming cereals traders.

The results presented in Appendix A-6 generally suggest that the hypothesis of "forced" sales, even for this relatively small group of households, is not confirmed in southeastern Senegal. Only about one-third of this group of households do indeed appear to sell cereals soon after harvest and then buy back more cereals later in the season. To delve further into this question, the 15 households in the buy-and-sell category were split into net buyers and net sellers (see the table in Appendix A-6). The general conclusion from this table is that these households are (on average) quite well off in terms of the indicators listed (equipment value per worker, value of cash crops produced and the estimated availability of cereals per capita) relative to the households in the "buy only" category. Of the households that both buy and sell coarse grains, net sellers tend to be more equipped (they exhibit the highest mean of all groups), produce more food and cash crops, and are less likely to be of the Fulani ethnic group in comparison to the net buyers. Nevertheless, the estimated cereals availability is virtually the same in both cases.

5.1.2. Food Availability Before and After Transfers; Stocks

Since many households in southeastern Senegal failed to achieve food production sufficiency in 1986, this section investigates how households assured food consumption security.[5] Table 5-3 shows the relationship between the food production security of a

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[5]Food consumption security is achieved through own-production of cereals and other entitlements permitting access to food (following Sen, 1987). As suggested in Ch. II, food consumption and food production security are two distinct concepts.

household and its net coarse grain market position. Buying households are more likely to have low production per capita, but this relationship is not always clear-cut (i.e., households may also rely on barter trade and gifts to make up the food production deficit). The table also shows that some households with medium and high levels of production per capita become buyers of food (in other words, food buying households are not exclusively low producing households).

TABLE 5-3: RELATIONSHIP BETWEEN HOUSEHOLD FOOD PRODUCTION SUFFICIENCY STATUS AND NET COARSE GRAINS MARKET POSITION

Household Coarse Grain Market Position	Percent of Households[a]	Kilograms of all Cereals produced per Household Consumer: Low 0-160 kgs	Medium 161-300 kgs	High 301+ kgs	Total
Buy Only	26%	53%	37%	11%	100%
Not in Mkt.	40%	36%	29%	35%	100%
Sell Only	24%	9%	43%	49%	100%
Sell & Buy	10%	14%	57%	29%	100%
Percent of Households[a]	100%	32%	37%	31%	100%

Source: ISRA/MSU FSP Surveys, 1986/7
a. Total number of households is 142.

Crop disposal and acquisition behavior in the post-harvest period is further examined below along with household heads' stated reasons for selling cash and food crops. Anticipated short run consequences and problems of implementing an effective floor price are also identified.

The coarse grains production deficit in the southern areas was on average made up for through purchases of coarse grains and--mostly Gambian--rice (Table 5-4). Although equipment borrowers in the north on average produced and sold more cereals

TABLE 5-4: HOUSEHOLD CEREALS TRANSACTIONS, RELATED TO REGION AND EQUIPMENT USE, 1986/7 (10-MONTHS)[a]

Study Region and Eqpmt.	1986 Production of all Cereals/AEC (1)	Cereals Transactions per AEC[b] Net Sales Coarse Grains (2)	Net Sales Rice (3)	Net Other Out (4)	Stock July 1987 (5)	Estim. Utilization (6)
North						
Borrower	376	26	-10	52	119	189
Fully Eq.	283	16	-19	34	65	189
South						
Non-User	158	-20	-28	11	28	167
Borrower	188	-15	-20	19	28	175
Fully Eq.	195	-23	-10	24	30	174
Avg.Smpl.	227	-4	-19	26	45	181

Source: ISRA/MSU Food Security Project Surveys (1986/87)

Notes:
a. Data are for a subset of 109 valid households; survey period is harvest (October/November) 1986 through July 1987.
b. Adult-equivalent consumers are computed using the following weights: adult 15 years + = 1.0, child 5-14 = 0.5, and infant 0-4 = 0.25. Nawetaans and their family members = 0.4 (4.8 months/year) adult consumer equivalents.
(1) Includes coarse grains and rice. Coarse grains are converted into consumable product equivalents assuming a 78 % transformation rate for millet, sorghum and maize (FAO, 1984). Milled rice-equivalents are obtained assuming a 65 % conversion rate between paddy and dehulled rice. For the sample, there are .75 adult equivalent consumers per capita (i.e., head or person). Consequently, when pro-rated to 12 months, the above estimated utilization data are roughly comparable with (unshelled) coarse grain consumption per capita per annum (see also Note (6)).
(2) and (3) Net sales are sales minus purchases.
(4) Barter, gifts and loans and (5) include CPE millet-sorghum-maize and rice.
(6) Calculated as production - all net transfers out - stocks as of July 1987 = estimated utilization over 10-months. The calculation assumes no carry-over stocks from 1985 and does not account for harvest and storage losses. See also Note (1).

per capita (adult-consumer-equivalent) than did fully equipped households, the means have to be interpreted with caution owing to large standard errors (also, less than 30% of the northern sample were in this equipment category). In the southern area, conversion of equipment non-users to users would appear to increase cereals production per capita but not alter average quantities of coarse grains purchased significantly. At the same time it is interesting to note the relationship between rice purchases and equipment classification in the southern area. Northern households that borrowed equipment exhibited the largest ending stocks (in July) and on average achieved an estimated utilization level identical to that of fully equipped households.

Average estimated revenues from sales of cash crops (FCFA 30,200/AEC in the north, FCFA 16,900/AEC in the south) in principle provided food production-deficit households with enough cash income to become food consumption-secure by purchasing cereals. However, households must allocate cash between food and non-food expenditures, which together are estimated at FCFA 30,000/AEC for a typical household[6]. Sales of livestock, barter of goods and services and income from non-farm activities provided additional means of obtaining food (see Section 5.1.3).

Ten percent of the southern households entered cash markets to acquire more than 50% of their estimated cereals disappearance (both rice and coarse grains).[7] Forty percent of the southern households acquired 20% or more of their disappearance in this manner. In comparison, only 10% of the northern households are estimated to have relied on cash market transactions to acquire 20% or more of their disappearance during the 10-month post-harvest survey period (through July, 1987).

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[6]Based on a survey of village chiefs in the sample. Excludes rural taxes and large expenditure items such as marriages.

[7]Availability estimates assume no storage losses and zero beginning stocks. Ending stocks (July) are included in the calculations.

Table 5-5 provides averages for household crop transactions and the estimated disappearance of coarse grains according to households' food production status. It appears that households in the low-producing category produce proportionately more rice than do households in the high-producing category. This could be related to labor constraints within the household (as mentioned earlier). Households in the medium own-production category on average sold a small amount of coarse grains, while rice purchases are on average similar for each category. Per AEC cash crop sales (and production) tend to increase from low to high food-producing households, and households in the low category tend to sell a smaller proportion of their peanuts. It is conceivable that these households must retain their own peanut seed since they can not (or can perhaps no longer) rely on the parastatal (SONACOS) to provide them with seed.[8] Finally, the estimated disappearance (consumption) of all cereals per capita increases significantly across the three categories. This implies access to cereals via own production is important in the survey areas. Viewed alternatively, relaxing production constraints is likely to significantly relax consumption constraints. In terms of the cash crop-food crop "debate" it is also noteworthy that households in the high food own-production category sell (and grow) significantly more cash crops than do households in the other two categories. This in turn suggests that the expansion of food crop production over time goes hand in hand with increased cash crop production (and vice versa).

Although rural head taxes, estimated at 1000 FCFA per active worker regardless of age and gender, are small relative to the average value of all (cash and food) crops sold, survey results reported in Table 5-6 show they are the most important first reason

[8]This may be related to past debt repayment problems and/or lack of collateral in these households.

TABLE 5-5: HOUSEHOLD MARKETING AND ESTIMATED CONSUMPTION CHARACTERISTICS (PER AEC) ASSOCIATED WITH HOUSEHOLDS' FOOD PRODUCTION SUFFICIENCY STATUS
(Standard Errors)

Per AEC for all Continuous Variables	Kilograms of all Cereals Produced per Household Consumer			Total
	Low 0-160 kgs	Medium 161-300 kgs	High 301+ kgs	
Percent of HHs	32%	37%	31%	100%
Cereals Output in kgs	98	231	487	268
	(6)	(6)	(32)	(17)
Percent of which is Rice (South)	24%	18%	13%	20%
	(5)	(2)	(4)	(2)
Net CG Sales & [Purchases], kgs	[22]	4	35	5
	(6)	(6)	(14)	(5)
Rice Purchases (Net) in kgs	20	16	21	19
	(5)	(2)	(4)	(2)
Cash Crop Sales (Net) in FCFA[a]	12558	22291	38298	24260
	(1783)	(2793)	(5313)	(2212)
Pcnt.of Peanut Production Sold	58	73	69	67
	(5)	(3)	(3)	(2)
Kg Disappearance of all cereals {10 Months}	125	182	260	181
	(10)	(7)	(12)	(7)

Source: ISRA/MSU FSP Surveys, 1986/7
Note: See Notes to Table 5-4 for the interpretation of AECs and disappearance (or utilization) estimates.
a. Excludes 4 households claiming to be net buyers of cash crops.

TABLE 5-6: FIRST REASON FOR CROP SALES, 1986/7; 10 MONTHS

First Reason	Percent of Responses		Total	
	Food Crop[a]	Cash Crop[b]	N	%
Pay Taxes	8	36	57	29
Social/Ceremony	32	19	44	22
Reimburse Debts	12	22	39	20
Buy Consumer Goods	14	10	22	11
Buy Cereals (Rice)	18	5	17	9
Agric. Investment	6	2	6	3
Other Reason	10	5	12	6

Source: ISRA/MSU Food Security Project Surveys (1986/87)
Notes: (a)=millet, sorghum, maize; (b)=peanuts and cotton.
Based on the first reason advanced by respondents.

given by household heads for selling peanuts and cotton.[9] This suggests that rural taxes are one reason for growing cash crops, possibly detracting from the production of cereals which historically have not had reliable market outlets. If one excludes 12 (7%) households claiming not to have sold any crops during the survey period, the value of taxes paid exceeded 20% of the gross value of all crops sold in 10% of the households. Sales of food for "social and ceremonial" reasons suggest some households use cereals to meet unexpected cash needs (deaths, medical bills, helping relatives), but do not plan to sell cereals.

Table 5-7 shows the incidence of taxes on households according to their food production security and coarse grain market participation status. Head taxes represented a larger percentage of the value of coarse grain transactions, cash crop sales and total crop production in households producing low amounts of cereals. The tax burden on average exceeded 75% of the amount spent on food for households only buying food.

[9]Farmers sell peanuts at government-subsidized prices. This raises the question whether both taxes and subsidies should be reduced, and what the consequences would be for different groups of farmers.

TABLE 5-7: INCIDENCE OF TAXES ON HOUSEHOLDS WITH DIFFERENT FOOD PRODUCTION SUFFICIENCY STATUS AND MARKET POSITION
(Standard Error)

	Kilograms of all Cereals produced per Consumer			Total
Head Taxes as a Percent of	Low 0-160	Medium 161-300	High 301+	
Net CG Sales [Purchases]	[27] (18)	[3] (32)	16 (19)	[5] (16)
Cash Crop Sales[a]	15 (6)	9 (2)	3 (0)	9 (2)
Total Crop Production[b]	5 (1)	2 (0)	1 (0)	2 (0)
	Coarse Grain Market Position			Total
	Buy Only	Sell Only	Buy & Sell	
Net CG Sales [Purchases]	[77] (19)	71 (15)	4 (59)	[5] (16)

Source: ISRA/MSU FSP Surveys, 1986/7

a. Average excludes 4 households claiming to be net buyers of cash crops (i.e., peanuts). Peanuts are valued at 90 FCFA/kg, cotton at 100 FCFA/kg (both are official prices).

b. Coarse grains are valued at prevailing average market prices, rice at 150 FCFA/kg.

Virtually all cash crop sales were completed prior to March 1987. In the northern areas farmers on average sold a larger quantity of cereals during the period harvest 1986-February 1987 (10 Kgs/AEC) than during March 1987-July 1987 (6 Kgs/AEC). Yet average cereals prices observed on rural markets were 10 FCFA/kg higher in the latter period (67 vs 57 FCFA/kg); see also Figures 5-1 and 5-2.[10] A likely explanation for this sales pattern is that some farmers need cash before the official cereals and peanut marketing seasons open and sell cereals during these periods of relatively low prices.[11] Enumerator estimates of total cereals quantities moving through the two northern markets[12] generally confirm this marketing pattern for millet and maize but not for sorghum (see Figures 5-1 and 5-3), which came from large sorghum producers outside the sample during February through July.[13] There is an inverse relationship between sales of cereals, distributed bi-modally around November through January and May, and peanut sales which peak during January-March.

The CSA had no grounds for purchasing cereals in the southern weekly markets, where households were on average net buyers of cereals, regardless of equipment use levels.[14] Purchased rice contributed significantly to the estimated total consumption of

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[10]See Goetz, April 1988, for price series of other crops.

[11]One function of the Food Security Commissariat (CSA) is to buy cereals from farmers at the official price (70 FCFA/kg). For logistical and other reasons it began purchasing cereals in the research areas in January 1987, roughly two months after the cereals harvest.

[12]Estimates of this kind are characterized by measurement problems and the data should be viewed as indicative of seasonal patterns.

[13]Some of the sorghum was attracted from the Gambia by the floor price.

[14]There were some sales by surplus producers, but most of these took place directly between farmers. One exception is the Medina Yoro Foulah area (outside the sample) which produced surpluses of cereals for export from the area; here the CSA failed to intervene because prices were close to the official floor price and because Gambian coarse grains were brought to the markets.

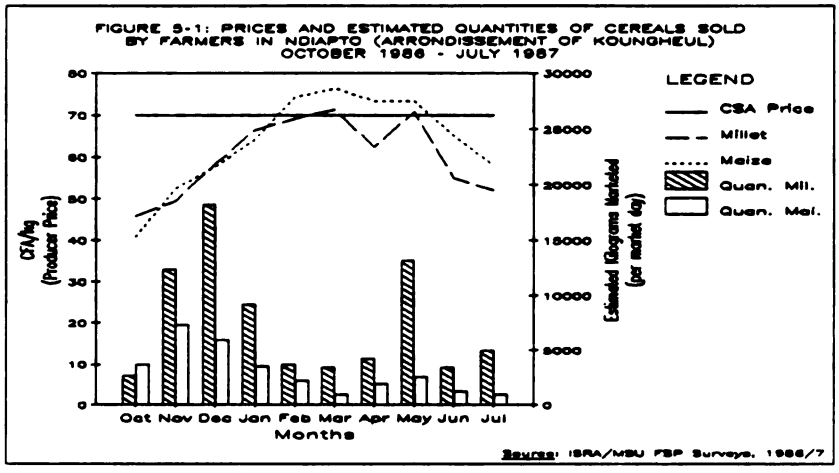
FIGURE 5-1: PRICES AND ESTIMATED QUANTITIES OF CEREALS SOLD BY FARMERS IN NDIAPTO (ARRONDISSEMENT OF KOUNGHEUL) OCTOBER 1986 - JULY 1987
LEGEND
CSA Price
Millet
Maize
Quan. Mil.
Quan. Mai.
CFA/kg (Producer Price)
Estimated (Kilograms Marketed (per market day)
Oct Nov Dec Jan Feb Mar Apr May Jun Jul
Months
Source: ISRA/MSU FSP Surveys, 1986/7

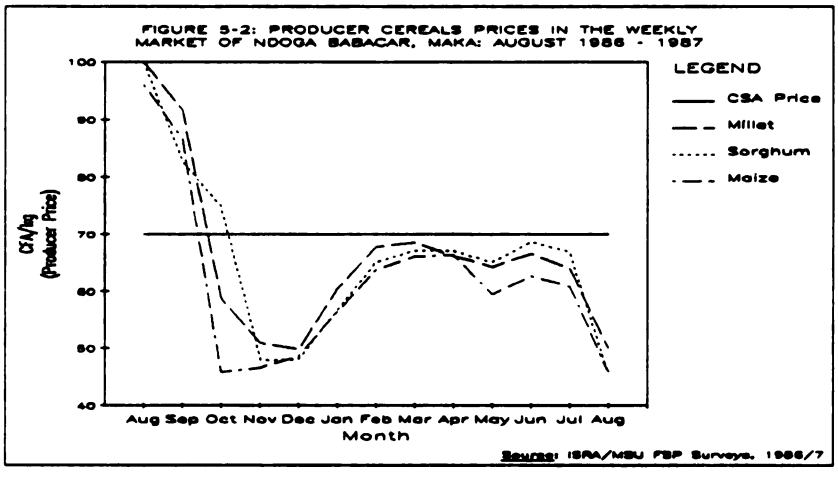
FIGURE 5-2: PRODUCER CEREALS PRICES IN THE WEEKLY MARKET OF NDOGA BABACAR, MAKA: AUGUST 1986 - 1987
LEGEND
CSA Price
Millet
Sorghum
Maize
CFA/kg (Producer Price)
Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug
Month
Source: ISRA/MSU FSP Surveys, 1986/7

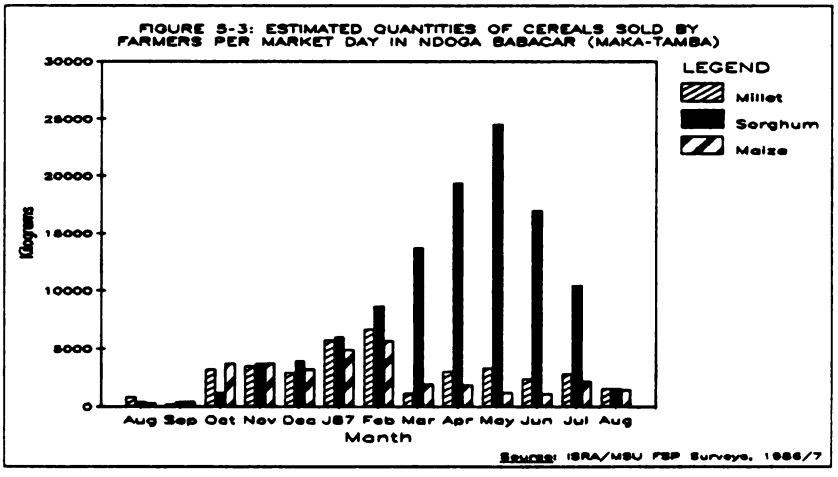
FIGURE 5-3: ESTIMATED QUANTITIES OF CEREALS SOLD BY FARMERS PER MARKET DAY IN NDOGA BABACAR (MAKA-TAMBA)
LEGEND
Millet
Sorghum
Maize
Kilograms
Aug Sep Oct Nov Dec J87 Feb Mar Apr May Jun Jul Aug
Month
Source: ISRA/MSU FSP Surveys, 1986/7

rice in these southern households despite better-than-average rainfall. An estimated 13% of the rice consumed during the period Harvest 1986 - February 1987 was purchased.[15] During March-July 1987, this percentage is estimated to have risen to 72%. Equivalent percentages for coarse grain purchases in the southern areas during these two periods are 8 and 18%, respectively.

5.1.3. Cash Crop Sales, Livestock Sales and Off-Farm Activities

As suggested above, households have both food and cash needs, and cash crop sales--aside from serving to repay production credits to SONACOS or SODEFITEX--play an important role in meeting cash needs. On average 65% of the peanuts harvested were sold during the 10-month survey period (Table 5-5), the proportion being 100% in the case of cotton.

Reasons given for livestock sales three months prior to and during the 1986 rainy season (see Goetz with Dieng, March 1987, p. 29), suggest livestock serves an important role in assuring food security during the hungry season.[16] In the three month period preceding the hungry season, 28% of all livestock transactions were carried out to acquire cereals. In the hungry season that percentage rose to nearly 50% of all livestock transactions. Hence the motivation for selling livestock changes seasonally.

Sales of small ruminants and poultry during the 1987 dry season (approximately October/November 1986 through July 1987) appear to serve an important auxiliary role in meeting the cash needs of some households (Table 5-8). Households in the "low" producing category on average sold enough small ruminants and poultry to acquire 24

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[15]Calculations assume no carry-over stocks of rice from 1985 production, but include ending stocks.

[16]The importance of borrowing (private sector) cash to acquire food during the hungry season is reported in GH (May 1987, pp. 27 ff.): most loans were taken out during August (the peak of the hungry season), and in 57% of all cases the loans were used to purchase food.

TABLE 5-8: LIVESTOCK TRANSACTIONS AND FOOD PRODUCTION SUFFICIENCY STATUS
(Standard Error)

Livestock Transaction	Kilograms of all Cereals produced per Consumer		
	Low 0-160	Medium 161-300	High 301+
Small Ruminants and Poultry:[a]			
Net FCFA Sale [Purchase]	1696 (1568)	[2003] (1112)	690 (1940)
% Net Sellers[b]	27%	32%	32%
% Net Buyers	24%	42%	39%
Cattle (incl. draft)			
% Net Sellers	16%	21%	11%
% Net Buyers	4%	4%	11%
Horses			
% Net Sellers	2%	2%	11%
% Net Buyers	0%	6%	7%
Donkeys			
% Net Sellers	0%	0%	0%
% Net Buyers	2%	9%	14%

Source: ISRA/MSU FSP Surveys, 1986/7
a. Includes sheep, goats and poultry.
b. Percentages add up by column. For example, 80% of the households in the low food production category neither sold nor bought cattle.

kgs of coarse grains per adult-equivalent consumer (using the official price of 70 FCFA/kg). Nevertheless, 27% of the households in this category were also able to invest in this type of livestock. It is important to separate transactions involving small ruminants, poultry and cattle on the one hand, and net investments in draft animals (oxen, horses and donkeys), on the other. To this end Table 5-8 also shows the percentages of households investing in and selling off different types of draft animals. It is noteworthy that a larger proportion of farmers were sellers than buyers of cattle. This appears to reflect exports of cattle from the research area to urban consumption areas (Ziguinchor, Kaolack and Dakar). In contrast, donkeys were introduced into the research areas by traders from the Peanut Basin.

A similar picture emerges when livestock transactions are stratified by the coarse grain market participation status of the household (Table 5-9). Households only buying coarse grains on average sold off an amount of small ruminants and poultry corresponding to 10 kgs of coarse grains per adult-equivalent consumer. Surprisingly, the proportion of net buyers (34%) exceeded that of the net sellers (24%),however. At the same time, 21% of the households in this category did sell off cattle during the survey period.

An examination of the net per capita value of transactions involving all types of animals and livestock (including draft animals) reveals the following: southern households, Fulani households, households owning cattle and households without off-farm activities on average sold off more livestock than households without these characteristics (Table 5-10). As in the two preceding tables, the large standard errors suggest, however, that the averages have to be interpreted with caution. The data thus indicate that livestock plays an important role in the economic affairs of households in southeastern Senegal, and this sector should not be ignored when rural development policies are designed. Binswanger et al. maintain livestock is the only major means of long run

TABLE 5-9: LIVESTOCK TRANSACTIONS AND COARSE GRAIN MARKET PARTICIPATION
(Standard Error)

Livestock Transaction	CG Market Participation: Buy Only	Not in Market	Sell Only	Buy & Sell
Small Ruminants and Poultry:[a]				
Net FCFA Sale [Purchase]	693 (1211)	[541] (1561)	[2280] (2033)	5905 (2146)
% Net Sellers	24%	31%	43%	64%
% Net Buyers	34%	35%	26%	14%
Cattle (incl. draft)				
% Net Sellers	21%	16%	11%	14%
% Net Buyers	3%	7%	3%	14%
Horses				
% Net Sellers	0	2%	14%	7%
% Net Buyers	3%	7%	3%	0
Donkeys				
% Net Sellers	0	0	0	0
% Net Buyers	13%	6%	3%	21%

Source: ISRA/MSU FSP Surveys, 1986/7
a. In FCFA per adult equivalent consumer. Net sales are positive.

TABLE 5-10: PER CAPITA NET LIVESTOCK TRANSACTIONS BY HOUSEHOLD CHARACTERISTIC
(Standard Error)

Region		Ethnicity		Cattle Owner		Off-farm Activity	
North	South	Fulani	Other	Yes	No	Yes	No
---in FCFA---							
837	2367	4830	[2601]	4017	683	267	3879
(1748)	(2513)	(2076)	(1794)	(2085)	(2016)	(1987)	(2078)

Source: ISRA/MSU FSP Surveys, 1986/7
Note: Numbers in [] are net purchases

capital accumulation in African agriculture with its relatively land-abundant and climatically uncertain environments.

The "off-farm activity sector," encompassing many different economic activities, is hypothesized to be of an importance similar to that of the livestock sector. Household heads were asked who in their household pursues what type of off-farm activity, during which period(s) of the year, how the proceeds were used, and how much they contributed to the food needs of the household. Results shown in Table 5-11 suggest that

TABLE 5-11: OFF-FARM INCOME BY FOOD PRODUCTION SUFFICIENCY STATUS
(Standard Error)

	Kilograms of all Cereals produced per Consumer		
Per AEC Variable	Low 0-160	Medium 161-300	High 301+
	----% of households----		
Someone in HH Pursues an Off-Farm Activity	67 (7)	60 (7)	50 (8)
Household Head Pursues Activity	64 (7)	53 (7)	43 (8)

Source: ISRA/MSU FSP Surveys, 1986/7

households in the "low" production category were somewhat more likely to pursue an off-farm activity relative to households in the other categories. Also, the household head is more likely to be involved in the off-farm activity in the case of households in the "low" category.

Southern households are more likely to use proceeds from off-farm activities to acquire food and these proceeds are more likely to contribute more than half of the household's food during the period in which activities are carried out (Table 5-12). In cases where household heads pursue the activity proceeds are frequently used mainly or exclusively to acquire food.

TABLE 5-12: USES OF PROCEEDS FROM OFF-FARM ACTIVITIES AND CONTRIBUTION TO FOOD AVAILABILITY

	North		South		Total	
Use of proceeds						
Used only for food	6	9%	16	12%	22	11%
Used mainly for food	29	43%	81	62%	110	56%
Used mainly otherwise	23	34%	27	21%	50	25%
Not used for food	10	15%	6	5%	16	8%
TOTAL	68	100%	130	100%	198	100%
Contribution to food						
More than half	9	20%	47	54%	56	42%
Half	6	13%	8	9%	14	11%
Less than half	30	67%	32	37%	62	47%
TOTAL	45	100%	87	100%	132	100%

Source: ISRA/MSU FSP Surveys, 1986/7
Note: Data are for the subset of (132) households with at least one member pursuing an off-farm activity. "Use of proceeds" data are at the level of individual members pursuing an activity.

In the northern areas, households without off-farm activities sold nearly twice the amount of coarse grains per adult consumer equivalent as households with such activities. They also tended to have a marginally higher disappearance of cereals per capita.

In the southern areas, households with off-farm activities purchased two times the quantity of rice as households without such activities, and apparently experienced a slightly better cereals situation than did households without off-farm activities.

Off-farm activities are therefore also important in achieving household food security, and they may contribute to agricultural production by enabling investments in agricultural inputs. We will see off-farm activities increase the probability of coarse grain purchasing and sales. This is hypothesized to reflect both the increased willingness and ability of households to participate in coarse grain markets, and the increased market information available to these households.

5.1.4. Consumption Preferences; Storage and Processing Issues

To gauge farmers' preferences with respect to different cereals, and to anticipate potential demand-side problems of expanded maize production complementing results reported in Ch. IV, questionnaires were designed to elicit information on how, and why, farmers would chose among rice, millet, sorghum and maize if they had a choice. They were also asked about difficulties experienced with maize (and rice) storage and transformation. This section presents results from these questions, while Section 5.1.5. and 5.2.5. examine changes in rice consumption in 1986/87 over 1985/86 and attempts to determine whether or not rice serves as a status good or to achieve food security in the case of own-production short-falls.

[i] Unconstrained Cereals Choices. Table 5-13 shows the relative proportions of rice, millet, sorghum and maize household heads would on average have chosen "if they had not produced any cereals of their own, and had a choice of 10 sacks which were to last them until the next year's harvest".[17] With an average of 3.3 sacks, rice ranked as

[17]The requirement that the 10 sacks selected had to last for one year was added to incorporate storage problems with individual cereals. When farmers were subsequently asked about reasons for their choices, storability did not appear to have been a major consideration.

TABLE 5-13: UNCONSTRAINED CHOICE OF CEREALS FOR CONSUMPTION
(Standard Error)

	Region		Wolof		Fulani		Total
	North	South	No	Yes	No	Yes	
	----------Number of 50 kg Sacks----------						
Rice	3.4	3.3	3.3	3.6	3.6	3.2	3.3
	(.2)	(.2)	(.2)	(.3)	(.2)	(.2)	(.1)
Millet	3.0	2.4	2.5	3.6	3.2	2.3	2.7
	(.2)	(.2)	(.1)	(.4)	(.2)	(.2)	(.1)
Maize	2.1	2.3	2.3	1.6	2.0	2.3	2.2
	(.2)	(.2)	(.1)	(.3)	(.2)	(.1)	(.1)
Sorghum	1.5	2.0	1.9	1.1	1.3	2.1	1.8
	(.2)	(.1)	(.1)	(.3)	(.2)	(.2)	(.1)

Source: ISRA/MSU Food Security Project Surveys (1986/87)

the preferred cereal, while maize was preferred over sorghum in both areas. Requiring higher precipitation than millet, sorghum is grown mostly in the southern areas, and this tends to be reflected in the choices.[18] Wolof households (mostly in the north) also appear to prefer millet over sorghum, while Fulani households prefer sorghum, relative to members of other ethnic groups. Overall, maize does not appear to be perceived as an inferior consumption item, and it is important to note that there is a strong preference for a variety of cereals.

Households heads were also asked why they had made each particular choice. Among those selecting rice, roughly 50% responded that rice required less (or no) pounding labor relative to coarse grains and that it was preferred for meals taken at noon, visitors and special occasions. Non-rice cereals are usually threshed prior to

[18]Sorghum is viewed as somewhat inferior in the northern areas. Apparently the historical role of this cereal in these areas (where sorghum--and rice--were grown when rains were more plentiful) was to provide food to migrant farm workers from Mali.

placement in sacks; had they been offered to farmers in unthreshed form, the proportion favoring rice may have been higher. In contrast, households not choosing rice indicated that it required expensive supplementary ingredients such as oil and other condiments.

Millet and sorghum were preferred since it was perceived that they "remain in the stomach" for a longer period of time, and were therefore particularly suitable during the agricultural season.[19] Maize was preferred since it yielded more flour than other cereals, and because it tasted good when mixed with other cereals. Household heads were also asked whether they preferred whole or broken rice; red or white sorghum and yellow or white maize (Table 5-14). The first distinction tends to reflect preferences between local and imported rice,[20] while the latter are important from a production perspective: the physical characteristics of red sorghum make it less desirable for birds (it grows on husks with spikes which thwart bird attacks; and it tends to taste bitter owing to a high tannin content). White maize is harder and more resistant to insect attacks (and also provides higher yields) according to SODEFITEX extension agents and farmers interviewed informally in the areas. However, yellow maize tastes better than the more bland white maize, according to some of the farmers interviewed informally. All (100%) of the Wolof households preferred broken rice, while preferences of non-Wolof households were about equally divided between broken and whole rice. This may reflect the fact that Wolof households no longer grow rice, and have developed a preference for broken rice imported from Asia. Taken together, the results suggest that

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[19]The digestibility problem of millet (i.e., that it takes longer to digest than maize or rice), which reduces its consumption at noon in urban areas, therefore poses an advantage for manual workers in rural areas.

[20]At least in urban areas, Thai broken rice is preferred since the increased surface area more readily absorbs the sauce in the traditional thioboudienne dish.

TABLE 5-14: PREFERENCES AMONG CEREALS
Percent of Households

	Region		Total	
	North	South	N	%
Rice Preference				
Whole	14	67	95	45
Broken	84	32	113	54
Indiff.	2	1	3	1
Sorghum				
Red	3	15	21	10
White	97	85	189	90
Indiff.		1	1	0
Maize				
Yellow	15	20	38	18
White	78	77	163	77
Indiff.	7	3	10	5

Source: ISRA/MSU FSP Surveys (1986/87)

rural households prefer variety in their consumption of cereals. So long as markets for food remain unreliable, this may pose problems for a policy designed to induce farmers to grow only a particular crop, such as maize.

[ii] **Processing, Firewood and Storage Issues.** Most of the northern (89%) and three-quarters of the southern household heads reported that higher processing and firewood demands of maize preparation reduced their overall consumption of this cereal. Only 7% of the household heads--mostly in the north--had used a mechanical thresher to shell and process maize at least once during 1986/87. In contrast, 27% of the northern and 16% of the southern household heads had used a thresher to transform millet or sorghum. Slightly more than one-half of the northern and 85% of the southern respondents reported problems of storing maize (insects, rodents and humidity).

Two-thirds of the southern household heads also indicated that the task of processing paddy rice into an edible form prevented them from consuming more local

rice, which is mostly grown by farmers themselves.[21] Only 1 out of 124 southern household heads had used a thresher to process rice (provided by SODAGRI at Anambé). Southern household heads also reported storage problems with rice similar to those of maize. In the northern areas rice is not stored for extended periods. Higher processing and cooking requirements therefore tend to place maize at a disadvantage relative to rice and millet or sorghum. This problem warrants further attention by policy makers if maize production and consumption are to be expanded under the NAP.

5.1.5. The Special Role of Rice

Fifty-nine percent of the household heads reportedly increased, while 33% decreased their rice consumption in 1986/87 over 1985/86. Among those reporting increases in consumption, about one-half had produced more rice in 1986 (in the south), while the remainder had increased their purchases of rice from the Gambia. In households with reduced rice consumption, 12% reported a decline in their own production of rice, 8% reported a scarcity of rice in local markets, and 80% (mostly in the north) replied they had produced more coarse grains in 1986, thereby reducing the need to purchase rice. Since farmers were presumably still coping with the effects of the 1984 drought in 1985, this suggests that for some households Gambian rice was an important way of assuring household survival. The finding also indicates that in rural areas, in contrast to urban areas, coarse grains substitute substantially for rice.

To assess the independent effects of prices and income on rice purchases, a reduced form regression model was estimated. The specification of the reduced form and the results of the estimation are presented and discussed in Section 5.2.5. below along with the results of an estimated marketed surplus function for coarse grains.

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[21]Virtually none of the rice grown in the research areas entered cash markets.

5.1.6. Opinions of Market Reform

As the field work progressed, it became clear that the implementation of policy reforms which this research project was to monitor was lagging behind original time-tables.[22] Since this ruled out pre- and post-NAP comparisons of household behavior, opinion surveys were combined with surveys of potential behavior to anticipate potential problems with the NAP. The results, presented in this section, are also useful as a check on the reliability of the manifest data reported earlier.

To set the stage for this section, it is appropriate to consider the following opinions expressed by farm household heads:[23] ninety-nine percent agreed with each of the following statements:

a. household heads should produce sufficient cereals to feed other household members from one harvest period to the next;

b. it is better to grow one's own cereals to feed the household because it is difficult to save proceeds from sales of cash crops until the next year's hungry season; and

c. it is better to grow one's own cereals, because even if one had the financial means, one would not necessarily find cereals for consumption on the market.

For a farmer who believes all other producers think alike, a general corollary of these results is that it is unwise to produce cereals for sale in his or her area (see also the discussion in Section 4.1.5.).

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[22]In the southern areas the CSA failed to enter into action (and support producer prices) in rural markets due to a lack of marketed surpluses.

[23]Questions were phrased as follows: "Some farmers in the area say that ... Do you agree with this declaration"?

[i] **Opinions of Select Cereals Policy Measures.** Many household heads, particularly in the southern areas, were unaware of the producer floor price of 70 F/kg for cereals (Table 5-15). Responses tend to reflect whether or not the CSA actually operated in the area where the respondent lived.[24]

TABLE 5-15: KNOWLEDGE OF THE CEREALS FLOOR PRICE
(Three Years After its Announcement)
Percent of Households

Knowledge of 70 FCFA/kg Floor Price	North	South	Total	
Unknown	20%	76%	109	52%
Known	77%	22%	94	45%
Incorrect	3%	2%	5	2%

Source: ISRA/MSU FSP Surveys, 1986/7

Many farmers responded they would not change the area sown to cereals if the official price of cereals were raised to 100 F/kg, lowered to 50 F/kg, or if the official price were eliminated (Table 5-16).[25]

Some farmers reporting they would not respond to a price increase may have been thinking of intensifying cereals production; among those who would increase cereals area under any price policy scenario, many added that they attempt to increase the area cultivated to cereals each year, regardless of prices. A few (northern) farmers felt the floor price keeps prices artificially low.

For a variety of reasons, three-quarters (158/208) of the farm household heads feel the government ought to assure a minimum cereals price to farmers. Some favor

[24]The CSA operated only in northern markets during 1987.

[25]See Goetz, April 1988, for potential responses to peanut price changes.

TABLE 5-16: HOW HOUSEHOLD HEADS SAY THEY WOULD WOULD CHANGE AREAS SEEDED TO CEREALS UNDER DIFFERENT OFFICIAL PRICE POLICIES
Percent of Households

Alternative Policies		North	South	Total	
100 F/kg:	seed more	74%	64%	142	68%
	seed less	0%	0%	0	0%
50 F/kg:	seed more	9%	16%	27	13%
	seed less	22%	2%	21	10%
Eliminate Floor Price:	seed more	25%	30%	58	28%
	seed less	2%		2	1%

Source: ISRA/MSU FSP Surveys (1986/87)

this policy believing it will facilitate buying food by making cereals more available (Table 5-17).

Farmers in the southern areas on average felt the official minimum price should be higher than did their counterparts in the northern areas (Table 5-18). This may reflect their experience with historically higher cereal price levels in the area. In comparison, Appendix A-7 shows farmers' reservations prices for selling cereals out of storage during July 1987.

TABLE 5-18: PREFERRED FLOOR PRICE LEVEL BY AREA SEEDED TO CEREALS IN 1987, IN FCFA/KG
D=Deficit, SS=Self-sufficient, S=Surplus

	North			South			
	D	SS	S	D	SS	S	Total
Mean FCFA	63	75	81	86	87[a]	91	83
Std. Dev.	14	18	17	36	25	14	28
Valid N	6	24	39	72	29	6	176

Source: ISRA/MSU FSP Surveys (1986/87)
a. Data exclude 1 outlier of 500 FCFA/kg and are for farmers willing to state a price (85%).

TABLE 5-17: REASONS GIVEN FOR AND AGAINST A CEREALS FLOOR PRICE
Percent of Households Reporting

A. Favor Floor Price	Region N	Region S	Total	%
1. Provides a buying/selling reference point..	13	19	32	26%
2. All products sold on the market should have an official price.....	5	14	19	15%
3. Gives us more power relative to traders....	13	5	18	15%
4. Induces producers to grow many cereals.....	5	10	15	12%
5. Facilitates cereals trade	14	0	14	11%
6. Helps everyone to have cereals.....	3	6	9	7%
7. Helps us plan our production.....	0	5	5	4%
8. Stabilizes cereals trade.....	4	0	4	3%
9. Cereals are our basic staple and must not be sold at a high price.....	1	2	3	2%
10. Provides us with cash income.....	1	1	2	2%
11. Helps us buy a large quantity of cereals...	1	1	2	2%
Total valid responses:	60	63	123	100

B. Disfavor Floor Price	Region N	Region S	Total	%
1. Favor free trade in cereals (without public price policy).....	3	10	13	39%
2. Producers should fix prices themselves.....	1	9	10	30%
3. The price will be too low.....	8	0	8	24%
4. The price will be too high.....	2	0	2	6%
Total valid responses:	14	19	33	100

Source: ISRA/MSU Food Security Project Surveys (1986/87)
Based on Open-Ended Questions
Note: Only a total of 156 valid responses were received to this open-ended question.

Household heads living in satellite villages were generally divided on whether or not the distance to the nearest cereals market outlet prevented them from marketing more cereals (Table 5-19). There are differences by triad, with all producers in the Diaobe area responding that market access was a constraint.

TABLE 5-19: MARKET ACCESS AS A CONSTRAINT TO SELLING MORE CEREALS

Research Triad	Poor Access		Good Access		Total Percent	
	No	Yes	No	Yes	No	Yes
	--# of Households-					
Ndiapto	2	9	5	5	33%	67%
Ndoga	8	5	7	4	62%	38%
Diaobe	0	11	0	7	0%	100%
Sandio	6	5	7	1	68%	32%
Diega	10	1	10	0	95%	5%

Source: ISRA/MSU Food Security Project Surveys (1986/87)

Many respondents in the northern area favor the policy of free cereals trade (Table 5-20). Table 5-21 gives reasons for this preference. As in the case of a cereals floor price, some household heads favor this policy because they believe it would facilitate buying cereals.

TABLE 5-20: DESIRABILITY OF FREE CEREALS TRADE

Opinion	North	South	Total N	Total %
	% of Households			
Disfavor	18%	53%	79	38%
Favor	67%	43%	110	53%
Don't care	15%	4%	18	9%

Source: ISRA/MSU FSP Surveys (1986/87)

TABLE 5-21: REASONS FOR AND AGAINST FREE CEREALS TRADE
Percent of Households Reporting

A. Favor Free Cereals Trade	Region N	Region S	Total	%
1. All areas will be supplied with cereals....	20	2	22	25%
2. One can profit from cereals sales.....	17	2	19	22%
3. It will be easy to get cash for cereals....	10	6	16	18%
4. Can lead to price reductions among farmers.	0	10	10	11%
5. Will allow us to seek best buy/sell prices.	5	1	6	7%
6. There will be no scarcity of cereals.....	3	0	3	3%
7. Traders are more collaborative than Gvnt...	0	3	3	3%
8. Will increase the number of buy/sell places	0	3	3	3%
9. Producers will grow more cereals.....	0	2	2	2%
10. Traders can buy and resell during soudure..	0	2	2	2%
11. We were "fed up" with trading restrictions.	1	0	1	1%
Total valid responses:	56	31	87	100

B. Do Not Favor Free Trade in Cereals	Region N	Region S	Total	%
1. Free cereals trade will lead to scarcity...	4	33	37	58%
2. Traders will transport cereals elsewhere and/or resell dearly during the soudure....	5	3	8	13%
3. Traders will speculate on prices.....	0	6	6	9%
4. It will not be profitable for us.....	3	2	5	8%
5. There will be no more producers if everyone becomes a cereals trader.....	0	3	3	5%
6. Producers will be spoiled since they will speculate with cereals prices.....	0	2	2	3%
7. Banabana will not buy at official price....	1	0	1	2%
8. Purchase price will be too high.....	1	0	1	2%
9. Producers will suffer if drought returns...	1	0	1	2%
Total valid responses:	15	49	64	100

Source: ISRA/MSU Food Security Project Surveys (1986/87)
Based on Open-ended Questions

The opinion survey results tend to complement the production and marketing data reported earlier. Many households rely on coarse grain markets to purchase food, even though these markets are perceived as unreliable. Given that these households already face relatively high prices (above the floor price), the imposition of a floor price is unlikely to improve the welfare of the set of farmers unable to produce enough food under current prices. The remainder of this section examines household head opinions on how input/output markets should be organized, and what they would do if they could double their coarse grain production under the NAP.

[ii] **Private Traders and Farmer Organizations: Which Mix?** Many household heads (87%) indicated it was a bad idea for the government--i.e., parastatals--to withdraw from fertilizer distribution, and most (67%) did not believe private cereal traders would be able to take on this role in the short run.[26] While the latter perception presumably refers to physical distribution, it may be linked to the belief that traders would be less forgiving than the government if crops fail (given historical experiences), and that they would charge higher interest rates for credit.

A further complication is introduced by the fact that 23% of the household heads sampled believe farmers do not have a moral obligation to repay fertilizer credit in the event of crop failure. The question then is, will this belief change if private traders rather than parastatals (commonly viewed as le Gouvernement) deliver the input? If not, traders will have problems when forced to repay their loans to commercial banks. It is important to anticipate and provide rules covering these situations ex ante to avoid the mistakes of past credit programs (i.e., unanticipated forgiving of debts). Whatever the risk sharing rule, all program participants need to be aware of it.

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[26]Findings are consistent with results reported in Crawford (1987, et al., pg. 83) for other areas of Senegal. The above questions were posed prior to the administration of the APS-related questionnaire.

Most farmers favor receiving fertilizer and improved seeds distributed under the APS through farmer organizations rather than directly from traders (Table 5-22), regardless of whether the inputs are distributed on credit or on a cash basis.

TABLE 5-22: PREFERRED SOURCE OF INPUTS UNDER THE APS
Percent and Number of Households

Agent	North	South	Total	
Traders	6%	8%	15	7%
Farmer Org.	77%	90%	177	85%
Indifferent	17%	2%	17	8%

Source: ISRA/MSU Food Security Project Surveys (1986/87)

Primary reasons given for this choice were that the solidarity of an organization would lead to more equitable input distribution, more equal bargaining power (better prices), and facilitate delivery of the inputs. Those in favor of receiving inputs directly from traders cited a general distrust of farmer groups.

Various existing farmer organizations could, in the opinion of household heads, assure the distribution of improved inputs to farmers. L'Association des Jeunes was cited most frequently in the northern areas (30%) while l'Association Villageoise received most votes in the southern area (51%) among those who felt existing farmer organizations could take on this role (77% in the North, 99% in the South). More than half (56%) the respondents in the northern area would not entrust the (peanut) section villageoise with the distribution, referring to problems in the past. In the southern area, this proportion was only 22%.

To market their cereals, on the other hand, most farmers would prefer to by-pass organizations and sell their output directly to traders (Table 5-23). Common reasons were that farmers "had more trust in themselves" and preferred the flexibility of

TABLE 5-23: PREFERENCES FOR ORGANIZING SALES OF CEREALS
Percent and Number of Households Responding

Agent	North	South	Total	
Myself	60%	57%	121	58%
Organization	36%	43%	84	40%
No Preference	5%		4	2%

Source: ISRA/MSU FSP Surveys (1986/87)

selling their output when, where, to whom and at prices they thought appropriate. Those favoring sales through an organization indicated its credibility would thus be advanced; it would be better equipped for dealing with traders; if one took credit from the organization one should resell through it; and surplus organizational funds could serve those in need (the latter response was cited mainly in the southern area).

The data thus suggest private food system participants would prefer to deal with each other in an organized manner. Surveys of existing farmer organizations reveal, however, most are ill-equipped to take on such tasks effectively.[27] This in large part explains why traders would prefer to organize farmers themselves, rather than rely on existing groups.[28]

[iii] Marketing Responses Under Doubled Cereals Production. This section presents data on the proportions of cereals output farmers claim they would sell if they could double their production; the timing of those sales; and the uses of proceeds from the sales. Household heads were asked, if they could double the amount of cereals produced in 1987 under the APS, which proportion of the total production would they

[27]A notable exception are the ABP's organized by SODEFITEX, but drawing on them may lead to "turf battles". See Diagana (June 1988) for survey results pertaining to existing farmer organizations.

[28]See Goetz et al. (September 1988) for private traders' opinions of the NAP and how they would prefer to organize input/output markets.

anticipate selling. For all farmers, including those not willing to sell any particular cereal (as well as those not willing to buy the inputs at currently proposed prices, cf. Ch. III), average percentages of total production they would sell at 70 FCFA/kg range from 26 to 30% (depending on the cereal; minimum = 0%, maximum = 100%). This corresponds to 52 - 60% of 1986 production, representing a sizeable increase in quantities marketed (cf. Table 5-1).

As indicated earlier, not all farmers will adopt the improved inputs and be able to increase their cereals production. Nevertheless, even small changes in coarse grain sales will depress prices if markets do not become better integrated over time and space, making it costly for the CSA to maintain a floor price (as the experience in the market of Ndoga Babacar, Maka in 1986/87 shows). In turn, lower prices received by farmers will alter the gross benefit cost ratios for using fertilizer presented earlier (Ch. III), raising questions about the profitability of fertilizer use.

Most farmers responded they would not sell their cereals at harvest, which could reinforce the sharp seasonal price decline observed in 1986/87. Instead, the following periods were listed, each with similar frequencies: 1. cash crop marketing season (presumably when food-deficit households would be able to buy cereals from proceeds of cash crop sales); 2. after that period but before the beginning of the rainy season; 3. at the beginning of the rainy season; and 4. during the soudure (hungry season), when prices traditionally reach their seasonal peaks. Table 5-24 suggests purchases of livestock would constitute the most important use of funds in the post-harvest period.

The above analysis is partial, and based largely on potential behavior. Nevertheless, a picture of the complex economic system in southeastern Senegal emerges. When one sector in this system is perturbed consequences will be felt elsewhere, such as in the off-farm activity and livestock sectors. Prudent development planning requires at least minimal knowledge of all of these sectors to anticipate consequences--good and bad--of

TABLE 5-24: PRIORITY USES OF PROCEEDS FROM SALES OF SURPLUS CEREALS
(Post-Harvest Period)
Number and Percent of Households

	North		South		Total	
First Use						
Purchase Livestock.....	33	43%	34	34%	67	38%
Pay Labor/Debts.....	4	5%	23	23%	27	15%
Buy Equipment/Animals.....	13	17%	6	6%	19	11%
Other Non-Agric. Use.....	5	6%	10	10%	15	8%
Save for Need/Medicine.....	0	0%	14	14%	14	8%
Buy Clothes.....	9	12%	3	3%	12	7%
Buy Fertilizer.....	4	5%	3	3%	7	4%
Construct House/Marry.....	6	8%	3	3%	9	5%
Other Agric. Use.....	3	4%	5	5%	8	4%
Total.....	77	100%	101	100%	178	100%
Second Use						
Purchase Livestock.....	18	26%	16	20%	34	22%
Buy Equipment/Animals.....	17	24%	11	13%	28	18%
Other Non-Agric. Use.....	11	16%	12	15%	23	15%
Save for Need/Medicine.....	2	3%	15	18%	17	11%
Buy Clothes.....	6	9%	6	7%	12	8%
Construct House/Marry.....	8	11%	4	5%	12	8%
Pay Labor/Debts.....	2	3%	8	10%	10	7%
Buy Fertilizer.....	2	3%	5	6%	7	5%
Other Agric. Use.....	4	5%	5	5%	9	5%
Total.....	70	100%	82	100%	152	100%
Third Use						
Buy Equipment/Animals.....	21	38%	11	20%	32	29%
Other Non-Agric. Use.....	8	15%	12	22%	20	18%
Save for Need/Medicine.....	8	15%	7	13%	15	14%
Purchase Livestock.....	4	7%	8	15%	12	11%
Construct House/Marry.....	7	13%	3	6%	10	9%
Buy Fertilizer.....	3	5%	5	9%	8	7%
Pay Labor/Debts.....	1	2%	4	7%	5	5%
Other Agric. Use.....	0	0%	4	7%	4	4%
Buy Clothes.....	3	5%	0	0%	3	3%
Total.....	55	100%	54	100%	109	100%

Source: ISRA/MSU FSP Surveys (1986/87)

individual programs and to identify strategic points of leverage in the system where program dollars will have a high pay-off.

To address the criticism that the analysis thus far is partial, the independent effects of various explanatory variables on households' coarse grain marketing behavior is now examined. In particular, we are interested in understanding the households' net position in the market, and in examining the implications of this phenomenon.

5.2. MARKETING EQUATIONS FOR COARSE GRAINS AND RICE

Aside from complicating the implementation of floor price policies, the trichotomy of households--net buyers, net sellers, non-participants--also raises questions for econometric modelling: which selection mechanism(s) determines whether or not a household participates in coarse grain cash markets; do net buyers and net sellers respond the same way to exogenous factors (e.g., prices), and is the continuous decision of how much to sell or buy and the discrete decision of whether or not to participate in cash markets influenced by the same set of variables? Implicit in most of the empirical literature on marketed surpluses of food in Africa is the assumption that observations are drawn from a homogenous population in which agents respond in identical fashion, for example, to a change in relative prices.

5.2.1. Recent Estimation Efforts

A recent attempt to estimate the marketed surpluses of agricultural households in West Africa is found in Strauss (1984). Building on earlier work by Krishna (1962); Lau, Lin and Yotopoulos (1978); and Barnum and Squire (1979), Strauss postulates the model

$$(1) \qquad X_i = X_i(p,z,k)$$

$$(2) \qquad X_i^c = X_i^c[p,\cap,A + p_n T(m) + f(p,z,k)]$$

where X_i refers to production and X_i^c to consumption of good i, p is a vector of prices, p_n is the price of labor, $\cap$ denotes household characteristics affecting taste, T is time

available to the household for work and leisure, m is household characteristics determining T, z is a vector of farm characteristics including fixed inputs, k is a vector of production technology parameters, A is exogenous income, and f is profits. From (1) and (2) the absolute value of the marketed surplus of commodity i is calculated as

$$(3) \qquad |MS_i| = X_i(\cdot) - X_i^c(\cdot)$$

This yields the marketed surplus elasticity of good i with respect to the price of good j,

$$(4) \qquad \frac{p_j}{|MS_i|}\frac{\delta MS_i}{\delta p_j} = \frac{X_i}{|MS_i|}\frac{p_j}{X_i}\frac{\delta X_i}{\delta p_j} - \frac{X_i^c}{|MS_i|}\frac{p_j}{X_i^c}\frac{\delta X_i^c}{\delta p_j}$$

which represents the difference between household supply (production) and demand (consumption) elasticities, weighted respectively by the ratios of quantities supplied and demanded to the absolute value of the marketed surplus. Note that for households not participating in the market for commodity i the elasticity is undefined.[29]

Implicitly assuming that production and consumption decisions are made simultaneously (see also Singh et al., 1986), Strauss derives the reduced form of the marketed surplus as

$$(5) \qquad MS_i = MS_i(p,\cap,m,z,k,A).$$

As an alternative, Strauss proposes directly estimating the underlying structural supply (X_i) and demand (X_i^c) equations. One advantage of doing so is that the derived--or restricted--reduced form estimator of π, i.e., $\hat{\pi} = -\hat{\Delta}\hat{\Gamma}^{-1}$, where $\hat{\Delta}$ and $\hat{\Gamma}^{-1}$ are consistent estimates of the structural parameters in the system $Y\Gamma + X\Delta + \epsilon = 0$, is asymptotically efficient relative to the OLS reduced form estimate, $\pi = (X'X)^{-1}X'Y$ when some structural equations are overidentified (see Schmidt, p.241 for a proof; Junankar

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[29] As Strauss points out (p.326), however, in a latent variable model where $Y_i = \max(0,Y_i^*)$, the unconditional expectation $E[Y_i] = E[Y_i | Y_i>0] \cdot P(Y_i>0)$. McDonald and Moffit discuss the interpretation and use of Tobit coefficients.

discusses problems of estimating profit functions given data limitations and market imperfections in developing countries). Marketed surplus elasticities are then calculated using equation (4), allowing price changes to affect both consumption and production decisions through profit effects.

The interdependent, albeit sequential, determination of production and consumption decisions in Strauss' formulation, and the separability of these functions for estimation purposes, assumes that there is no uncertainty, that there are markets for all inputs and outputs, and that the household may participate with minimal cost in these markets. For example, with perfect knowledge of yields and market prices in the post-harvest season, a household may decide at planting to produce only one-half of its food needs, and to generate sufficient cash crop income to in turn make up the food production deficit through purchases in the post-harvest season.

5.2.2. Model Specification Under Uncertainty

Given uncertain rainfall, thin and often non-existent food markets and severe credit constraints in subsaharan Africa, the assumptions made in Strauss' model are strong. Observational evidence and opinion surveys of household heads in Senegal and Mali (see Dioné, 1989) reveal that coarse grain markets are perceived as unreliable both as a source of and an outlet for food.[30] This suggests that households in Senegal strive for at least some degree of self-sufficiency, and that own-production levels do influence the decision to consume and sell or buy coarse grains, once crops have been harvested. Hammer develops an intertemporal model of household food self-sufficiency behavior under yield uncertainty, and (successfully) tests the model using time series data from Senegal. Shaffer et al. (1983) and Binswanger et al. (1987) attempt to explain the

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[30]In one market shed studied, for example, coarse grain prices averaged 100 FCFA/kg in August 1986, and 45 FCFA/kg in August 1987. Staatz et al. (1989) report similar survey findings in Mali.

unreliability of food markets and argue this phenomenon is widespread in land-abundant subsaharan Africa. Uncertainty is thus pervasive and has to be dealt with analytically.

The basic reduced form equation (5) proposed by Strauss is estimated here, but own-production levels rather than technology parameters are included as predetermined variables. Variables affecting the household's (agricultural) labor-leisure choice are excluded under the assumption that this problem was solved during the preceding growing season. Marketed surplus (MS_i) is then specified as a function both of 1) price expectations which, for lack of a better measure are equated with average market prices observed in the post-harvest season, i.e., $E_{t-1}[p_t] = \theta \cdot p_t$, where $\theta \equiv 1$ and E_{t-1} denotes expectations at planting about post-harvest season prices; 2) entitlements $\underline{E}$ which include own-production levels of crops but also obligations incurred during the growing season, such as borrowing of draft equipment and cash;[31] and 3) consumption preferences and other household characteristics affecting marketed surpluses of coarse grains.

This leads to a specification in which behavior during the marketing season depends on relative prices p, including expectations at planting although they are not distinguished from observed prices, current period constraints $\underline{E}$ such as own-production and household characteristics Ω which include the age of the household head, the number of consumers per active worker and ethnicity,

$$(6) \quad MS_i = MS_i(p,\underline{E},\Omega) + \epsilon$$

The distribution of the error term ϵ is discussed in Section 5.2.3.

Market prices, however, are neither uni-dimensional nor costless to observe for individual households. Given genuine uncertainty, costs of observing market outcomes,

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[31]It is not known whether these transactions, in the terminology of Bromley and Chavas (189, p.721), are contingent on harvest outcomes or unconditional such that the terms of exchange are known when the transactions is made. If these borrowing decisions are made simultaneously with subsequent coarse grain marketing decisions, a simultaneous equation bias arises.

and following the argument in Heiner (1983), the question of how much a household sells or buys is cast as: When is it the right time to increase or decrease stocks held?[32]

If this is a more adequate formulation of the question, it appears that Strauss is only partly correct in criticizing Bardhan (1970) and Haessel (1975) for including quantities produced in their equations: "[the authors] assumed that production was fixed; hence price affected marketed surplus only by changing consumption" (emphasis added). Household food storage is an empirical regularity in subsaharan Africa, and sales or purchases can be viewed as depleting or adding to these stocks[33] (see Renkow, 1988, for a similar analysis recognizing that households manage inventories of food and the discussion with regard to price uncertainty in Singh et al., p.57).[34] Hence price changes will lead not only to relative changes in the consumption of individual commodities, but also to changes in stocks. A higher price of food may lead to increased sales of food, due to a higher opportunity cost of holding stocks, but it may also lead to purchases of food if it signals impending scarcity. Similarly, the availability of coarse grains processing technology may increase the opportunity cost of holding unthreshed stocks relative to the cost of threshing coarse grains, and thus also represents a change in the relative price of coarse grains to that of rice (for example).

Another dimension of observed prices is market access. Poor market access due to lack of transport and/or distance not only reduces [increases] the net (of transport cost) price received [paid] by the seller [buyer], thus lowering [raising] the opportunity cost of holding stocks, but also increases the farmer's cost of observing market prices in

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[32]Therefore, rather than treating marketed surplus solely as a "static" planned quantity, it is viewed here as a flow from a buffer stock to cope with uncertainty.

[33]Strauss assumed beginning and ending stocks were zero. In this study ending stocks were found to be positive for most households. Borrowing of cash (mostly for consumption purposes) during the preceding growing season is used as a proxy for low beginning stocks.

[34]Binswanger et al. (1987) argue that stocks of food and livestock holdings are major forms of capital accumulation in land-abundant agriculture.

order to make transaction decisions. Conversely, a household pursuing off-farm activities may find it less costly to observe prices and therefore be more likely to participate in markets, ceteris paribus.

Consequently, there are two major differences between the estimation attempted here and that pursued in the agricultural household literature (which is based on systems of demand and supply equations). The first variation from previous work is explicit allowance for genuine uncertainty (i.e., that which cannot be parameterized), which leads to a number of new variables as regressors. The second variation results from transactions costs. It builds on the uncertainty dimension, and is discussed in the following section.

5.2.3. Model Specification with Transactions Costs

The non-market participation of households discussed earlier is largely explained by transactions costs. These costs drive a (shaded) wedge between household buying and selling prices, as shown in Figure 5-4, which is based on the concept of non-traded goods in the international trade literature (Dornbusch, 1980).[35] The y-axis shows the market price of food paid or received by a household participating in the cash market. The x-axis shows the value (price) of food to the household. It there are zero transaction costs ($\tau = 0$), the household can equate its shadow price with the market price, and market participation behavior is continuous (as opposed to discrete or subject to a threshold) as both prices vary.

For any transaction cost $\tau > 0$, however, we expect to observe a non-empty autarky set $\{A\} \notin \phi$. In other words, there will be a set of households which cannot equate market and shadow prices (over a certain range) owing to transaction costs. Only

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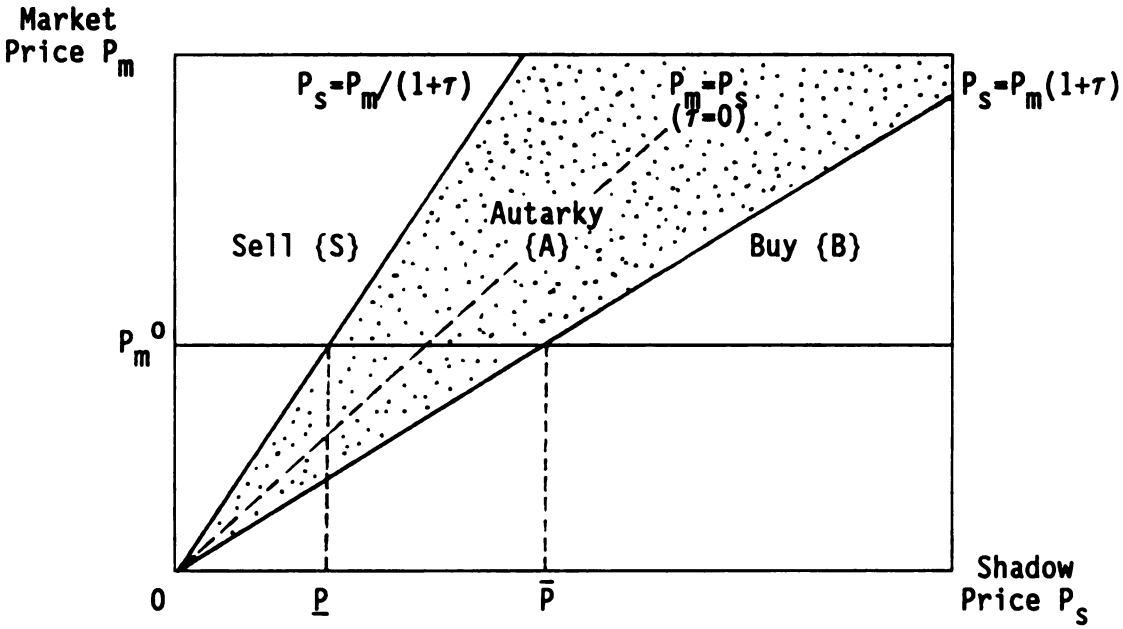
[35] A similar analysis examining the behavior of households in the market for land tenancy is given in Bell et al. (1988).

FIGURE 5-4: SELLING, PURCHASING AND AUTARKIC BEHAVIOR OF HOUSEHOLDS AS A FUNCTION OF MARKET AND SHADOW PRICES AND TRANSACTIONS COSTS τ



Note: transactions costs (τ) are assumed to be a fixed percentage of volumes transacted.
Source: Based on Dornbusch (1980).

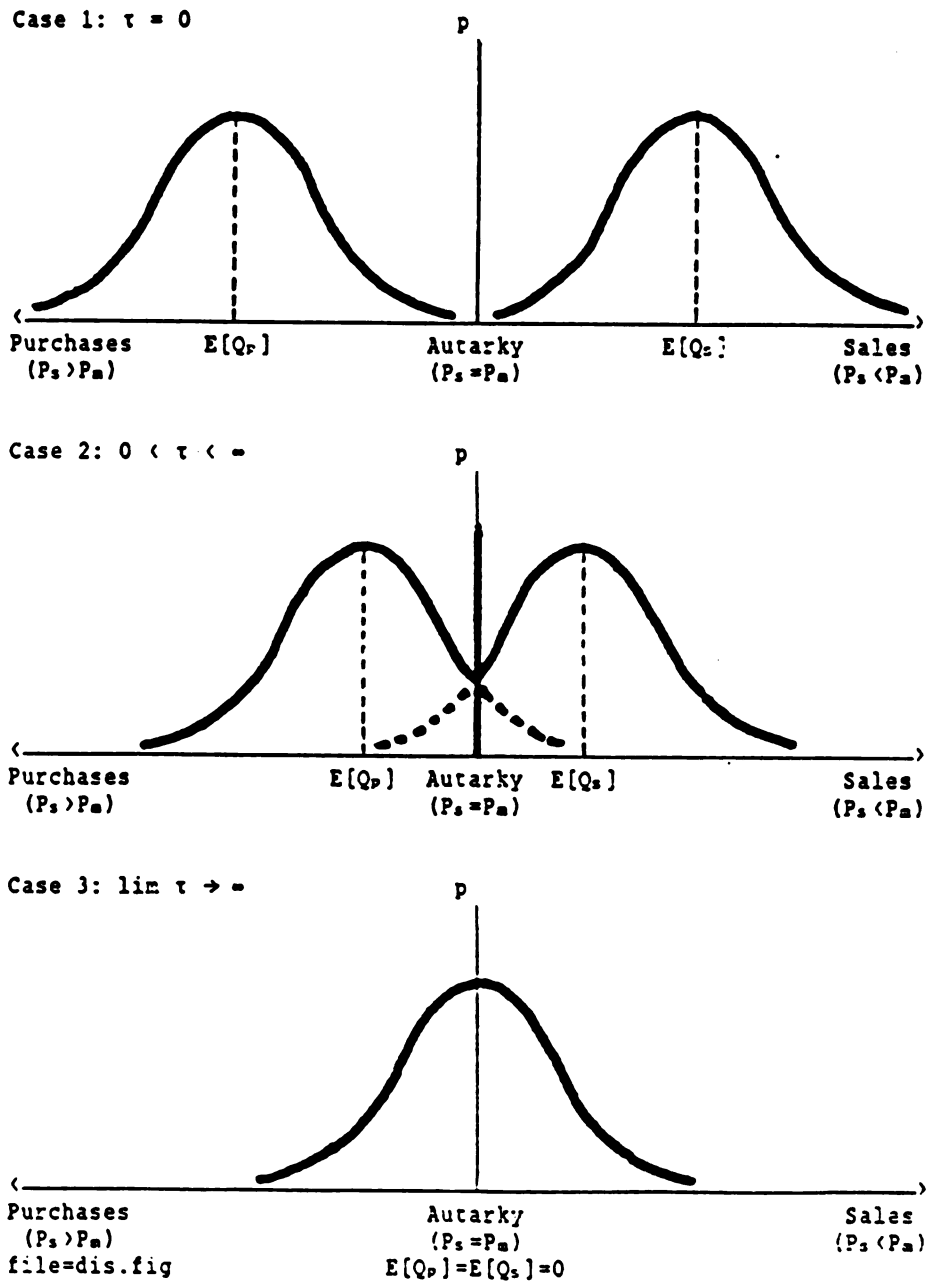
as $\tau \to 0$, $\{A\} = \phi$ as households are able to equate the internal shadow price p_s with market price p_m. As $\tau \to \infty$, precluding exchange, the set $\{B\} = \{S\} = 0$.

Transactions costs therefore lead to an important econometric question: how is the distribution of the error term ϵ to be specified in light of the sample separation? Do we assume that observations are drawn from identical distributions so that buyers, for example, exhibit the same price elasticity as sellers, conditional on market participation?

Figure 5-5 shows the implications of alternative assumptions about the transaction cost parameter τ for specifying the error term density. For ease of exposition it is assumed that net marketed surpluses of buyers and sellers are iid $\sim N(|MS_s|,\sigma_s) = N(|MS_b|,\sigma_b)$. Case 1 shows two symmetric densities for buyers and sellers for the

FIGURE 5-5: PROBABILITY DENSITY FUNCTIONS FOR QUANTITIES BOUGHT AND SOLD UNDER ALTERNATIVE TRANSACTIONS COST ASSUMPTIONS

Note: Identical (symmetric) densities assumed for simplicity. τ=transactions cost; E=expectation operator; Q_s=quantity sold; Q_p=quantity purchased; P_s=shadow, P_m=market price.



hypothetical situation where $\tau = 0$ and the observations have been drawn from two heterogeneous populations, allowing for different responses to the same exogenous variable in the estimation of parameters. Here $\{A\} = \phi$ since all households will trade. In case 2 the densities will slide toward each other as τ increases. The set $\{A\}$ has support for $\tau > 0$, since some households k will not participate in the market:

$$\{A\} = \{k | p_{mk}/(1+\tau_k) < p_{sk} < p_{mk}(1+\tau_k)\} \notin \phi$$

We cannot determine whether households $k \in A$ are "closer" to set $\{B\}$ or $\{S\}$ although one conjecture is that the higher (lower) food output per capita, the closer the household will be to set $\{S\}$ ($\{B\}$). Case 3, finally, shows the situation where $\tau \to \infty$, such that expected quantities traded become zero.

The classical transactions costs or friction model, developed by Rosett (1959) to explain why asset holders will not adjust portfolios in response to small changes in asset yields, is specified as (using the notation in Maddala, 1988):

$$(7) \quad y_i^* = \beta' x_i + u_i$$

$$y_i = y_i^* - \alpha_1 \quad \text{if } y_i^* < \alpha_1 \quad (i \in S)$$

$$(8) \quad y_i = 0 \quad \text{if } \alpha_1 \le y_i^* \le \alpha_2 \quad (i \in A)$$

$$y_i = y_i^* - \alpha_2 \quad \text{if } \alpha_2 < y_i^* \quad (i \in B)$$

where y_i^* = desired change in coarse grains (or asset) holdings of individual i; y_i = actual change in coarse grains holdings (sales and purchases); x_i = exogenous variables; β = coefficients to be estimated; u_i = random error term, assumed to be $\sim N(0,\sigma^2)$; α_1 (<0) = desired decrease in coarse grains holdings; α_2 (>0) = desired increase in coarse grains holdings; $\phi(\cdot)$ = standard normal density function; and $\Phi(\cdot)$ = cumulative standard normal density function. The associated likelihood function is

$$(9) \quad L(\alpha_1, \alpha_2, \beta, \sigma | y, x) =$$

$$= \prod_{i \in S} \frac{1}{\sigma}\phi\left(\frac{y_i + \alpha_1 - \beta' x_i}{\sigma}\right) \prod_{i \in A} \left[\Phi\left(\frac{\alpha_2 - \beta' x_i}{\sigma}\right) - \Phi\left(\frac{\alpha_1 - \beta' x_i}{\sigma}\right)\right] \prod_{i \in B} \frac{1}{\sigma}\phi\left(\frac{y_i + \alpha_2 - \beta' x_i}{\sigma}\right)$$

The problem with this specification for the present purpose is that asset yield variables X_i entering the likelihood function are assumed to be identical for each agent. For example, intra-day changes in asset prices are observable at a low cost once the fixed cost of commissioning a broker have been incurred. In subsaharan Africa it is commonly observed that market prices vary considerably within a market day; that they tend to be agent-specific (see Schmid and Robison, 1988, on arms-length transactions in the U.S.); and that roundabout trades--e.g., livestock for peanuts for food--further obscure actual prices paid and received by individuals. This means measured market prices are indicative proxies for price levels prevailing in any individual transaction. These observations suggest the following may be a more fruitful approach to answering the questions raised earlier, i.e., what determines whether or not a household participates in markets and, if so, how much it buys or sells.

[a] A probit model designed to discern the probability of market participation under the maintained hypothesis that net buyers and net sellers react in the same manner to the effects of exogenous influences (although this too can be dealt with in Rosett's (1959) model):

(10) $P(Y=1) = \Phi(\beta'X)$

where Φ is the cumulative standard normal distribution function, $Y=1$ if the household buys or sells, and $Y=0$ otherwise.

[b] Two OLS equations, one for the entire sample and one only for those participating as net buyers or net sellers:

(11) $Y = \beta'X + \epsilon$

where Y denotes net sales of coarse grains and $\epsilon \sim N(0,\sigma^2)$.

[c] A trinomial logit equation with three possible (unordered and mutually exclusive) outcomes reflecting the trichotomy of households: not in the market, net buyers and net sellers.

(12) $P(Y=m) = \exp(\beta' x_m) / [\Sigma_m \exp(\beta' x_m)]$, $m = 0,1,2$ with $\beta_m = 0$.

[d] Two tobit equations, one for net buyers and one for net sellers, using households not participating in the coarse grain market as the zero category in both cases. Here the likelihood functions are (note the similarity to Rosett's model)

$$(13)\quad L(\beta_s, \sigma_s) = \prod_{k \epsilon A} \left[1 - \Phi\left(\frac{\beta' x_i}{\sigma}\right) \right] \prod_{k \epsilon S} \frac{1}{\sigma} \phi\left(\frac{y_i - \beta' x_i}{\sigma}\right)$$

$$(14)\quad L(\beta_b, \sigma_b) = \prod_{k \epsilon A} \left[1 - \Phi\left(\frac{\beta' x_i}{\sigma}\right) \right] \prod_{k \epsilon B} \frac{1}{\sigma} \phi\left(\frac{y_i - \beta' x_i}{\sigma}\right)$$

[e] Along the lines of Cragg's (1971) model (see Haines et al. (1988) for a recent application to consumption behavior) two separate probit equations are estimated predicting the probability of market participation for net sellers and net buyers, and

[f] two truncated equations where ϵ is explicitly truncated at zero, to examine the continuous behavior of households conditional on being net buyers or net sellers.

5.2.4. Empirical Results

Table 5-25 presents estimated coefficients for equations (10) and (11) under the maintained hypothesis that households respond in the same manner to environmental circumstances, regardless of whether they are net buyers or net sellers.[36] Particularly noteworthy is the result that households with off-farm incomes are more likely to participate in the market, but that this factor tends not to affect the quantity of net sales significantly. As hypothesized earlier, this may be due to reduced costs of observing coarse grain prices and/or speculative activity, effects not picked up in the OLS equations which assumes continuous adjustments by farmers.

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[36]Wages and livestock prices were omitted due to multicollinearity with rice prices. Cash crop (cotton and peanut) prices are fixed pan-territorially by the government.

TABLE 5-25: PROBABILITY OF PARTICIPATING IN COARSE GRAINS CASH MARKETS VERSUS NET QUANTITIES SOLD
(absolute t-statistics)

Dependent Variable= Net Sales (0,1 and/or continuous) Exogenous Variable	Entire Sample				Net Buyers & Sellers Only
			Trinomial Logit		
	Probit	OLS	Buyers	Sellers	OLS
Constant	4.86	1136	1.33	15.6	1588
	(2.46)	(2.66)	(0.324)	(3.49)	(2.83)
Coarse Grain Price	0.0356	6.60	0.0873	0.0650	7.95
(CFA/kg)	(2.25)	(2.05)	(2.47)	(1.60)	(1.74)
Rice Price	-0.0415	-10.1	-0.0430	-0.135	-13.2
(CFA/kg)	(2.97)	(3.76)	(1.44)	(3.94)	(3.47)
Poor Market	-0.223	-3.68	-0.513	-0.351	22.8
Access=1	(0.675)	(0.048)	(0.833)	(0.441)	(0.227)
Mechanical Trans-	0.0820	192	-1.28	1.15	299
formation Avlb.	(0.176)	(1.86)	(1.17)	(1.12)	(2.23)
Off-Farm Income=1	1.31	103	2.67	2.32	94.5
	(2.90)	(1.26)	(2.66)	(2.39)	(0.829)
Fulani Ethnic	-0.205	-178	-0.234	-0.684	-198
Group=1	(0.524)	(2.20)	(0.310)	(0.841)	(1.92)
Coarse Grain Output	0.0000555	0.0739	-0.00018	0.000456	0.857
(kgs)	(0.470)	(2.81)	(0.652)	(1.76)	(2.42)
Cash Crop Output	-0.00180	-0.396	-0.00333	-0.00035	-.433
('000 CFA)	(2.11)	(2.38)	(1.47)	(2.05)	(1.92)
Consumers/Active	-0.0852	-121	-0.0309	0.476	-163
	(0.205)	(1.43)	(0.038)	(0.516)	(1.39)
Household Head Age	-0.00453	2.79	-0.00412	0.00420	1.83
	(0.452)	(1.23)	(0.208)	(0.189)	(0.630)
Traction Equipment	0.643	201	0.250	3.33	273
Borrowing HH=1	(1.46)	(2.31)	(0.302)	(2.99)	(2.48)
Borrowed '000 CFA in	0.00534	-2.16	0.0147	0.00698	-2.26
1986 Hungry Season	(0.572)	(3.61)	(0.856)	(0.403)	(3.36)
Nbr. of Observations	116	116	116		85
Adjusted R-Square		0.35			0.43
Log-Likelihood	56		84		
Prediction Success: p=0	29%		42%	23%	
p=1	95%		80%	80%	

Conversely, the availability of mechanical transformation, Fulani ethnicity, coarse grains output and the borrowing of equipment and credit during the 1986 growing season affect net sales significantly but appear not to enter the market participation decision (again, comparing the OLS and limited dependent variables models in Table 5-25). Cash crop markets tend to be physically separate from, and of shorter duration than, coarse grain markets. Hence increased participation in these markets does not convey information on food prices. The probit equation performs poorly in predicting when households do not participate in markets (prediction success of only 29%). Presumably this is due to attempting to predict market participation for both buyers and sellers. The trinomial logit specification suggests net buyers and sellers do react differently to exogenous influences, although most of the coefficient estimates are insignificant at the 10% level.

Results for the case where net buyers and sellers are postulated to have been drawn from different populations are reported in Table 5-26. For the not in the market/net sellers equation the tobit equation performs fairly well, except that it has difficulty distinguishing discrete from continuous behavior for the availability of mechanical transformation, off-farm income, cash crop production and borrowing during the hungry season. For households not in the market/net buyers the tobit equation yields dismal results, showing only one significant coefficient (borrowing during the 1986 growing season). Of particular interest is the result that a higher coarse grains price significantly increases the probability of market participation but, conditional on market participation, a higher price reduces quantities purchased (note that these results have to be interpreted with caution since market prices are based on only 5 observations or market places). This may reflect the fact that a higher price signals impending scarcity for these households, which on average had produced less coarse grains per capita (Table 5-2), so that they entered the market as buyers. For both sets of households, therefore, a higher coarse grain price increases the probability of market participation,

TABLE 5-26: DETERMINANTS OF HOUSEHOLD BEHAVIOR IN THE COARSE GRAIN CASH MARKET
(absolute t-statistic)

	Not In Market/Net Sellers			Not In Market/Net Buyers		
Exogenous Variable	Tobit	Probit	Trunc	Tobit	Probit	Trunc
Constant	1895	9.74	1973	-501	0.984	-5717
	(3.33)	(3.49)	(1.78)	(0.579)	(0.371)	(2.31)
Coarse Grain Price (CFA)	15.2	0.0523	49.7	1.14	0.0419	-31.8
	(2.73)	(1.86)	(3.26)	(0.213)	(2.48)	(2.33)
Rice Price (CFA)	-18.5	-0.862	-31.3	2.45	-0.0216	49.5
	(4.70)	(3.77)	(3.04)	(0.428)	(1.18)	(2.77)
Poor Market Access=1	-47.7	-0.0406	-119	24.2	-0.169	114
	(0.423)	(0.774)	(0.476)	(0.202)	(0.444)	(0.557)
Mechanical Transformation Avlb.	276	0.723	434	-96.1	-0.392	356
	(2.29)	(1.13)	(2.01)	(0.439)	(0.577)	(0.755)
Off-Farm Income=1	172	1.55	-6.89	167	1.44	-724
	(1.70)	(2.32)	(0.034)	(1.01)	(2.48)	(1.74)
Fulani Ethnic Group=1	-128	-0.664	-81.4	116	-0.273	-153
	(1.19)	(1.23)	(0.397)	(0.814)	(0.555)	(0.547)
Coarse Grain Output (kgs)	0.0738	.000274	0.0988	-0.0436	-0.000044	0.0797
	(2.15)	(1.61)	(1.54)	(0.853)	(0.266)	(0.762)
Cash Crop Output ('000 CFA)	-0.441	-.00235	-0.338	-0.149	-0.00243	1.72
	(2.30)	(2.03)	(0.900)	(0.358)	(1.62)	(1.64)
Consumers/Active	-182	-0.427	-461	86.7	-0.0444	430
	(1.72)	(0.720)	(2.06)	(0.565)	(0.088)	(1.35)
Household Head Age	-1.09	-.00177	-7.82	-3.78	-0.00267	-17.8
	(0.365)	(0.123)	(1.13)	(0.946)	(0.220)	(2.02)
Traction Equipment Borrowing HH=1	526	2.36	988	-22.5	0.175	23.1
	(3.72)	(3.09)	(2.81)	(0.158)	(0.342)	(0.081)
Borrowed '000 CFA in 1986 Hungry Season	5.36	0.0150	10.5	2.71	0.00506	3.29
	(2.29)	(0.905)	(2.57)	(3.43)	(1.05)	(2.58)
Nbr. of Observations	71	71	40	76	76	45
Log-Likelihood	298	27	258	351	41	298
Prediction Success: p=0		74%			55%	
p=1		95%			84%	

but sellers sell more while buyers buy less, as we might expect, once they have decided to participate. The problem of the tobit model in predicting the effect of off-farm income arises from the fact that off-farm activities increase the probability of participation while, conditional on being in coarse grain markets, households with off-farm income buy less than those without such income (significant at the 10% level).

The results thus suggest that off-farm activities increase the probability of market participation by reducing the cost of observing prices, and imply some specialization among households, with one group entering markets as net sellers and the other as net buyers, depending on the nature of the off-farm activity. In a more dynamic sense, off-farm activities may also allow households to invest in production-increasing inputs, even though in this data set off-farm income did not appear to be strongly associated with equipment ownership or the use of mineral fertilizer (Ch. III). These hypotheses could be tested in future research, and it would be important to follow a panel of households over multiple years.

The tobit model also has difficulty discerning the effect of cash crop output (which is highly correlated with cash crop sales, with a correlation coefficient[37] of 0.968) in the case of coarse grains buyers. The more cash crops produced, the lower the probability of participation, but once transactions costs have been incurred, households buy more coarse grains for every 1000 FCFA of cash crops produced (and sold). For the sample these coefficients are marginally significant at the 10% level.

For both buyers and sellers, having borrowed money (mostly for consumption purposes and unexpected family needs) led to significantly higher sales and purchases, conditional on market participation. It is conceivable that sellers lacked alternative means of repaying loans, while buyers had such alternatives and instead stocked food to

[37]Significant at the .001 level.

avoid mistakes of the past hungry season (i.e., running out of food). This is an example of households responding in opposite fashion (sell more, buy more) to the same exogenous stimulus, suggesting that buyers and sellers were indeed drawn from different populations.[38] On the other hand, the amount of coarse grains produced tends to significantly increase both the probability of market participation of sellers and quantities sold (tobit coefficient), but plays no significant role in the case of buyers in this sample.

5.2.5. The Rice Regression Equation

In the rice regression equation livestock and draft equipment ownership are introduced as proxies for wealth. Since 16% of the households did not purchase rice, a tobit model was employed.

Results shown in Table 5-27 suggest rice prices did not significantly affect the probability and level of rice purchases, while higher coarse grain prices reduced rice purchases. The latter result is surprising and may reflect strong income effects between rice and coarse grains. Using equipment value as a proxy for long run wealth suggests wealthier households purchase significantly more rice, although this is not true for livestock ownership as a proxy for wealth. Similarly, short run income, measured by cash crop production levels, does not appear to affect rice purchases. The availability of mechanical coarse grains processing technology and higher own-production levels significantly reduce rice purchases. The first phenomenon is likely to reflect the reduced cost of processing coarse grains into an edible form. Households headed by older farmers bought significantly less rice, ceteris paribus, conceivably reflecting weaker preferences for broken rice.

It is interesting to note, finally, that the coefficient estimate for off-farm income is not significantly different from zero in the rice equation, suggesting involvement in

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[38]Survey results indicate the net market positions were fairly stable over the period 1985-87.

TABLE 5-27: REDUCED-FORM ESTIMATES FOR RICE PURCHASES
[Dependent Variable=kgs Rice purchased; (t-statistics)]

Exogenous Variable	Tobit
Constant	494 (3.22)
Rice Price	0.644 (0.685)
Coarse Grain Price	-4.63 (4.13)
Equipment Value	4.72 (4.39)
Livestock Owner	18.4 (0.753)
Fulani Household	-7.93 (0.286)
Household Head Age	-2.02 (2.51)
Consumer/Active	-43.6 (1.55)
Off-Farm Income	6.43 (0.234)
Poor Market Access	-88.1 (3.38)
Mech. Tran. Techn.	-112 (3.09)
Coarse Grain Harvest	-0.0231 (2.37)
Cash Crop Harvest	0.0280 (0.472)
Rice Harvest	-0.0481 (0.703)
Log Likelihood	603

market activities does not provide additional information which reduces the cost of market participation. This is plausible in the case of rice markets which, although often clandestine, appear to convey information readily. Part of the proper functioning of the market may result from the lowered uncertainty stemming from an almost perfectly elastic supply of rice on world markets.

5.2.6. Policy Implications

The following implications may be drawn for policy makers in Senegal. Less costly market information appears to increase the probability that a household will participate in coarse grain markets, as reflected in the coefficient on the off-farm income variable (which may also measure an increased willingness and ability of farmers to manipulate their stocks of food through purchases and sales). To the extent that exchange is beneficial, the social returns to increased market information have to be weighed against the cost of providing such services in sparsely populated rural areas.

Higher coarse grain prices increase market participation but, as suggested above, price signals are interpreted differently by buyers and sellers. It makes a difference whether households perceive the price change to be caused by market forces (scarcity) or as a temporary aberration due to government intervention in markets (these results have to be viewed with caution owing to the limited price data). Promoting coarse grain threshing technology in rural areas may stimulate sales of coarse grains, but according to the significance of the t-statistics, would benefit mainly net sellers in the short run. This is to be expected, since threshing is a supply-side task--as opposed to a demand-side task such as milling.

Higher cash crop sales reduce the probability of participation in coarse grains markets as sellers, thereby detracting from the objective of increasing marketed surpluses of food. However, because of (possibly sizeable) economies of scope in cash and food crop production, and the peanut seed-labor linkage, we cannot recommend a reduced

emphasis on cash crop input delivery and production in the short run. Reducing transactions costs in cash crop markets with regard to access, queuing, patronage and irregularities at scales may free farmers' time which could be better invested in ascertaining coarse grains prices.

5.3. SUMMARY AND CONCLUSION

Results presented in this chapter suggest that households in southeastern Senegal pursue a variety of strategies to achieve food security, and that over 30% rely on coarse grain markets to purchase some food. It was argued that some of these households will have difficulty responding to a floor price incentive, and that such a policy would have only narrow distributional benefits. Opinion surveys regarding free trade policies confirm this general result, since some farmers prefer free trade in cereals believing that would make it easier for them to purchase cereals. More generally, policies have to be designed to increase the productivity of rural residents both in on- and off-farm activities.

Consumption preference data suggest households prefer a varied mix of cereals over a single cereal in their diet; so long as markets for cereals remain uncertain, this suggests it will be difficult to induce farmers to grow only a single food crop, such as maize. It was also argued that the introduction of coarse grain processing technology and market information services could have high pay-offs in stimulating sales of coarse grains and in reducing purchases of imported rice. These issues are discussed further in Ch. VI.

CHAPTER VI

IMPLICATIONS FOR PUBLIC POLICY AND FUTURE RESEARCH

The Government of Senegal has set the objective of achieving 80% food self-sufficiency by the year 2000. Policy instruments initially chosen to achieve this objective include: (a) a producer floor price designed to stimulate the production and sales of local coarse grains; (b) sales of coarse grain fertilizer and as of yet undeveloped fertilizer-responsive, improved coarse grain seed varieties; and (c) reduced sales of peanut seed on a credit basis. Underlying each of these instruments of public policy were certain key assumptions about the behavior of rural food system participants. These were tested using empirical data collected during 1986/87 on 40 private traders in 7 market places and up to 210 farm households in 15 villages located throughout the agriculturally important southeastern part of Senegal. Two complementary policy instruments were the liberalization of coarse grain markets and the privatization of the distribution of the improved inputs for cereals production mentioned in (b). This final chapter summarizes results of the analyses presented earlier and provides selected policy recommendations designed to assist in answering the following questions.

1. How can marketed surpluses of coarse grains in southeastern Senegal be stimulated, at reasonable prices to consumers, while also raising rural incomes and assuring rural food security? Are fertilizer and improved seed distribution the most cost-effective policy options?

2. How important is the cash crop-food crop "trade-off" (GOS policy statements and work by other researchers indicate it is important), and how does the "trade-off" manifest itself? A related question is, how easy will it be to induce farmers to substitute maize for millet/sorghum production? What should national crop research priorities be (or not be)?

3. What is the significance of, and what are the consequences of, coarse grain market uncertainty? To what extent is a floor-price policy cost-effective and equitable as an instrument for raising rural incomes and sales of coarse grains?

4. What are the prospects for, and anticipated consequences of, market liberalization in Senegal and, more generally, Africa? Will the private sector be able to fill the vacuum left by state withdrawal from the agricultural marketing system?

The following sections may suggest that Senegal's rural development problems can be tackled on a piecemeal basis, i.e., by influencing input and output markets separately (or independently). It is important to stress that an holistic approach is required, paying attention not only to input markets in general and specific inputs in particular, but also to the output markets that affect the profitability of employing the inputs.

6.1. SUMMARY AND IMPLICATIONS

6.1.1. Agricultural Input Distribution Policy

[i] Credit as a Constraint. Making credit available to households for food purchases before and during the growing season is likely to have high pay-offs both in terms of raising the productivity of labor (increased energy expenditure, less time spent searching for food), and increasing the size of the labor force. The availability of food at the household level during the growing season is a prerequisite for retaining (married) sons and attracting non-family labor. Multivariate analyses show households which have additional labor also seeded a larger quantity of coarse grains, the output of which in principle exceeds the food needs of the additional workers and their dependents.

That food was a constraint at the beginning of the 1987 rainy season--following a year of normal rainfall--is evident from the fact that one-half of the households sampled would have purchased food if they had had additional funds. Private sector credit, obtained by one-third of the households, was used primarily to purchase food. Particu-

larly in the southern areas, some households (15%) appear to be so constrained for food that they have difficulty carrying over sufficient coarse grain seed from one production season to the next.

[ii] Agricultural Equipment Supply and Maintenance. Tabular analysis reveals households using draft technology on average produce twice as much output per farm worker compared with households not using that technology, depending on the crop and region. An important challenge is to expand and to sustain the ownership of equipment through time--i.e., to reduce the incidence of distress sales--and to promote equipment repair facilities in rural areas. The southern survey area (Upper Casamance) was largely ignored by the equipment distribution component of the Programme Agricole: only 28% of these households sampled were fully equipped (owning both a plow and/or a hoe and animal draft power), in comparison to 72% in the Peanut Basin. Due to borrowing, nearly all households in the northern area had access to equipment.

In both areas, households headed by younger individuals, owning cattle, and not pursuing off-farm activities owned more equipment per active worker than households without these characteristics. This is perhaps explained by the fact that younger heads are more willing to take on the risk of owing equipment, and that on-farm investments in livestock and equipment go hand-in-hand. This tabular analysis does not suggest that households have to pursue off-farm activities if they are to raise their equipment ownership level per active worker, however. Cash crop sales and association with parastatals appear to serve that purpose.

Equipment use and availability are one important factor explaining why the northern survey zone out-produces the southern zone, despite its lower rainfall. Promoting labor-saving technology rather than fertilizer is a priority in the southern region with its more fertile soils. Making more equipment available to more households could also improve the distribution of rural incomes. SODEFITEX was the sole source of new

draft equipment in southeastern Senegal during the survey period (households in the south working with SODEFITEX in 1986 owned more equipment per worker), but it was drawing on limited and deteriorating stocks left over from ONCAD.

Equipment provides further advantages relative to fertilizer in that it is durable (i.e., it can serve as collateral in future [private sector] transactions and it remains even when the rains fail). In contrast to fertilizer, this input can also yield local off-farm income multipliers in terms of spare parts manufacturing and equipment maintenance, and it therefore concords well with a broader rural economic development strategy.

[iii] Fertilizer. The evidence collected in this study suggests that farmers perceive the use of fertilizer on coarse grains to be profitable in a year of average rainfall (with an average 75% yield increase) and under official prices, and that fertilizer is seen as a necessary input for field maize production in the northern areas. Nevertheless, nearly half of the northern farmers indicated they would not use fertilizer and improved seed at respective prices of 100 F/kg and 210 F/kg, even if they were provided on credit. Crude estimates suggest that most households (90%) would adopt fertilizer only if its price fell to 70 F/kg (assuming coarse grain prices of 70 F/kg).

Farmers did not believe that maize is more fertilizer-responsive than millet and sorghum, as is generally reported in fertilizer trials for West Africa. Furthermore, about one-third of the farmers were convinced that animal manure is superior to mineral fertilizer. This is due to their belief that manure remains in the soil for multiple years (46% of the responses), but also because it leads to a higher yield response (40%). Not surprisingly, farmers located in the higher-rainfall, southern research areas were more likely to believe mineral fertilizer was better than manure than their counterparts who were located in the drier, northern areas.

The profitability of using fertilizer on cereals will be severely squeezed if the cost of its delivery initially rises in a privatized market and coarse grain prices fall as sales

rise even marginally. This requires a judicious use of output-market policies, given the uncertainty of coarse grain markets in Senegal, as discussed further below. Furthermore, the expected profitability of using mineral fertilizer on maize has to be analyzed jointly with investment alternatives of farmers. At current official input/output prices, more than 50% of the northern, but only 10% of the southern, farmers reported they had superior investment opportunities to using fertilizer on maize. More generally, there is a need for raising the on-farm productivity of coarse grain production. A related issue for agronomic research concerns the potentially beneficial interaction between animal manure and mineral fertilizer in sandy soils.

Weed control chemicals are inputs complementary to fertilizer to be considered in Senegal's input distribution policy. All farmers in the southern area using chemical herbicides (obtained from SODEFITEX) were convinced its use was "worthwhile". More research is needed on the quantitative importance and prevalence of harvest failures caused by uncontrolled weed growth. Limited informal observations suggest that weed growth may also affect farmers' willingness to adopt fertilizer. A related finding from a linear regression is that households having retained married sons are more likely to use fertilizer than households without that characteristic (controlling for participation in SODEFITEX's cotton and maize production program). This tends to confirm the Delgado-McIntire (1982) hypothesis, that because of labor-shifting effects, farmers will not adopt some improved technologies unless they also have access to additional labor.

[iv] Summary. Input market policies are integral to a strategy of stimulating productivity growth in southeastern Senegal. Yet different households require different inputs, and the productivity of individual inputs on different crops varies according to rainfall conditions and not only across but also within different regions of the country. A pragmatic agricultural production support project would promote a broad set of inputs,

such as draft equipment and weed control chemicals along with fertilizer, and allow farmers to select the inputs they expect will be most profitable for them.

The provision of spare parts and artisanal equipment maintenance should be considered in conjunction with the objective of raising the productivity of off-farm activities (see below). Potential new firms with economies of scope in providing alternative low-cost services to farmers should be identified and promoted. Examples may include firms selling draft equipment, maintaining the equipment, and training draft animals. Over the longer run, local small scale manufacturing of equipment for local conditions (such as heavier soils in the Casamance requiring more robust seeders than the sandy soils of the Peanut Basin) could be stimulated.

6.1.2. National Crop Research Priorities

While analysts and decision makers generally view the cash crop-food crop relationship as a competitive one, this study illustrates that when the market for one of the crop types is thin and uncertain, there can be non-technical complementarities among inputs. Further, cost-reducing economies of scope were found among households producing both food and cash crops. It is consequently argued that the food crop-cash crop trade-off in southeastern Senegal is not as severe as commonly believed, and that a policy of only funding research on food crops would be misguided.

[i] Labor-Peanut Seed Linkage. When the household is analyzed as a coalition of individuals with divergent interests, arising in response to high transaction costs in uncertain markets--instead of a black-box with a singular objective of maximizing profits--an interdependency emerges between cash and food crop production. Household heads with access to peanut seed through credit from SONACOS are able to attract seasonal workers and/or to retain married offspring within their households, in turn permitting them to grow more food crops (i.e., to allocate more seed, land and labor to food production). So long as market uncertainty renders coarse grains unsuitable as cash

cash crops, reduced peanut seed distribution on credit may lead to lower rather than higher national food production.[1]

[ii] Economies of Scope. A technological food crop-cash crop complementarity is evident from the 25% cost saving achievable when cash and food crops are produced within the same household as opposed to crop specialization in two separate households. This result depends on the presence of a non-congested or "public" input[2] (such as labor), which arises from the fact that certain cultural operations for cash and food crops are carried out at different times in the agricultural calendar.

The econometric analysis of household cost functions also revealed that households are producing beyond the point of minimum average cost for food crops. At the same time they are producing a lower amount of cash crops than that corresponding to the level at which average costs of producing cash crops are minimized. It is thus argued that the uncertainty of coarse grain markets is an incentive for households to produce food beyond the minimum cost level, given current technology and prices. Given these findings, forcing households to increase food crop production at the expense of cash crop production would on average lead to production at points of operation even further away from minimum average costs in the short run. The implication is, of course, of higher food costs for buying households.

[iii] Sectoral Complementarities (Infrastructure). Aside from micro-level, on-farm complementarities among crops, there are also complementarities between food crops and cash crops at the sectoral level. The parastatal SODEFITEX, for example, organizes farmers into producer associations, provides literacy programs in rural areas,

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[1]A further complementarity, important particularly in the drier areas of the Peanut Basin, is that between peanut hay required to sustain a horse during the dry season, and the increased size of the millet field that can be cultivated by the horse.

[2]The input is non-congested or "public" in the sense that it is not fully employed at all times (i.e., congested) if only one crop is grown.

erects storage facilities for coarse grains, and constructs roads providing access to rural areas (in some instances it would have been impossible to access the survey villages throughout the year without these roads). It is not obvious how these indirect benefits to production in the food sector can be quantified, but the evidence for sectoral complementarities in Senegal generally corroborates similar findings from Mali (Dioné, 1989).

[iv] Food-Cash Crop Marketing. If there are complementarities between cash crops and food crops at the input marketing and production levels, the relationship is somewhat competitive at the output marketing level. Households selling more cash crops are more likely to sell less food crops, ceteris paribus. This suggests that once cash needs are met through peanut and cotton sales, households may have less pressure to sell off food stocks. As in the case of production incentives, the challenge for policy makers in the short run is to stimulate household (production and) sales of both food crops and cash crops, so that the economies of scope are realized. As discussed below, policies other than those directly affecting relative food prices are available to stimulate marketed surpluses of coarse grains.

[v] Summary. Under existing technology and prices, the food crop-cash crop trade-off is less of a problem than commonly imagined when it is viewed from a cost miminization perspective. There is a cost saving, or certain resources fixed to the farm in the short run are more fully employed, when a household produces both cash and food crops. This is due to the existence of non-congested (i.e., slack) inputs such as labor or equipment. Furthermore, coarse grain market uncertainty was argued to lead to an interdependency between peanut seed, the amount of labor available to household heads and national food output. Improving the system that provides households with access to peanut seed is therefore important; the seed does not necessarily have to be delivered through SONACOS--private sector options (traders, on-farm storage) should also be explored.

In the short-term, reduced peanut seed availability could lead to a smaller labor force and lower rather than higher national cereals production. Increasing the relative profitability of cereals production, and the reliability of cereals markets, are two conditions (among others) necessary for reducing this interdependency between food and cash crops. More generally, future research should be directed toward improving the on-farm productivity and competitiveness of food crops and cash crops, and not focus exclusively on one type of crop or the other. This includes aggressively seeking new market outlets for cash crops and their by-products (see also Lele, 1989, who argues for the creation of a CGIAR-type cash crop research institute).

6.1.3. Intra-Cereals Substitution

Senegal's New Agricultural Policy also envisions that farmers will substitute (allegedly) more fertilizer-responsive maize for millet-sorghum production. This section examines production, transformation and consumption issues identified from the survey data, and related analyses of substitution and the potential expansion of maize production.

[i] Maize Production Constraints. Maize is traditionally cultivated near the compound (in 95% of the households sampled), where it benefits from night soil, animal manure and close supervision. It serves primarily as an early-maturing food security crop. The potential for expanding this type of maize production is limited, and output increases are likely to be possible only by shifting production to field crops.

In the northern survey area the availability of mineral fertilizer poses a constraint to extensified maize production, along with the relatively high moisture requirements of existing varieties. In the southern area (with more fertile soils), wildlife attacks pose the most important constraint. Maize is particularly vulnerable as it is among the first crops to mature in the growing season. In both areas the labor-intensive nature of maize cultivation (e.g., plowing) constrains the output of this crop. Overall, an integrated

package, including more drought-resistant varieties, insecticides, fertilizer and labor-saving technology should be provided if maize production is to be expanded. Also, resource management issues arise in the south with regard to wildlife and agriculture.

[ii] Processing and Transformation Issues. Given the subsistence-orientation of farm households, an assessment of the prospects for substituting maize for millet and sorghum production must include transformation and cooking requirements of these cereals (as well as consumption preferences, as discussed in [iii] below). Higher processing and cooking requirements of maize place it at a disadvantage relative to millet, sorghum and rice.[3] Imported rice is preferred, for example, because it requires no pounding labor relative to local coarse grains. As discussed further below, households with access to coarse grain transformation technology were less likely to purchase rice; this may reflect reduced preparation costs of local cereals. Policy makers need to consider the post-production tasks involved in transforming maize into an edible form in considering prospects for intra-cereal substitutions.

[iii] Consumption Preferences and Tastes. Farmers in southeastern Senegal prefer a dietary variety of coarse grains, which includes mixing of maize into traditional millet and sorghum dishes. Respondents on average indicated that their diets would comprise 33% rice, 27% millet, 22% maize and 18% sorghum if income were not a constraint and they had not produced any coarse grains themselves. Millet and sorghum are preferred especially during the growing season because farmers believe they "remain in the stomach for a longer period of time." Rice, on the other hand, is preferred for special occasions (ceremonies) and guests. So long as coarse grain markets are less-than-reliable, it will therefore be difficult to induce farmers to specialize in the production of a particular coarse grain (such as maize). Only when reliable markets provide a

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[3]The opposite argument is made in southern Africa regarding millet and sorghum.

variety of different cereals at reasonable prices will farmers be able to specialize in the production of a single cereal, and still maintain a dietary variety.

The data also suggest that households will switch their consumption back from rice to local coarse grains, for example, when a year of good own-cereals production follows one of poor production. This finding is in contrast to results reported for urban areas in West Africa, which reveal a low price elasticity of demand for rice by poor urban households (see, e.g., Reardon et al., 1989).

[iv] Summary. In assessing the response of rural households to a policy designed to change the mix of cereals production, relative production and transformation or processing costs both across and within different coarse grain types must be taken into account, along with consumption preferences and tastes of different ethnic groups. It is not as straightforward as assumed under the NAP to induce farmers to substitute maize for millet and sorghum production. A further issue, not addressed here but found to be of importance in countries such as Malawi, is the storability of different cereals and improved cereals varieties.

6.1.4. Output Market Reform

Using evidence of observed market prices in a poor and good rainfall year, and farmer responses to survey questions, coarse grain markets were argued to be thin and uncertain. This feature of coarse grain markets is important since it affects the behavior of farm households in three major areas: (1) in input markets, household heads are induced to form coalitions with their off-spring and to use peanut seed to attract non-family labor. Because coarse grains cannot serve as a reliable cash crop, peanut seed is necessary to attract additional workers, who in turn allow the production of more food; (2) in terms of crop mixes and production levels, coarse grain market uncertainty provides households with an incentive to grow both food and cash crops to meet household food and cash needs; and (3) in output markets, high transaction costs reduce

the propensity of households to participate in coarse grain markets. Households with off-farm income activities (interpreted as providing better market information and therefore lower transaction costs), are more likely to participate in food markets, as buyers or sellers, ceteris paribus.[4]

[i] Limits to a Floor Price Policy. The potential for using a floor price policy to stimulate the production and sales of coarse grains in the short run is limited. Even in an (on average) food surplus area in a year of normal rainfall (such as the north), 20% of the households were net buyers of food, while 21% did not participate in coarse grain markets. The official floor price raised the cost of food to buying households, reducing their real incomes, and it is not evident that they were able to respond positively to that policy, given poor (private) credit markets. Moreover, net sales of coarse grains were concentrated in a relatively small proportion of households (80% of total sales by volume being effected by 15% of all households), implying only narrow distributional benefits to the floor price policy.

In the southern area, where less than 10% of the households were estimated to have been net sellers of coarse grains and about 65% of the households failed to produce sufficient amounts of cereals (including rice) to last for one year, the floor price was not relevant since only small quantities of local coarse grains found their way into market places. Observed market prices (where they existed) were close to or even above the official floor price. There was thus no leverage point for government price policy in this region.[5]

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[4]Another effect of off-farm activities may be that the steady income stream which they provide increases the willingness and ability of households to manipulate their food stocks.

[5]A further problem with the floor price policy is that coarse grains produced in the Gambia were attracted into Senegal. Hence a minimum of cross-country price coordination is necessary if unexpected effects of price policies are to be avoided.

For a variety of reasons, most household heads (75%) favor a floor price policy and free cereals trade, but they disagree on a desireable price level (as expected, those not seeding an area to cereals in 1987 sufficient to cover household consumption needs favored a lower price, which in addition was lower in the northern than in the southern areas). Some farmers favor a floor price policy because they believe cereals would be more readily available. Nevertheless, over two-thirds of the household heads, including many in the northern areas who had experienced floor prices in 1987, indicated they would not change the area seeded to cereals if the floor price were abolished, raised or lowered.

[ii] Alternatives to Direct Price Policies. Price policies are preferred by decision makers since they appear to be tangible and straightforward as instruments for raising marketed quantities of coarse grains. However, indirect price policies, which may be more cost effective and equitable in the long run in stimulating production for sale by changing the opportunity cost of holding food stocks and participation in markets, should also be considered. Multiple regression analyses suggest the availability of mechanical coarse grain transformation technology reduces purchases of rice and also stimulates sales of coarse grains. Conceivably, the technology has this effect because it changes the relative opportunity cost of transforming coarse grains into an edible and/or marketable form. Providing more transformation technology to more farmers, is likely to have high pay-offs, although more research is needed to sort out supply-side (threshing) and demand side effects (milling). As suggested in the introduction to this section, it appears that households with more market information are more likely to participate in coarse grain markets because of lower transactions costs. The benefits of market information (as a public good) need to be weighed against the cost of providing it in geographically isolated areas.

[iii] Beyond Crop Policies. The need to pay head taxes to the State was cited as the most important first reason (36% of the responses) for selling cash crops. The value of taxes paid exceeded 20% of the gross value of all crops sold in 10% of the households sampled. To the extent that taxes reduce households' ability to invest in equipment, Senegal's rural tax policies may need to be re-evaluated (see Dione, 1989 for a more thorough discussion of this issue in Mali). Since farmers sell peanuts at government-subsidized prices to pay rural taxes, the question arises whether both taxes and subsidies should be reduced, and what the consequences would be for different types of farmers.

More generally, the data reveal that households pursue a variety of strategies beyond crop and/or food production to obtain income and/or achieve food security, including the pursuit of off-farm activities (in 65% of the households) and the raising of livestock. This in turn requires--and provides the opportunity or leverage points for--a broader approach toward rural economic development programs, rather than a singular crop-oriented focus, to raise rural incomes. The challenge is to attack problems on simultaneous fronts, raising the productivity of economic activities both on and off the farm.

6.1.5. The Privatization Debate

Most household heads (87%) indicated it is not a good idea for the government (parastatals) to withdraw from input marketing, and many (67%) doubt private cereals traders will be able to quickly fill the void left by state withdrawal. One-quarter of the respondents believe farmers do not have a moral obligation to repay fertilizer credits in the case of a crop failure. Most farmers (85%) would prefer to buy fertilizer and seeds through a farmer organization, but sell their cereals surpluses individually (58%). This could lead to credit repayment problems for traders. Existing sections villageoises, in the opinion of some farmers (56% in the north, 22% in the south), should not distribute the improved cereals inputs unless they are reorganized so as to reduce patronism. Two

frequently cited organizations which could, in the opinion of household heads, distribute inputs are L'Association des Jeunes Agriculteurs de la Casamance and L'Association Villageoises, i.e., farmer-organized groups (see also Diagana, 1988).

As recently as the 1987 agricultural season, trader involvement in fertilizer distribution was minimal in southeastern Senegal. Not surprisingly, cereals traders are unaware of fertilizer doses, compositions and timing of application for the soils of the regions they work in. SODEFITEX extension agents living in villages provide such information to farmers in their programs. This raises the questions, who will provide such knowledge to farmers under privatization?

Traders did sell equipment, draft animals and fungicides to farmers on a cash basis during the 1987 dry season. Why are these products purchased with cash, while fertilizer is not? On the one hand, fertilizer has not been available historically for distribution by private traders. On the other, equipment and draft animals are more durable and can be sold for food if there is a drought. Once applied, fertilizer is gone (except for marginal second-year benefits) and cannot be resold to buy food. Fungicide has a more or less proven record of effectiveness for farmers, is relatively inexpensive (and more necessary in the farmer's mind?), and is used on a crop which has assured market outlets at known prices--peanuts. This partially explains why there is effective cash demand for these inputs in the areas, but not for mineral fertilizer.

Further, market prospects for maize in rural areas are weak. This is due to consumer preferences for other cereals, problems of home-processing and storage of maize, and the fact that most farmers grow their own maize for consumption during the growing season. A potentially important role for the public sector is to fund research and pilot projects to expand maize utilization (for example, consider joint ventures between commercial food manufacturers and private traders). Demand for maize could be stimulated by developing new processing facilities, introducing more efficient stoves,

new product forms (especially for urban areas), and possibly using maize as livestock feed. Again, these developments are unlikely to materialize without some initial guidance and support from public sector research and development organizations.

A resilient private sector in Senegal appears potentially capable of carrying out more functions as envisioned under the NAP. Private actors are already selling certain types of agricultural inputs, and seeking out profitable trading opportunities (peanuts and their derivatives, consumer goods, Gambian rice and fertilizer). Morris (1988) has demonstrated for the Fleuve that the private sector can effectively compete with a parastatal if certain market-wide preconditions exist, and if private agents are not expected to bear all of the initial risks of a given activity (such as developing processing equipment). The same argument is likely to apply to southeastern Senegal.

An important privatization issue is not so much the question of whether the private or the public sector is "better" (i.e., more cost-effective) at supplying a certain set of services, but how the two sectors can best complement one another in providing the entire set of services required by producers and traders. While the record of dismal past parastatal performance cannot be ignored, not all parastatals are alike and important lessons about what does and does not work in terms of input distribution and output marketing can be learned, for example, from the SODEFITEX-model (including how they identify farmers with whom to work, how they organize the farmers into groups, and how they deal with debt repayment problems in the case of crop failures).[6] At the same time simple analogies across crop sectors must be drawn with caution; SODEFITEX operates with the considerable advantage that cotton cannot be consumed on the farm, which facilitates credit recuperation. Raising the on-farm productivity of cereals is one way of reducing default on cereals loans and increasing private sector involvement.

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[6]See Diagana, 1988, for a detailed discussion of how SODEFITEX organizes producers. Also Ba, 1986.

6.1.6. Privatization and the Interaction Among Technology, Prices and Institutions.

Some southern household heads indicated they would have saved rather than invested additional funds in agriculture in 1987. This response reflects limited perceived and actual investment opportunities due to a lack of labor and/or equipment markets combined with unreliable (food crops) or limited (cash crops) output markets (the latter due to limited inputs available from parastatals and/or for purchase from other producers in the case of peanut seed).

This suggests that there is a general coordination failure in the input-output markets surrounding farmers in southeastern Senegal. A counter-example case study shows that successful coordination can lead to high performance levels. One example is a farmer (also a village chief and religious leader) in the northern area who operates as follows: He works under a contract with the cotton parastatal SODEFITEX, which assures input delivery, an output market (for cotton and maize), and the presence of a SODEFITEX extension agent in the village. He uses the following technology package.

- a cotton-maize rotation
- plowing to the correct depth at the right time
- mineral fertilizer application at the right time, (using a dose somewhat higher than that recommended by ISRA)
- mechanical seeding and correct (intra- and inter-) row spacing
- herbicide applied at the right time combined with manual and mechanical weeding later in the season,

This individual was able to produce 4000 kg/ha of maize in one season, representing 3-4 times the average regional yield.[7]

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[7]The individual also had access to a travelling equipment repair man. The village was located at a distance of approximately 15 km from Ndoga Babacar, which constituted a

The argument is not that all economic activity has to be organized or coordinated by the public sector. However, a parastatal such as SODEFITEX has the economies of scale and size enabling it to provide an extension agent to relatively remote villages, as well as roads to access those villages. Without these "public" goods, which rational and self-motivated businessmen will not provide (even if they were able to) since they can not exclude other individuals from benefiting from such investments, private actors either will not become significant agents of change or they will do so at prohibitive costs. These costs will be passed on to farmers and consumers, unless productivity can be raised elsewhere in the food marketing chain in compensation.

A similar problem involves the supply of and demand for local coarse grains. Due to high transport costs and the relative isolation of rural areas, which together cause a subsistence-orientation in food production (see also Binswanger and McIntire, 1987), food supply and demand are poorly articulated by private, self-motivated actors: in good rainfall years, when supplies are high, demand is low and selling of food is not remunerative. The opposite obtains in poor rainfall years, with food becoming unaffordable. The average result is continued subsistence production with little incentive for investment in improved cereals technology--which is turn is interdependent with unavailability of the technology. Mechanisms are needed to coordinate and/or assist in managing food supply and demand over time by providing incentives to: (a) conduct storage functions (temporal arbitrage between good and bad years); (b) complete improved spatial arbitrage between food production deficit and surplus regions through reduced transport and information costs--the latter will be effective in stabilizing output markets if yields in different regions of Senegal are not co-variant; and (c) increase but stabilize demand in

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constraint to the marketing of cereals through private channels; however, the village was visited by a truck sent by SODEFITEX during the marketing season. As a reward for growing 8 ha of maize in 1985, and 9 in 1986, in his personal field, this individual was provided with an airplane ticket to Mecca by SODEFITEX.

food deficit areas over time by lowering costs of local cereals to consumers (through better processing, transport, etc.).

Under current conditions there is little rural specialization into agricultural and non-agricultural activities, which tends to be both caused by and a cause of unreliable output markets.[8] Until specialized non-farming firms (and urban areas) provide agricultural households with reliable sources of food demand, the presence of the CSA or some such demand-creating entity is necessary (but not sufficient) to stimulate coarse grain production. Higher coarse grain prices alone will not lead to the production of food surpluses among farmers barely able to meet subsistence requirements. An output price policy has to be complemented with an input package and a policy, or the development of a (credit) market, which relaxes resource constraints and provides some of the expected benefits accruing at harvest as early as the preceding planting season (so that the inputs can be purchased and used at that time). Obviously, increased marketed surpluses can lead to severely depressed output prices in the post-harvest season if output markets are not sufficiently integrated. This in turn affects the financial profitability to farmers of new technologies such as fertilizer. This is yet another instance of the important interaction among markets/institutions and technology.

6.2. LIMITATIONS OF THE STUDY AND DIRECTIONS FOR FUTURE RESEARCH

To some extent this study was handicapped by being carried out too early relative to actual policy changes in southeastern Senegal, an area about which little empirical knowledge existed previously. It was originally expected that changes in the input distribution system would take place before the study was completed, permitting a "pre- and post-NAP" analysis of farmer (and trader) behavior. In fact, parastatals continued to be the main actors in terms of input distribution (SONACOS' withdrawal from peanut

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[8]See also the argument in Shaffer et al., 1983.

seed sales on credit in 1987 being an exception). Nevertheless, the analysis of answers to hypothetical questions, aside from confirming manifest behavior, provided useful insights for evaluating the feasibility of certain policies in effecting economic growth in the area. One finding is that the private sector cannot be expected to immediately fill a vacuum left by parastatal withdrawal.

The study did not have the resources to examine anticipated intra-household effects of the NAP (other than superficially in terms of seed and chemical input allocation). Hence it is impossible to predict precisely how changes in technology and crop mixes will affect the welfare (income) and productivity of certain household members such as females.[9] These changes can be as subtle as a woman losing her remuneration for carrying millet from the field to the home when the household head adopts a cart and draft animal and carries out the task himself (Gastellu, 1988, p.125), or as obvious as in situations where men take on the growing of a crop following the introduction of a labor productivity-increasing technology (cf. von Braun, 1988, p.1095, for the case of rice in the Gambia).

The data collected provided some insight into food (cereals, and peanut) availability at the household level, but nothing could be said about the nutritional status of individual household members such as children. Some research suggests that access to kilocalories through cereals is positively correlated with adequate protein intake (see, e.g., Sukhatme, 1970). Collection of consumption and transactions price and quantity data for individual household members and food items would provide important insights in this regard.[10]

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[9]For example, Diop, 1985, p.167 writes that peanuts provide women with economic independence (from their spouses).

[10]In one southern market (Sare Yoba Diega) market transactions were insignificant, however.

Detailed crop budget information is required to understand the on-farm technological relationship between (cash and food) crops, and improved inputs such as fertilizer, under different soil types and rainfall conditions. Data on input allocation by crop (combined with seasonal consumption data) would also permit examining the effects of food consumption during the growing season on the productivity of labor (see, e.g., Strauss, 1986); studying the relationship between technical-scientific knowledge of farmers and the profitability of improved technology; and evaluating the changes (if any) in productivity needed to make cereals more competitive with traditional "cash crops".

This study was also unable to investigate in sufficient detail the effects of off-farm activities and livestock ownership on household welfare. More research is needed on the benefits and costs of these alternative income-generating activities, the skills and knowledge required to pursue them, and their effects on the willingness and ability of households to invest in improved inputs. Results from such findings need to be related to increased specialization, productivity and employment in rural areas of Senegal.

As this study has shown, it is not enough to focus only on on-farm production of cereals, if the welfare of rural residents is to be increased. More research is needed on the benefits and costs of related activities which add value (utility) to the product, such as storing, processing, cooking and transportation of cereals, and the role of tastes in driving production and consumption.[11] Imported (broken) rice is favored not necessarily because it is viewed as a luxury item but because it offers real economic advantages in terms of preparation costs.[12]

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[11]Millet cannot be stored, for example, once it has been processed. This reduces the incentive for employing mechanical transformation technology located at some distance from one's residence. One program strategy could be promoting the development of small-scale, low cost technology which would be made available to all villages.

[12]Ross (1980) discusses problems involved in encouraging urban consumers (Dakar) to switch from imported rice to millet and maize (and local rice). He also finds that consumers with higher incomes are willing to pay a premium for the Siam rice variety,

A final limitation of this study, as is true of all short-term efforts, is that it covered only a 12-month period with unique rainfall characteristics and patterns of resource ownership and allocation. Hence the conclusions must be interpreted with caution. Ideally, a panel of farmers would be followed over a number of years to better understand their coping strategies and behavior.

6.3. KNOWLEDGE, PERCEPTIONS AND BELIEFS: IMPLICATIONS FOR EXTENSION AND FURTHER RESEARCH EFFORT ON THE MARKET REFORM PROCESS

Policy reform is not a one-time activity, although privatization is often billed as such. Policy makers and analysts (advisors) are dealing with complex food systems and detailed micro-level empirical knowledge is needed to test the assumptions, driven by ideology, lack of data or both, underlying recommendations for restructuring incentives of food system participants to increase the welfare of rural residents. In Senegal, it is attractive but not sufficient to decree reduced peanut seed distribution on credit; to demand increased use of fertilizer on cereals; and to mandate a producer floor price for cereals to raise national food production and rural welfare.

Policy reform should also not be limited to a single, topical "issue" in the input-production-marketing-consumption sequence. Increased production of food through new inputs will not fully benefit urban consumers if transportation and processing bottlenecks prevent food prices from falling as much as they could have in response to increased (unprocessed) supplies. It behooves policy makers to not place all their eggs in a single basket.

The knowledge generated in this study contributes to an understanding of the possible effects of new policies, and how food system participants may or may not

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suggesting future analyses must take into consideration different types of rice.

respond to them. However, as the dynamic food system evolves under a new set of policies, it will be necessary to continue to monitor the effects of, and constraints to the implementation of, economic development programs through data collection and analysis of economic activities in rural areas.

APPENDIX A-1:
EQUIPMENT AND DRAFT ANIMAL PRICES

TABLE A-1a: EQUIPMENT PRICES

Item	Total Cost	Annual Cost[a]
	--------in FCFA--------	
Plow	20,000	6,200
Hoe	24,000	7,740
Seeder	20,000	6,200
Souleveuse[b]	18,000	6,000
Cart[c]	19,000-24,000	2,100

Source: SODEFITEX (B. Diop), personal communication, 1987 (except for souleveuse).
a. Purchased on credit.
b. Estimate.
c. Depending on draft animal.

TABLE A-1b: DRAFT ANIMAL PRICES

Item	Total Cost (FCFA)	Useful Life (Years)	Annual Cost (FCFA)
Cattle/Oxen	57,375	5	11,475
Horse	85,000	8	10,625
Donkey	17,500	7	2,500

Source: ISRA/MSU FSP Surveys, 1986/7.

APPENDIX A-2:
PARTIAL BUDGET FOR HERBICIDE USE
CASE STUDY IN THE SOUTHERN AREA

The following calculations, using data from one progressive southern farmer, illustrate the monetary trade-offs between manual weeding and the use of herbicides.

Assumptions: Only one weeding operation or one application of herbicide are carried out since animals were grazed in the field prior to planting and, according to the farmer, the urine of animals killed off some of the weeds; herbicide is applied after seeding, the manual operation is carried out 15 days after seeding.

Cash cost of 1 liter (l) of herbicide is 2,500 FCFA.
Application rate is 4 l/ha.
Credit cost of herbicide pump = 18,000 FCFA, amortized over 5 years and 2 hectares.
Cash cost of batteries = 415 FCFA/pack of 5 batteries.
Cost of application labor = 0.5 hours valued at 114 FCFA/hour.

Cost of manual weeding = 124 hours per ha valued at 114 FCFA/hour.

TABLE A-2: PARTIAL BUDGET CALCULATIONS

Expense Item	CFA	Total CFA
Cost of Manual Weeding		14,592
Cash cost of Herbicide	10,000	
Batteries	415	
Labor for Application	57	
Cost of Herbicide Pump	1,800	
Total		-12,272
Net Grain (Manual-herbicide)		2,320
Gross Benefit-Cost Ratio		1.19

Source: ISRA/MSU FSP Surveys, 1986/7.
Note: if the herbicide had been bought on credit @ 2850 FCFA/l, the net gain would have fallen to 920 FCFA.

APPENDIX A-3:
FERTILIZER BENEFIT-COST RATIOS BASED ON FARMERS' YIELD RESPONSE PERCEPTIONS

ASSUMPTIONS USED IN CALCULATING BENEFIT-COST RATIOS

[TABLES A-3a, A-3b, AND A-3c]

1. Using 1986 yield averages by Arrondissement, which reflect the use of fertilizer on some of the cereals (therefore there is a tendency to overestimate yields under the "no fertilizer" situation).

2. Assumes farmer applies all the fertilizer at recommended application rates (exception in Table A-3b).

3. Assumes official prices (except in Table 3-20 in the text).

4. Labor cost of fertilizer application is not taken into account.

TABLE A-3a: PARTIAL FERTILIZER BUDGET ANALYSIS USING FARMERS' YIELD RESPONSE PERCEPTIONS

A. 1987 RAINFALL CONDITIONS

CFA/kg Output: 70	Sine Saloum (Koungheul)	Sen. Oriental (Maka)	Casamance (see note)
1. MILLET YIELD	782	781	778
Base Yield	782	781	778
Value of Output	54,740	54,670	54,460
Kgs NPK + Urea	200	200	200
NPK CFA/kg	88	91	94
Urea CFA/kg	77	80	83
Total Cost	17,050	17,650	18,250
Yield w/ fert.	1,228	1,218	1,486
Value of Output	85,942	85,285	104,019
Net Benefit	14,152	12,965	31,309
Gross B/C Ratio	1.83	1.73	2.72
2. SORGHUM YLD.	957	905	1,082
Base Yield		905	1,082
Value of Output		63,350	75,740
Kgs NPK + Urea		200	200
NPK CFA/kg		91	94
Urea CFA/kg		80	83
Total Cost		17,650	18,250
Yield w/ fert.		1,466	2,034
Value of Output		102,627	142,391
Net Benefit		21,627	48,401
Gross B/C Ratio		2.23	3.65
3. FLD MAIZE YLD	1,141	1,073	1,206
Base Yield	1,141	1,073	1,206
Value of Output	79,870	75,110	84,420
Kgs NPK + Urea	250	250	250
NPK CFA/kg	88	91	94
Urea CFA/kg	77	80	83
Total Cost	20,900	21,650	22,400
Yield w/ fert.	1,848	1,663	2,340
Value of Output	129,389	116,421	163,775
Net Benefit	28,619	19,661	56,955
Gross B/C Ratio	2.37	1.91	3.54

Arrondissements are: Kounkane, Dabo and Dioulacolon

TABLE A-3b: PARTIAL FERTILIZER BUDGET ANALYSIS USING FARMERS' YIELD RESPONSE PERCEPTIONS

B. POOR RAINFALL CONDITIONS [HALF DOSE OF FERTILIZER]

CFA/kg Output: 70	Sine Saloum (Koungheul)	Sen. Oriental (Maka)	Casamance (see note)
1. MILLET YIELD	782	781	778
Base Yield	430	266	381
Value of Output	30,107	18,588	26,685
Kgs NPK + Urea	100	100	100
NPK CFA/kg	88	91	94
Urea CFA/kg	77	80	83
Total Cost	8,525	8,825	9,125
Yield w/ fert.	954	461	716
Value of Output	66,783	32,255	50,103
Net Benefit	28,151	4,842	14,293
Gross B/C Ratio	4.30	1.55	2.57
2. SORGHUM YLD.	957	905	1,082
Base Yield		262	584
Value of Output		18,372	40,900
Kgs NPK + Urea		100	100
NPK CFA/kg		91	94
Urea CFA/kg		80	83
Total Cost		8,825	9,125
Yield w/ fert.		407	1,017
Value of Output		28,508	71,196
Net Benefit		1,311	21,171
Gross B/C Ratio		1.15	3.32
3. FLD MAIZE YLD	1,141	1,073	1,206
Base Yield	616	215	507
Value of Output	43,130	15,022	35,456
Kgs NPK + Urea	125	125	125
NPK CFA/kg	88	91	94
Urea CFA/kg	77	80	83
Total Cost	10,450	10,825	11,200
Yield w/ fert.	1,460	633	1,013
Value of Output	102,234	44,315	70,913
Net Benefit	48,654	18,468	24,256
Gross B/C Ratio	5.66	2.71	3.17

Arrondissements are: Kounkane, Dabo and Dioulacolon

TABLE A-3 : PARTIAL FERTILIZER BUDGET ANALYSIS USING FARMERS' YIELD RESPONSE PERCEPTIONS

C. POOR RAINFALL CONDITIONS [FULL DOSE OF FERTILIZER]

CFA/kg Output: 70	Sine Saloum (Koungheul)	Sen. Oriental (Maka)	Casamance (see note)
1. MILLET YIELD	782	781	778
Base Yield	430	266	381
Value of Output	24,086	14,870	21,348
Kgs NPK + Urea	200	200	200
NPK CFA/kg	88	91	94
Urea CFA/kg	77	80	83
Total Cost	17,050	17,650	18,250
Yield w/ fert.	954	461	716
Value of Output	53,426	25,804	40,083
Net Benefit	12,291	(6,716)	484
Gross B/C Ratio	1.72	0.62	1.03
2. SORGHUM YLD.	957	905	1,082
Base Yield		262	584
Value of Output		14,697	32,720
Kgs NPK + Urea		200	200
NPK CFA/kg		91	94
Urea CFA/kg		80	83
Total Cost		17,650	18,250
Yield w/ fert.		407	1,017
Value of Output		22,806	56,956
Net Benefit		(9,541)	5,987
Gross B/C Ratio		0.46	1.33
3. FLD MAIZE YLD	1,141	1,073	1,206
Base Yield	616	215	507
Value of Output	34,504	12,018	28,365
Kgs NPK + Urea	250	250	250
NPK CFA/kg	88	91	94
Urea CFA/kg	77	80	83
Total Cost	20,900	21,650	22,400
Yield w/ fert.	1,460	633	1,013
Value of Output	81,787	35,452	56,730
Net Benefit	26,383	1,784	5,965
Gross B/C Ratio	2.26	1.08	1.27

Arrondissements are: Kounkane, Dabo and Dioulacolon

APPENDIX A-4:
PRINCIPAL FIELD MAIZE PRODUCTION PROBLEMS

TABLE A-4: PRINCIPAL GENERAL FIELD MAIZE PRODUCTION PROBLEMS, 1987

	North	South	Total
	----% of Households----		
First Response			
Wildlife Predators.....	2%	75%	39%
High Fertility Needs.....	56%	2%	29%
Labor Intensive.....	20%	8%	14%
High Rainfall Needs.....	20%	0%	10%
Insect Attacks.....	0%	14%	7%
Other Response.....	2%	2%	2%
Total.....	100%	100%	100%
Second Response			
High Fertility Needs.....	38%	25%	31%
Wildlife Predators.....	21%	29%	26%
Insect Attacks.....	0%	24%	13%
Labor Intensive.....	21%	18%	19%
High Rainfall Needs.....	14%	0%	6%
Other Response.....	5%	4%	4%
Total.....	100%	100%	100%
Third Response			
Insect Attacks.....	23%	38%	33%
Wildlife Predators.....	27%	27%	27%
Labor Intensive.....	18%	21%	20%
High Fertility Needs.....	0%	13%	9%
Other Response.....	23%	2%	9%
High Rainfall Needs.....	9%	0%	3%
Total.....	100%	100%	100%

Source: ISRA/MSU Food Security Project Survey, 1987

APPENDIX A-5:
PRICES UNDERLYING THE COST DATA

TABLE A-5: PRICES OF VARIABLE INPUTS[a]

Item	Unit	FCFA per Unit
N-P-K Fertilizer	kg	88
Urea Fertilizer	kg	88
Insecticdes	liters	40
Herbicide	kg	2,700
Fungicide	kg	300
Coarse Grain Seed	kg	70
Rice Seed	kg	130
Peanut Seed	kg	90
Cotton	kg	100
Labor[b]	AEP-hrs	98.5

Source: ISRA/MSU FSP Survey, 1987

a. See Appendix A-1 for fixed costs (equipment prices) and draft animal prices.

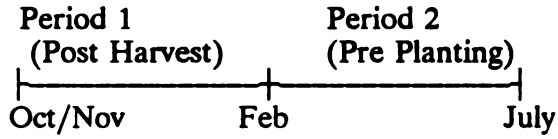
b. Wage rate varies by region; labor is assumed to be employed for 10 months, at 30 days a month and 8 hours per day.

APPENDIX A-6:
NOTE ON THE "FORCED SALES" HYPOTHESIS

15 households both sold and bought coarse grains during the survey period.

Of these 15 households, 12 were in the north and 3 were in the south. Since the northern areas are more "commercially active," this suggests the northern households were possibly already responding to the New Agricultural Policy, i.e., engaging in cereals trade.

Note on time periods:



Of the 12 northern households in the buy&sell category,

5 households sold bought	74 kgs during period 1 and 109 kgs during period 2.
1 household sold bought	20 kgs and 50 kgs, both in period 1.
1 household sold bought	350 kgs and 150 kgs, both in period 2, and

5 households appeared to be trading within or across the two periods, i.e., they first purchased coarse grains and then sold coarse grains (all but one of these households--buying 82 kgs in period 1 and selling & buying 400 kgs during period 2 were net coarse grain sellers).

For the three southern households in the buy&sell category,

1 household bought sold	200 kgs and 250 kgs, both in period 1.
1 household bought sold	284 kgs in period 1 and 47 kgs and bought 234 kgs, both in period 2.
1 household sold bought	280 kgs in period 1 and 14 kgs in period 2.

From the above, and on the basis of the small number of households involved, it is concluded that the hypothesis of "forced sales" after harvest and repurchases later on in the season at higher prices generally does not hold for this sample.

APPENDIX A-7:
RESERVATION PRICES FOR SELLING CEREALS

TABLE A-7: HOUSEHOLD HEADS' RESERVATION PRICES FOR SELLING THEIR OWN CEREALS, JUNE 1987

	North			South			
	D[a]	SS	S	D	SS	S	Total[b]
Mean FCFA	83	94	101	113	107[c]	99	104
Std. Devn.	24	21	25	46	28	28	34
Valid N.	4	24	45	50	23	6	152

Source: ISRA/MSU FSP Survey, 1987

a. D=Deficit, SS=Self-sufficienct; S=Surplus area seeded to coarse grains in 1987 (according to farmer's assesment).

b. For 154/208 (=74%) farmers willing to give a response.

c. Calculation excludes 2 outliers of 500 FCFA/kg.

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