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The purpose of the study was to analyze farm level coarse grains (millet, sorghum, maize) production and market and non-market transactions in the OHV and CMDT regions of southern Mali.

Primary data, collected in a series of region-wide surveys of 189 farmers from September 1985 to October 1986, were used in the analysis which included descriptive statistics, multiple regression, and tests of statistical inference.

The results point to the importance of domestic grain production in household level food security, but also of the role of the institutional environment, on-farm and off-farm diversification, the timing of cash obligations and market proximity.

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COARSE GRAIN PRODUCTION AND TRANSACTIONS IN MALI: FARM HOUSEHOLD STRATEGIES AND GOVERNMENT POLICY

by

Victoire Cristina D'AGOSTINO

Projet Sècurité Alimentaire C.E.S.A. - M.S.U.
BP 2314
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REPUBLIQUE DU MALI

SECRETARIAT TECHNIQUE DE LA CESA

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COARSE GRAIN PRODUCTION AND TRANSACTIONS IN MALI: FARM HOUSEHOLD STRATEGIES AND GOVERNMENT POLICY

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Victoire Cristina D'AGOSTINO

PREFACE

This thesis was prepared as part of a research project on food security carried out under the auspices of the Technical Secretariat of the Malian Food Strategy Commission (CESA--Commission Nationale d'Evaluation et Suivi de la Stratégie Alimentaire du Mali). The research project was conducted jointly by researchers from CESA and the Department of Agricultural Economics of Michigan State University (MSU), with funding provided by the U.S. Agency for International Development under the Food Security in Africa Cooperative Agreement between MSU and USAID (No. DAN-1190-A-00-4092-00). Preliminary results from this research project have already been published in Mali in the form of working papers, several of which are cited in the bibliography.

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COARSE GRAIN PRODUCTION AND TRANSACTIONS IN MALI: FARM HOUSEHOLD STRATEGIES AND GOVERNMENT POLICY

By

Victoire Cristina D'Agostino

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ABSTRACT

COARSE GRAIN PRODUCTION AND TRANSACTIONS IN MALI:
FARM HOUSEHOLD STRATEGIES AND GOVERNMENT POLICY

By

Victoire Cristina D'Agostino

The purpose of this study was to analyze farm-level coarse grain (millet, sorghum, and maize) production and market and non-market transactions in the Operation Haute Vallee and Compagnie Malienne de Developpement des Textiles regions of southern Mali. The study was part of a larger microeconomic research effort undertaken as part of the Michigan State University Food Security Project.

The analytical measures include descriptive statistics, multiple regression and inferential statistical tests. Primary data were collected in a series of region-wide farm surveys of 189 farmers from September 1985 to October 1986. Baseline data, as well as data on village characteristics, household cereals production and stocks, monthly coarse grain transactions, and taxation were used in the analysis.

The results primarily point to not only the importance of domestic grain production in assuring household level food security, but also the role of the institutional environment, on-farm and off-farm diversification, the timing of cash obligations, and market proximity in determining grain transaction behavior and thus forming an integral part of farm household food security strategies.

To

My parents, Annie-Claude and Thomas D'Agostino

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TABLE OF CONTENTS

		Page
LIST OF TABLES		v
LIST OF FIGURES		viii
CHAPTER		
1.	INTRODUCTION	1
	Problem Statement and Setting	3
	Research Question	6
	Objectives of the Study	7
	Scope of the Study	7
	Research Methodology	8
	Organization of the Thesis	14
2.	APPROACHES TO THE STUDY OF AGRICULTURAL DECISION-MAKING IN DEVELOPING COUNTRIES	16
	The Anthropological View	18
	The Economic Perspective	23
3.	CONCEPTUAL FRAMEWORK FOR THE STUDY	32
	Factors Affecting Production	35
	Factors Affecting Coarse Grain Transactions	38
4.	AGRICULTURAL CHARACTERISTICS OF THE STUDY AREA	46
	Physical Environment	46
	Cropping Patterns	49
	Institutional Environment	56
	Survey Villages	60
	Farmer Characteristics from the Census	62
	Conclusion	72
5.	FARM HOUSEHOLD LEVEL ANALYSIS OF COARSE GRAIN PRODUCTION AND TRANSACTION BEHAVIOR	75
	Preliminary Results	75
	Econometric Methods	91
	Specification of the Cereals Production Models	94
	Empirical Results: Cereals Production and Labor Productivity	103
	Specification of the Cereals Transactions Models	113
	Empirical Results: Cereals Market and Non-Market Transactions	124

CHAPTER

Page

6. CONCLUSION. 144
Summary of Findings 144
Policy Implications 151
Areas for Further Research. 162

APPENDIX A
ALTERNATIVE SPECIFICATIONS OF THE COARSE GRAIN PRODUCTION MODEL. 167

APPENDIX B
1985/86 PRICE CYCLE: Rural Assembly Market Price of Millet in Zangasso (South CMDT), November 1985 - October 1987 173

BIBLIOGRAPHY. 174

LIST OF TABLES

		Page
4.1	Percentage Crop Area Cultivated by ODR (1986-87). . .	51
4.2	Percentage of Crop Production by ODR (1986-87). . . .	52
4.3	Total Area Cultivated by ODR in Hectares (1984-86). .	53
4.4	Production of Principal Crops by ODR in Metric Tons (1984-86)	54
4.5	Yields of Principal Crops by ODR in kg/ha (1984-86) .	54
4.6	OHV and CMDT Survey Village Characteristics	61
4.7	Percentage of Census Farms by Equipment Levels. . . .	63
4.8	Percentage of Census Farms by Access to Equipment . .	64
4.9	Percentage of Census Farms Expanding Land	65
4.10	Percentage of Census Farms by Farm Size	67
4.11	Mean Farm Family Size of Census Farms	68
4.12	Percentage of Census Farms by Household Food Situation.	69
4.13	Percentage of Census Farms Engaging in Non-Agricultural Activities	70
4.14	Cereals Market Participation by Census Farms.	71
5.1	Coarse Grain Production by Farm Households in the OHV and CMDT Zones in 1985.	76
5.2	Coarse Grain Sales by Farm Households in the OHV and CMDT Zones during 1985/86	79
5.3	Seasonal Distribution of Grain Sales by Farm Households in the OHV and CMDT Zones during 1985/86	81

Page

5.4 Most Important Reason Given for Coarse Grain Sales by Sample Households in the OHV and CMDT Zones during 1985/86 (Percentage of Farmers Reporting Sales) 82

5.5 Estimated Concentration of Coarse Grain Sales by Farm Households in the OHV and CMDT Zones during 1985/86 83

5.6 Estimated Coarse Grain Purchases by Farm Households in the OHV and CMDT Zones during 1985/86. 86

5.7 Most Important Reasons Given for Coarse Grain Purchases by Sample Households in the OHV and CMDT Zones during 1985/86 (Percentage of Farmers Reporting Purchases). 87

5.8 Principal Revenue Source Used to Finance Coarse Grain Purchases Made by Sample Households in the OHV and CMDT Zones during 1985/85 (Percent of Farmers Reporting Purchases). 88

5.9 Coarse Grain Gifts and Barter by Farm Households in the OHV and CMDT Zones during 1985/86 90

5.10 Estimated Equations for Total Cereal Production: OHV and CMDT Regions of Mali, 1985. 104

5.11 Estimated Equations for Value Generated Per Farm Worker: OHV and CMDT Regions of Mali, 1985 109

5.12 Estimated Equation for Gross Coarse Grain Sales by Sample Farmers: OHV and CMDT Regions of Mali, 1985 125

5.13 Estimated Equation for Non-Monetary Transactions by Sample Farmers: OHV and CMDT Regions of Mali, 1985 127

5.14 Estimated Equation for Total Cereals Outflows by Sample Farmers: OHV and CMDT Regions of Mali, 1985 129

5.15 Estimated Equation for Gross Cereals Purchases by Sample Farmers: OHV and CMDT Regions of Mali, 1985 131

5.16 Estimated Equation for Net Cereals Sales by Sample Farmers: OHV and CMDT Regions of Mali, 1985 133

Page

5.17 Estimated Equation for Cereals Availability Per Consumer: OHV and CMDT Regions of Mali, 1985 136

5.18 Estimated Equation for First Trimester Sales of Coarse Grains by Sample Farmers: OHV and CMDT Regions of Mali, 1985 139

5.19 Estimated Equation for Third Trimester Sales of Coarse Grains by Sample Farmers: OHV and CMDT Regions of Mali, 1985 141

LIST OF FIGURES

		Page
1.1	Mali: Study Areas and Regional Boundaries.	9
3.1	Conceptual Model of Coarse Grain Allocation	44
5.1	Concentration of Net Sales.	84

CHAPTER 1

INTRODUCTION

The state of agriculture and the food crisis in sub-Saharan Africa has been extensively examined (World Bank, 1981; Shapouri et al. 1986; Eicher and Staatz, 1986; Berry, 1984). The importance attributed to this subject is not surprising given that most of the populations in sub-Saharan countries are in some way involved in the agricultural system and that official estimates of agriculture's share of GDP in most countries range between thirty and sixty percent (World Bank, 1981). Much of the literature on the food crisis cites declining average per capita food production, increasing commercial food imports and food aid as indicators of the severity of the crisis. Some writers have broadened the debate on the state of sub-Saharan agriculture to not only include questions of food availability, but also questions of food entitlements, thus distinguishing between problems of production and problems of access to food supplies from trade and own production (Sen, 1981; Streeten, 1983; Mellor and Johnston, 1984).

The term "food security" has become used to denote this dual nature of the food crisis in Africa and is defined as "the ability of a country or region to assure, on a long-term basis, that its food system provides the total population access to a

timely, reliable and nutritionally adequate supply of food" (Eicher and Staatz, 1986). This definition incorporates both supply and demand sides of the food situation, and has been otherwise called the "food security equation" (Rukuni and Eicher, 1987). While the demand side of the household food security equation is concerned primarily with purchasing power and thus income constraints, the supply side encompasses all aspects of food availability, which is at the same time an issue of production, marketing, processing, and storage. In developing countries in which the agricultural population represents a significant share of the total population, the distinction between the supply and demand side of the food security equation becomes less clear because farmers allocate their own production not only to home-consumption and storage but also to monetary and non-monetary transactions (including gifts, exchange and barter).

In Mali, a country in which the rural population represents approximately 85% of the total population of 7.6 million inhabitants (Republique du Mali, 1987), the government's National Food Strategy outlined in 1982 has underscored the importance attributed to issues of food security. The focus of the research presented in this thesis will be on issues of food availability and food access. More specifically, this thesis will treat the subject of coarse grain production, disposal of production, and farmer food strategies in the main agricultural surplus zones of Mali.

Problem Statement and Setting

Since 1981, the Government of Mali has undertaken a series of policies designed to reform cereals marketing under the auspices of the PRMC (Programme de Restructuration du Marche Cerealier). While these reforms have represented a major shift in cereals policy for Mali, the goals that have historically characterized official cereals marketing and price policy have not changed significantly.

Stated government policy has principally centered around two goals: an income objective and a production objective (Humphreys, 1986). The income objective has been manifested in official policy stressing the importance of increasing or protecting the incomes of both producers and consumers. However, although prior to the PRMC it had been a stated government policy objective to assure producer incomes by state grain board purchases of cereals at remunerative prices, in reality this policy amounted to little more than an income transfer from producers to consumers. In order to protect consumer incomes, grain board sales were maintained at stable (and low) prices possible only because of a system of forced sales and quotas in the rural areas.

The second objective which has influenced Mali's cereals policy and is still very much part of the cereals policy reforms has been that related to cereals production. Specifically, the Government of Mali has always maintained food self-sufficiency

as a priority objective to be achieved through an increase in domestic cereals production.

In 1981, with the advent of the PRMC, the Malian government's methods of assuring the protection or increase of incomes and the increase in domestic cereals production altered. Among its objectives, the PRMC sought to increase official prices to consumers and producers and to liberalize private grain trade. Both measures were designed to provide farmers with production incentives.

While the twin objectives of increased cereals production and farm revenue have been part of the policy of cereals marketing reform in Mali from the beginning, it is far from certain whether any progress towards attaining these objectives has yet been made. Cereals production has been erratic since the reforms were instituted in 1981/82 and appear to be correlated more with rainfall than with official price patterns. During the first three years of the PRMC, cereals production was acutely deficit, with the 1984 production making up only 50% of the estimated national consumption needs. During the past two years (1985/86 and 1986/87), however, the cereals harvest has been exceptionally large and this has reversed Mali's food situation.

Most evaluations of the PRMC conclude that it is impossible to see a direct causal link between the policy reforms and short-run farmer decision-making about acreage expansion, intensification, or transactions of coarse grains. Given that the PRMC reforms concerning the provision of producer incentives

to augment their production and marketed surplus have largely revolved around price policy, it becomes necessary to examine several issues. One concerns the appropriateness of price policy to influence domestic cereals production: in a country where dryland grain production is extremely variable, are farmers responsive to price signals in their production decisions over the long run or the short run? Another issue concerns the identification of policy instruments, other than price policy, which might influence coarse grain production and disposal activities more directly.

It would appear that in order to identify policies to address the associated problem of cereals production and disposal of that production, it is necessary to have a clearer understanding of farmer strategies vis-à-vis the production, storage and disposal of their coarse grains. These strategies not only condition the way these farmers respond to government policies related to the cereals subsector, but also determine the food security position of different groups of farmers as well as urban consumers.

It is hoped that this study will contribute to a better understanding of the cereals production and disposal strategies followed by different groups of farmers in Mali. It is anticipated that an appreciation of the diversity of the strategies farmers employ to assure their food security will lead to more appropriate policy measures to meet the goals of Mali's food strategy.

Research Question

The central research question to be addressed in this study is whether coarse grains production, use of this production, and consequently food security can be influenced through policy, and if so, what possible policy alternatives could be.

In order to shed light on this major question, the research will focus on answering the following subsidiary questions:

1. How and to what extent does total coarse grain production and production per farm worker vary between farmers and among households in the same area?
2. What factors contribute to observed levels of coarse grain production and production per farm worker?
3. How and to what extent do market and non-market transactions of coarse grains vary between farmers and among households in the same area and across time?
4. What factors contribute to observed levels of market and non-market transactions for coarse grains?
5. How do farmers combine coarse grain production, storage, sales and non-monetary transactions in constituting their families' food security strategies?
6. How is household-level food security influenced by rural differentiation, and what does this imply for the equity effects of agricultural policies?

Objectives of the Study

The objectives of the study are:

1. To present evidence to further support findings concerning rural differentiation among Malian farmers.
2. To develop socio-economic models of factors that influence decisions to produce, sell, give and exchange coarse grains.
3. To describe, with the aid of these models, how the diversity among groups of Malian small-holders, combined with the physical, cultural and policy environment, condition farm household behavior vis-à-vis coarse grain production and market and non-market transactions.
5. To make recommendations as to possible policy measures that might influence the production and allocation of coarse grains by different groups of Malian small-holders.
6. To identify further research questions.

Scope of the Study

This study, essentially an analysis of coarse grain production and transaction decisions, is based on the premise that a fuller understanding of the decision-making processes of Malian farmers with regard to these transactions can only be obtained through a disaggregation of the decision process itself. Of primary interest are the determinants of production and transaction decisions and the identification of policy levers available to influence these decisions.

The study is an analysis of cross-sectional data collected in the Operation Haute Vallee (OHV) and Compagnie Malienne pour le Developpement des Textiles (CMDT) zones of Mali during the period 1985-1987.

Research Methodology

The data used in the analysis to be presented in this thesis were collected as a component of a larger study of the millet, sorghum and maize subsectors in Mali, under the auspices of the Food Security Project M.S.U. - C.E.S.A. While the project has as its objective the study of the entire cereals marketing channel of farmers, rural markets, traders, transporters, and urban markets, the data used here are drawn primarily from the farmer component (Dione, Dembele, and Mariko, 1986).

Selection of Zones

The zones of study, the CMDT and the OHV, were selected because they are in the most productive regions of Mali--the regions of Bamako, Segou and Sikasso (Figure 1.1). The rainfall in these zones is the highest in Mali. The level of technology employed by farmers in these zones is relatively elevated by Malian standards, principally due to the combined effects of improved technologies employed in cotton, maize and tobacco; better organized agricultural extension; and access to credit provided by the OHV and the CMDT. In the case of the CMDT farmers, the relatively higher level of technology is due in large part to access to inputs associated with cotton production (Dione, Dembele, and Mariko, 1986).

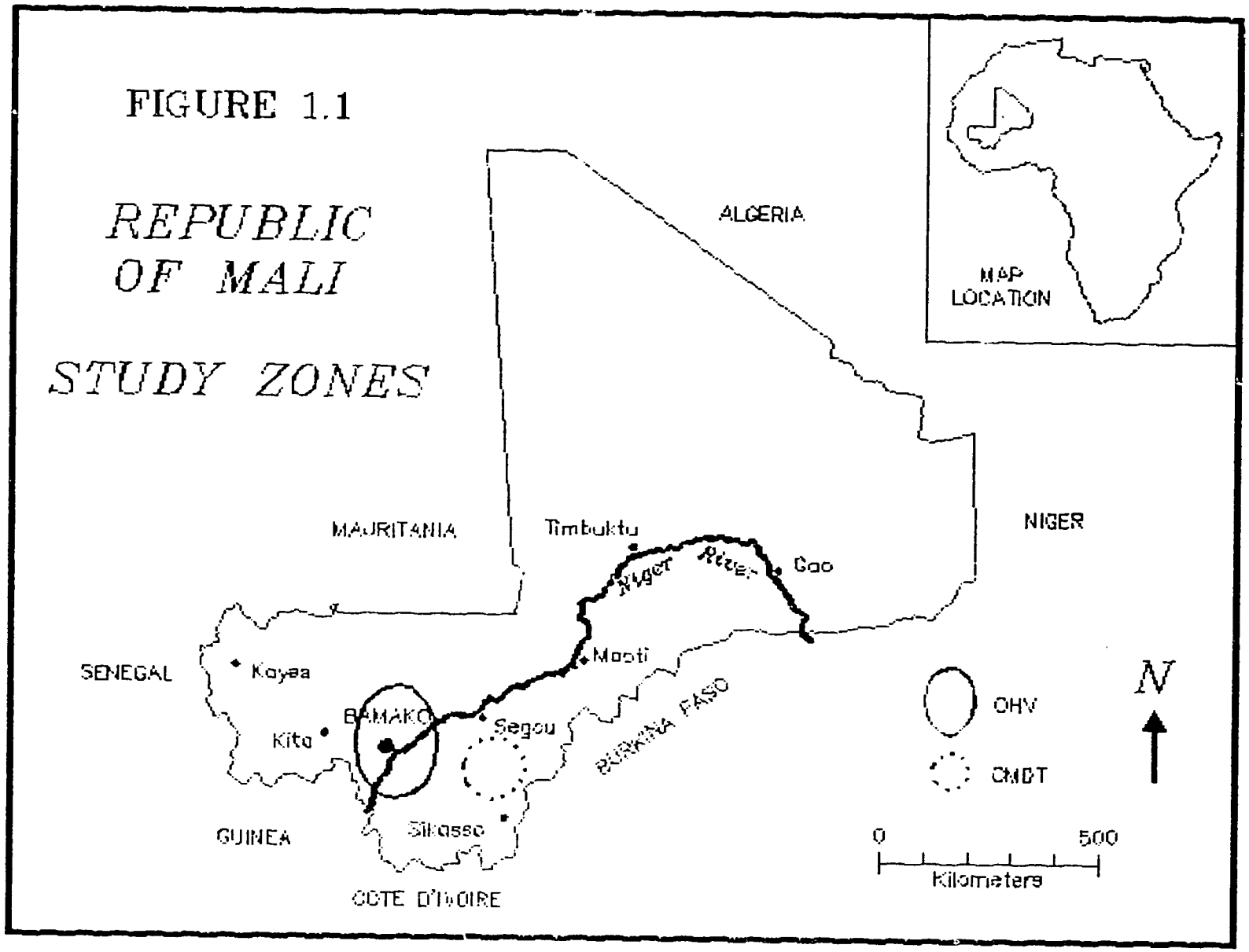
FIGURE 1.1
REPUBLIC OF MALI
STUDY ZONES
ALGERIA
MAP LOCATION
MAURITANIA
NIGER
SENEGAL
GUINEA
COTE D'IVOIRE
BURKINA FASO
Timbuktu
Gao
Niger River
Mopti
Segou
BAMAKO
Kita
Kayes
Sikasso
OHV
CMDT
N
0
500
Kilometers

The selection of these two zones was based on the assumption that these areas have the greatest potential of producing a marketable cereals surplus, and therefore the effects of policy reforms concerning cereals production and commercialization will be felt the most in these zones (Dione, Dembele, and Mariko, 1986).

Selection of Subzones

In both the CMDT and the OHV zones, rainfall and soil conditions vary significantly. Normal rainfall varies roughly between 700 to 1200 millimeters from the north to the south of each zone. The soils range from clay-lime in the south, to clay-sand or even laterite in the north (Dione, Dembele, and Mariko, 1986). As a result of these ecological factors, a progressive decline in the importance of cotton and maize cultivation and an increase in millet and sorghum production is evident going from south to north (Dione, Dembele, and Mariko, 1986).

In order to account for these agroclimatic differences, the following subzones were chosen for the survey:

-- CMDT South: the zone d'expansion rurale (ZER) of Zangasso, in the sector of Koutiala.

-- CMDT North: the ZER of Dougoulo, in the sector of Bla.

-- OHV South: the ZER of Ouelessebougou and Sougoula, in the sector of Ouelessebougou.

-- OHV North: the ZER of Sirakorola and Tougouni, in the sector of Koulikoro.

Selection of Villages

Four villages were selected in each subzone. Villages were chosen taking into account their access to the market (distance and condition of the roads), their position vis-à-vis extension from the CMDT and OHV, and the presence or absence of village associations, which facilitate both access to credit and inputs and the marketing of agricultural products (Dione, Dembele, and Mariko, 1986).

Thus in each subzone, the following four villages types were chosen (Dione, Dembele, and Mariko, 1986).

-- the village in which the subzone's most important rural market is located.

-- a village within a 15 kilometer radius of the market village.

-- a village in which there is an extension agent and/or a village association, and situated within a 15 kilometer radius of the market village.

-- a village in which there is an extension agent and/or a village association, and situated outside a 15 kilometer radius from the market.

Selection of Farm Households

A general census of the principal characteristics of approximately 1,300 farm households was made in eighteen villages, sixteen of which were retained for the survey. A household was defined as a family in which decisions concerning the management of resources and agriculture are centralized and

made by an individual, known as the "chef d'exploitation" or head of household. This definition does not preclude a household in which the head of household consults with other members of the family (usually married sons or brothers), but it is confined to households in which the ultimate responsibility for the decision lies with the head of household. A farm household, so defined, can have members with individual fields, but it is characterized by collective fields.

The census collected farm household information, which included total farm population, number of farm workers (actifs), equipment utilized, land availability, non-agricultural activities, and the food situation of the family. With the results of the census, four strata of farm households were delineated (Dione, Dembele, and Mariko, 1986):

-- farms with a complete set of agricultural equipment, which were generally self-sufficient or surplus in cereals. Self-sufficient or surplus was defined in terms of the ability of the family to have adequate supplies of food from all sources, including purchases, and not just self-sufficiency from its own production. This stratum was called "equipped," meaning that the household has draft oxen, a multi-purpose plow, a seeder, and a cart.

-- farms that were semi-equipped and self-sufficient in cereals. "Semi-equipped" means a farm household that has either draft animals but no multi-purpose plow (multiculteur), or a multi-purpose plow without draft

animals or a general-purpose plow or seeder without animals. The idea is that the semi-equipped are households with only a partial set of equipment that may be rendered unusable due to a missing complement.

-- farms that were semi-equipped and deficit in cereals.

-- farms that were non-equipped, which were generally deficit in cereals. "Non-equipped" means that the farm household either has no equipment other than a short-handled hoe (daba), or the equipment owned is in such a condition as to render it unusable.

Three farms in each of the four strata were randomly selected in each of the sixteen villages, resulting in a sample size of 192. For different reasons, the final sample was 189 farm households.

Survey Design

The data used in this thesis were obtained from a series of both one-shot and monthly field surveys conducted from 1985 to 1987.

A basic census of farm households was carried out at the outset of the study to obtain data on the type of farm organization, types of crops produced in the 1985/86 season, initial stocks, farm and family size, non-farm activities, migration of family members, types of farm equipment owned or rented, access to credit, volume of production and sales, access to land and food self-sufficiency status of the farm household.

Another principal source of data used in the thesis was a

cereals transactions survey conducted on a monthly basis from October 1985 to October 1986. This survey provided information on monthly sales, purchases, incoming and outgoing gifts, and exchanges of millet, sorghum and maize.

Finally, data were taken from a survey conducted in February 1987. The objective of this survey was to collect data on household tax levels including the head tax and administrative taxes, tax obligations and tax payments in 1986 and 1987, sources of revenue utilized to meet these payments, period of payments and preferred timing of payments.

Organization of the Thesis

The thesis consists of six chapters. Chapter 1 places the study in the overall context of food security, and outlines the research in terms of the problem statement, the research question, the objectives and scope of the study, and the methodology of the field data collection. Chapter 2 is a review of the economic and anthropological literature on agricultural decision-making in developing countries, with specific reference to sub-Saharan Africa. This review serves as the basis for the conceptual framework and hypotheses of the study developed in Chapter 3. In Chapter 4 the physical and institutional characteristics of the survey area are presented as well as some descriptive information on the villages and the farm households. Chapter 5 focuses on the economic analysis of the data collected in the study: the development and specification of the models concerning farmer transaction strategies, and the empirical

results. The thesis concludes with Chapter 6, which contains implications of the results for cereals policy in Mali, and suggests areas for further research.

CHAPTER 2

APPROACHES TO THE STUDY OF AGRICULTURAL DECISION-MAKING IN DEVELOPING COUNTRIES

Ever since the pioneering field work of the anthropologist Polly Hill in the 1950s and the publication of W.O. Jones' essay "Economic Man in Africa" in 1960, there has been a considerable body of economic and anthropological literature devoted to the understanding of small-holder decision-making in Africa. The center of the discussion is how small farmers make their decisions and how responsive these decisions are to changes in macro-level policy. It is widely believed that if one understood this micro-macro link between individual farmers and aggregate agricultural performance, the present difficulties besetting the agricultural sectors in many sub-Saharan African countries could be tackled more effectively. And so, a substantial literature has evolved to explain the workings of the "black box" of farmer decision-making and to postulate, within a given theory or framework, how farmers in different situations will respond or not respond to policies designed to influence their behavior.

T.W. Shultz (1964) is traditionally credited with having focused the debate on the rationality of farmer behavior with his now famous conclusion that farmers are "efficient but poor". This statement strongly refuted perceptions at that time that

farmers were poor because they were conservative and adhered to inefficient cultivation practices. Shultz stated that traditional individual farmers are maximizing their utility, and from this followed his conclusion that they are efficient since they are unable to reallocate factors of production in a way to increase production.

In his 1968 article "The Theory of the Optimising Peasant", Lipton argued that Shultz's conclusion is only possible under the assumption of utility maximization under perfect competition, with perfect markets in factors and products, and with the ability on the part of the farmer to "predict with reasonable confidence the outcome of each array of production, consumption and sales decisions at his disposal" (Lipton, 1968, p.327). Lipton questioned whether the neo-classical paradigm of perfect competition was applicable to under-developed, climatically uncertain, subsistence farming communities. He suggested that farmers, rather than allocating their productive factors so as to equate the marginal value product of money in each use, tended more towards a search for what he called "survival algorithms." Lipton claimed that these algorithms helped explain how farm families with similar resource endowments, but different tastes, leisure preferences, risk situations, and management capabilities, could adopt survival strategies vastly different from one another. Lipton maintained that his hypothesis explained "rational, security-centered peasant conduct, remote from the self-confirming tests of collinear production functions,

but close to the farmers' accounts of their own conduct", and he suggested policy measures that would take into account this sort of small-holder behavior (Lipton, 1968, p.348).

The Shultz-Lipton debate in the 1960s has since provoked reaction among many economics and anthropology scholars, and has influenced decision-making theories and the design of empirical research in both these fields.

The Anthropological View

Economic anthropologists in the 1950s and 1960s were concerned with the relevance of western economic theory for describing the behavior of farmers in Africa. During this period there was a long-running debate on this issue, with anthropologists divided between two schools of thought: the "substantivists" and the "formalists" (Eicher and Baker, 1982). The substantivists argued that most exchange in non-Western non-market economies was carried out on the basis of reciprocity and redistribution and therefore could not be described very well through the use of micro-economic profit-maximization models. The formalists, on the other hand, contended that farmers in non-Western countries were responsive to economic incentives, acted on the basis of self interest, and thus behaved in a manner consistent with neo-classical models of individual decision making.

In the 1970s, anthropological research shifted away from this debate and became more problem-oriented, focusing on rural

change and agricultural development (Barlett, 1980). According to Barlett, the issues relevant to the substantivist-formalist debate were "not pertinent to this problem-oriented research, since most of it was carried out within economies that are partially, if not wholly, market oriented and since the social and institutional environments are included as important parts of any 'formal' economic analysis." In this re-orientation, which has influenced recent anthropological research, "substantive" perspectives are joined with formal analysis, although the rigidity and accuracy of many formal economic concepts and assumptions are challenged, including theories on rationality, preferences, efficiency, maximization and utility (Barlett, 1980). Many anthropologists maintain that there is a undeniable need for qualitative ethnographic research to complement any sort of formal analysis.

Some of these anthropologists questioning the neo-classical profit or utility maximization models have rejected the models on the basis that they are not adequate or accurate in describing actual farmer behavior. The idea of traditional farmers as efficient maximizers is perceived as unnecessary and problematic in that a "maximizing decision-maker must keep in mind probability distributions of each one of the possible returns as well as the value of the returns (of each of his options)" (Ortiz, 1980, p.193). Ortiz argues that micro-economic models tend to forget that poor and ill-informed farmers will be striving farmers who can "neither offer a statistician a nice set

of probabilities, or point to single maximizing strategies" (Ortiz, 1980, p. 195). She points out that farmers probably do not rank options according to their probability, but rather are "likely to focus on whether or not there is an overlap between the ranges of competing outcomes (of their decision) and the likelihood of having to face disaster or great satisfaction" (Ortiz, 1980, p. 199) Under these circumstances of uncertainty, farmer decisions will be flexible and contingency strategies numerous.

In line with Ortiz's essay on the limitations of the neo-classical decision-making paradigm, Berry has pointed out the shortcoming of the assumption of farmer rationality in understanding small-holder behavior. Rationality simply means that farmers act "not in accordance with instinct or custom, but on the basis of reasoned assessments of their circumstances" (Berry, 1984, p.70). However, this does not help us understand decision-making because what farmers do in an uncertain environment may be consistent with different rationales. That is to say, decisions that farmers take can, at the same time, increase real income and reduce vulnerability to risk. "The presumption that individuals are rational does not enable us to predict their behavior, and efforts to explain agricultural performance in terms of the rationality of peasants frequently proves tautologous, inconsistent, or confused" (Berry, 1984, p.71).

Others have added their voices to the critique of neo-

classical decision-making theory and argued that behavioral models, with assumptions concerning the multiplicity of farmer goals and the notion that their decisions are made under "bounded rationality", are more appropriate to the understanding of the "black box" of small-holder decision-making (Chibnik, 1980). Chibnik's "statistical behavior" approach is a reconciliation of anthropological theory and statistical method, under the proposition that "a theory of how people make their economic choices is without interest and probably impossible until we have tackled the prior question of the factors determining what choices are available to them" (Chibnik, 1980, p.89).

While a complete conciliation between the qualitative, descriptive ethnographic approach and formalist theories and methods has not yet been achieved, there appears to be a growing interest among anthropologists to work towards this end. Anthropologists are attempting to define what variables, be they institutional, social, cultural, or physical, account for differences in on-going agricultural choices made by farmers in response to their decision-making environment. According to Barlett, anthropological decision-making research today sees agricultural choices as "fluid and responsive to the decision-making environment." This more dynamic approach not only emphasizes the diversity of behavior among farmers and rural groups, but also seeks to clarify and measure variables that interact to produce the behavior outcome. While methods and approaches may differ, many anthropologists engaged in decision-

making research accept that farmers usually make choices within the context of the household and are influenced by the household's needs and goals as well as by the physical and social resources available to the household. This interpretation of the farmer decision-making context has points in common with neo-classical economic decision-making theory.

Therefore, although there are anthropologists who disagree with the use of economic concepts such as maximization, rationality and efficiency, there appears to be a growing consensus that formal model-building has a contribution to make to the study of agricultural decision-making. Johnson, in his article "The Limits of Formalism", concludes that while there are limits to the use of formalist methods, formal model-building "based on rigorous deductive reasoning is a powerful aid in the analysis of economic behavior" (Johnson, 1980, p.20). Johnson believes that an important contribution of these models is their predictive power, which provides the ability to anticipate the reactions of local farmers to new opportunities and constraints.

In conclusion, while anthropological models vary in their approaches, they generally maintain that a better understanding of agricultural decisions and farmer responses to agricultural policy is to be gained through the study of decisions about allocations, access, and behavior in an ethnographic context. Anthropologists differ primarily in their acceptance of western economic concepts, theories, and methods, although today there is a growing recognition that a synthesis of formalist and

ethnographic analysis provides a greater understanding of the agricultural decision-making process than either tradition does in isolation.

The Economic Perspective

Neoclassical economic models of behavior are based on a common theory, although modelling techniques tend to vary with researchers. All of these economic models of behavior include the actor's set of objectives, the constraints facing the actor in achieving these objectives, and a pattern of behavior which results from the actor's pursuit of his objectives given the constraints imposed by the environment. The constraints facing the actor derive from the actor's environment: constraints imposed by the production function with which the actor must work, social rules regarding what is acceptable behavior, and the availability of resources.

The strength of these economic models has been judged both on their ability to describe farmer behavior and on their predictive power.

Helleiner's article on small-holder decision-making points out that the ceteris paribus assumption of micro-analysis may be one of the difficulties with neo-classical decision theory (Helleiner, 1975). The inability of neo-classical theory to predict responses to price or other policies is due to the ceteris paribus assumption which permits the measurement of the response to change in only one of the many factors influencing

small-holder decision-making, while holding all other factors constant. Even when this influence is as important as an output price, Helleiner maintains that conclusions drawn will be misleading and erroneous. He points out that what needs to be understood is the effect of alterations in various packages of influences: "a price change coupled with the increased provision of cheap credit may induce responses totally different from price changes unaccompanied by credit innovations but concurrent with marketing or land reform" (Helleiner, 1975, p. 43). While this point is true, Helleiner seems to be limiting himself to a discussion of price elasticities while neglecting an important tool in economic analysis, namely multiple regression. Multiple regression attempts to measure the effect of several independent factors (independent variables) on the variable of interest (dependent variable). To use Helleiner's terminology, the set of independent variables is the "package of influences" whose combined effect on, say, production is measured using multiple regression and reflected in the coefficients of these variables.

In conclusion, Helleiner's principal criticism of neo-classical decision theory is that "the simplified apparatus of micro-economics, in which factor inputs are varied so as to achieve the combination of material return and risk reduction which maximizes welfare, is in any case, not sufficient for an explanation of African small-holder behavior" (Helleiner, 1975, p.48)

Another critique of the explanatory power of neoclassical

theory has come from Sara Berry. Arguing against the usefulness of economic concepts such as rationality and utility maximization in explaining farmer decision-making, Berry cites that one of the "clearest findings of the whole corpus of literature on agricultural decision-making in underdeveloped economies is that there is no evidence that poor farmers' goals or decision-making processes are consistently different from other peoples" (Berry, 1980, p.322). Indeed, Berry finds that the major contribution of empirical decision-making studies is that it is irrelevant to hypothesize irrationality or subjective resistance to change to explain farmer behavior. These empirical studies have shown rather that farmers usually "profit when they can, and usually choose the best outcome given their constraints of production, consumption and marketing" (Berry, 1980, p. 327). Thus Berry proposes that the ability and willingness of farmers to take advantage of economic opportunities is more a question of assets than of attitudes.

Berry suggests that farmer decision-making is highly dependent on social relationships between and within farm households and hence more complicated than can be explained by neoclassical description: "some people's actions constitute other people's constraints ...people's behavior depends not only on what other people are doing, but also on the form and quality of the social relationships among them" (Berry, 1980, p. 331). Berry notes that this is not unlike what the micro-economist Leibenstein observed in his work on firm behavior in the United

States. Leibenstein, and other economists have "long recognized that firms (and farms) probably do not operate on their marginal cost curves but at points inside the curve which are determined by the ways in which people interact within the productive enterprise, and which cannot be predicted in terms of constrained utility maximization" (Berry, 1980, p. 332).

More recently, the micro-economic decision literature has emphasized the predictability rather than the explanatory power of decision models as grounds upon which these decision-making models should be judged. Some have diverted the focus from the issue of the rationality of farmer behavior: "the argument is not that small farmers really behave in a manner consistent with the axioms of rational choice set down by decision theorists, but rather that they tend to behave in this manner so that decision analysis can be used to predict their behavior with reasonable success" (Hardaker, 1979, p. 319). Hardaker also notes that "as a behavioral theory, decision theory may be useful if it predicts the behavior of small farmers better than alternative models of choice such as profit maximization."

The difficulty is that the evidence on the predictive power of decision models is mixed. Hardaker presents studies in which decision models, based on the maximization of subjective expected utility, are both supported and refuted. He concludes that this model needs to be tested for reliability and feasibility and its predictive power compared with other models. Hardaker also suggests mathematical programming approaches as a way to model

small farmer production decisions. However he notes that several empirical studies cited in his review have two principal drawbacks: they are based on assumed certainty (i.e., they ignore risk as a decision variable), and the objective function in terms of profit or income is assumed linear, "whereas small farmers are generally accepted to have non-linear often multi-attribute utility functions" (Hardaker, 1979, p. 320)

More recently, neoclassical economic analysis of farmer decision-making has been refined to incorporate risk and uncertainty into either the objective function or the set of constraints in models of farm behavior. These models have included "safety-first" models, based on the assumption that the decision-maker is concerned with more than one aspect of the outcome of his action, and models based on the expected utility hypothesis, which supposes that the decision-maker weighs outcomes according to their monetary value and then selects the action with the highest expected value (Fleisher and Robison, 1985). A great deal of attention in the literature has been given to the theoretical and empirical difficulties associated with measurement of farmers' attitudes towards risk, the derivation of utility functions, and the incorporation of multiple objectives into the decision models (Friedman and Savage, 1948; Anderson, Dillon, and Hardaker, 1977; Roumasset Boussard, and Singh, 1979; Binswager, 1980; Fleisher and Robison, 1985). In the conclusion of his review of decision-making research methods, Hardaker adds that more work needs to be done

on pursuing the model of choice provided by decision theory, concentrating not only on small farmers preferences, measured by utility functions, but also on their beliefs measured by subjective probabilities. He also believes that the Bayesian model of learning could provide useful insights into decision-making.

Another recent development in neoclassical analysis of farmer decision-making has been the advent of the "New Household Economics." These models attempt to address the problems in predicting the consequences of agricultural policies in developing countries where the behavioral patterns of semi-commercial farm households are determined by both production and consumption issues. The "New Household Economics" seeks a thorough understanding of the microeconomic behavior of agricultural households by exploring "what factors determine the level of farm production and the demand for farm inputs, what factors govern consumption and the supply of labor, and how the behavior of the household as a producer affects its behavior as a consumer and supplier of labor, and vice versa" (Singh, Squire, and Strauss, 1986, p. 4). The distinguishing feature of these recursive models is that they provide a link between demand and supply responses to exogenous policy changes. This link is demonstrated in what Singh, Squire and Strauss call the "profit effect". As an example, they cite the change in price of a major commodity both produced and consumed by the farm household. Traditional consumption theory predicts than an increase in the

price of such a commodity will depress consumption of this commodity. However, such a price increase will also increase farm profits, which increases household income and, in turn, demand for the commodity. In the integrated production-consumption models of New Household Economic theory, both negative and positive influences of a price increase on demand are taken into consideration. According to Singh, Squire, and Strauss, "the consistent incorporation of the profit effect can change the direction and magnitude of results predicted by traditional models of consumption and labor-supply behavior" (p.9).

Singh, Squire, and Strauss note that these agricultural household models are most appropriate when the profit effect, its distinguishing feature, is likely to be important. Where changes in exogenous prices have little effect on farm profits, the models are less likely to make a difference. Another qualifier to the use of such models in developing countries is that even if profits are affected by an exogenous price increase, such profits may be only a small part of farm income. This might be the case when the commodity (ies) is mainly consumed by the farm household and only a small percentage is marketed. In such a case, the impact on total income of a percentage change in these profits will be small. Finally, the effect of full income on the demand for non-agricultural commodities is likely to be much more important than on the demand for agricultural commodities, since agricultural commodities tend to be inelastic with respect to

income. Singh, Squire, and Strauss hold that the above three points condition the use of agricultural household models: "if profits are relatively insensitive to producer prices and constitute a relatively small part of full income and if consumption of a particular item is relatively insensitive to full income, then an agricultural household model will not necessarily make our analysis more accurate" (p. 29).

The application of "New Household Economic" theory to developing country situations has been limited to date. Singh, Squire, and Strauss present a series of case studies conducted in several countries in Asia and West Africa which extend the basic model. In southern Africa, Low uses this theory of the household as a production/consumption unit to explain farm household behavior, explicitly taking into consideration the market/non-market interaction which conventional neo-classical models do not allow (Low, 1986). Low traces through the implications of relative costs of procuring consumption goods through the market (via market production and retail purchases) compared to own production in Botswana and Lesotho. Using the household economics approach, Low suggests why agricultural development projects in southern Africa have not been successful in increasing farm production. He shows that "since wage employment opportunities have continued to be available, market production has tended to take place off the farm and production-increasing crop technology has been adopted to save time in own production of farm-household consumption requirements, rather than to

increase farm production and produce surpluses for the market" (Low, 1986, p.7).

Thus the successful application of the farm-household economics model permits an appreciation of the broader scope of interactions among variables which determine farmer behavior, and consequently farmer response to exogenous agricultural policies. In this respect, the extension of neoclassical decision-making theory to incorporate the consumption/production aspects of semi-subsistence farm households represents a significant breakthrough in the application of economic theory for policy-relevant empirical work.

It is clear that many theories and approaches exist for the analysis of agricultural decisions in the context of developing countries. Today it appears that there is an emerging consensus that economic decision models can be enriched by ethnographic and anthropological theories and empirical research. Especially in developing countries, the complexity of farm household decision-making warrants a flexible approach which incorporates not only neo-classical utility maximization as the decision rule, but also the on-going decision processes at the farm household level.

The approach of this study of semi-commercial farmers in Mali will be outlined in the conceptual framework presented in Chapter 3. The inspiration for this approach is eclectic, drawing on different aspects of the anthropological and economic literature discussed in this chapter.

CHAPTER 3

CONCEPTUAL FRAMEWORK FOR THE STUDY

The conceptual framework used to guide this study of coarse grain production and transactions in Mali is based on the general economic framework of farm household decision-making. Broadly outlined, the framework for this study views the farm household as having a set of objectives, facing constraints to achieve these objectives, and emitting a pattern of behavior resulting from the pursuit of these objectives given the constraints imposed by the environment.

The objectives of the farm household can be many: the assurance of the family's needs in terms of consumption, the achievement of a certain level of income, the maintenance of a certain standard of living, etc. In fact, the variety of farm household objectives held is probably limited only insofar as the sample under study is limited. However, farm households probably have in common certain objectives related to agriculture: the achievement of the highest levels of production possible, and the assurance of household food security. These objectives are related. Maximizing production makes economic sense when markets for the sale of output and the purchase of consumption goods are risky in terms of price and quantity fluctuations. In such instances of market volatility it is rational for farmers to rely

exclusively on their own production to meet family consumption requirements. Maximizing production also is economically justified when climatic conditions produce significant inter-annual variation in yields. In this case the maximization of domestic production and the constitution of family stocks becomes an important part of family food security strategies.

The attainment of these two primary objectives is constrained by several sets of factors. Physical constraints include rainfall, soil fertility, and farm size and location. Institutional constraints take the form of access to credit for inputs and equipment, access to cash crop cultivation, and quality of extension services. Agricultural policy, including commodity price stabilization schemes, bank credit for traders and farmers, and parastatal involvement in agricultural marketing, is part of the set of macro-economic policy constraints. Also in this category is trade policy, which influences, among other things, prices for domestic agricultural production as well for competing imported foodstuffs. Finally, in the realm of socio-political and cultural constraints are factors such as the size of the household (which determines the available non-hired labor force), relationships within the household as well as between the household and other households in the village, the political influence of the household within the village, the ethnic group or caste of the household, the age of the head of household, and other factors.

The above sets of constraints together form the decision-making environment of farm households. Decisions made in this environment concerning agricultural production, sales, purchases, and exchange of agricultural goods are part of the pattern of behavior followed by farm households in pursuit of their objectives.

And so, in this framework farm household decisions are viewed as the outcome of a recursive circle of objectives-constraints-behavior. While we can observe these decisions in terms of levels of agricultural production, levels of grain sales and purchases, and levels of exchange, the real challenge to the researcher lies in identifying the constraints which determine these levels.

Economic theory is often used to guide empirical studies in their search for the constraints that determine the outcomes of farm household decisions. The framework used in this study uses both economic and anthropological theory to identify the socio-economic and institutional factors determining cereals production and transaction decisions. The perspective incorporated into the analysis and interpretation aspects of the model is that of the New Household Economics, which encompasses both production and consumption issues. In this respect, we view the household's production choices as consisting of on-farm production, domestic activities, non-agricultural activities, off-farm activities, and leisure, with the household allocating labor to equate marginal utilities across activities. The consumption decisions of the

household consist of consuming home production, non-farm production, exchange production and leisure, with farm households equating marginal utilities across these consumption possibilities. Preliminary analysis by Dione (Dione, 1987) of the data used in this study suggested that a significant number of Malian farmers are not net producers of coarse grains, and that the household food security position, in terms of net production or net consumption, has a significant influence on coarse grain production and transactions decisions. This finding supports the use of the New Household Economics approach as a framework for data analysis and interpretation.

This framework, supplemented by hypotheses from decision-making theory, empirical research and observation, may be useful in guiding the examination of variables that relate to and explain or predict farm household behavior with respect to production and transactions.

Factors Affecting Production

The principal factor affecting production is widely documented as being the household's factor endowment, which includes available land, the size of the household work force, and access to capital. Wealth, either inherited, from cash-cropping or from nonagricultural activities, is also considered part of the farmer's endowment. The household's factor endowment is in turn influenced by both the productivity of resource use (the intensity with which the resources are employed) and

resource quality (Matlon, 1981; Timmer, Falcon, and Pearson, 1983).

The farm household's physical and socio-economic environment, in a broad sense, includes all exogenous factors which determine the farm household's opportunity set and therefore affect production. Agroclimatic conditions, such as rainfall and weather changes, insects, and disease can be considered part of the farm household's environment. The institutional environment is another factor that directly affects production through access to research and extension, access to credit, availability of inputs, and markets for products. Production is further determined by local institutions. Finally the importance of the personal traits of the farm household head or decision-maker must be taken into consideration when examining the determinants of production. The level of management skills, age and education, and ethnicity may all directly or indirectly influence production.

Matlon's study of production and rural incomes in northern Nigeria revealed that income, wealth and the liquidity position of the farmer determines a farmer's access to resources, his production and employment strategy, and thus the productivity of resource use. His results indicated that the poorest households may be farming the lower quality soils and following poor management practices such as late planting and weeding and non-intensive weeding. Matlon explains this seemingly "non-rational" behavior by suggesting that poor households are constrained by

low food and cash reserves and act out of an economic necessity, which reflects their low working capital position. He finds that these poor households tend to plant late in order to avoid the risk of low germination and replanting, and that these farmers are often so constrained by pre-harvest cash shortages to purchase grain that they are obligated to spend critical weeding time in wage or exchange labor.

Matlon also suggests that the demographic composition of the household, levels of employment, enterprise selection and location are important factors that contribute to variations in production and income status of farm households.

Other farming systems research has focused on an examination of the resource endowment itself (such as the land/labor ratio), with emphasis placed on the extent to which resource limitations and family structure determine the income-earning opportunities of the household and constrain the growth of the farming system (Crawford, 1982). Matlon's approach and this approach are related: resources lead to income, income leads to investment in factors of production, and such investment eventually leads to more income.

Insofar as the study of coarse grain production is concerned, the model used in this study is not a classical production function in which production is a function of land, labor and capital. Rather, this framework attempts to determine more the factors affecting the levels of land, labor and capital. We look not only at the effects of rainfall as reflected in the

rainfall zone, but also at the effects of the institutional environment, in terms of access to credit for equipment and inputs, the cultivation of cash crops, the extension service, etc. We also look at the effects of equipment ownership, access to land, acreage expansion, non-agricultural activities, and the interaction between equipment and the household's available labor supply.

Factors Affecting Coarse Grain Transactions

Coarse grain transactions may be considered a function of production, as well as consumption, and therefore similar factors may be hypothesized as influencing these decisions.

The hypothesis that both grain production and transaction decisions are influenced by output prices has been greatly debated in the literature. Some writers argue that equilibrium prices are a necessary but insufficient condition to increasing food crop production and marketed surplus. In sub-Saharan Africa this is believed to follow from the relative inelasticity of aggregate supply caused by poor factor markets, labor markets and general resource constraints in most countries (de Janvry, 1986; Bond 1983; Stewart and Streeten, 1986; Krishna, 1984). Krishna hypothesizes further that food crop production can be ranged along a subsistence-commercial continuum, with farmer responsiveness to price movements increasing with the degree of commercialization (Krishna, 1986). Krishna's hypotheses would appear to be plausible and suggests a framework with which to evaluate the price-responsiveness of farmers producing primarily

for home consumption in sub-Saharan Africa. The degree to which subsistence-oriented farmers are integrated in the marketing system for their products will likely provide an indication as to the differing levels of price-responsiveness among them.

Education, ethnicity, age, non-agricultural activities, cash cropping, power and access relationships and other qualitative variables have also been demonstrated as influencing transaction decisions (Hill, 1970; Berry, 1980; Matlon, 1981).

Also shown to influence grain transactions is the relative size of the farm. Cross-sectional evidence from India reveals a tendency for the marketed surplus/production ratio to fall and then rise as the farm holding increases (Krishna, 1986). The explanation for this is believed to be that very small farmers must engage in distress sales to meet their payment obligations; farmers with a little more land reduce their sales ratio to improve their consumption; but the sales ratio of farmers having a holding of more than a certain critical size increases normally with the holding size. Cash obligations and consumption needs relative to the size of the farm holding are factors which influence farmers' decisions to transact grain. A corollary to this hypothesis is that the timing of cash obligations tends to determine the timing of transactions.

A recent study of grain marketing in Burkina Faso suggests that grain sales are related to different seasons, with most grain sales occurring in the immediate post-harvest period (Sherman, Shapiro, and Gilbert, 1986) This is partially

explained by the suggestion that farmers have a "pent-up demand for cash" that they must satisfy as soon as the harvest is completed. This study also finds that household and regional variations in grain sales are attributable to grain production. In their analysis, the authors find that the only consistent explanatory variable is the size of harvest. As for other factors influencing grain sales, the analysis reveals that neither price nor cash crop acreage were significant explanatory variables, and animal ownership was an important factor only in one village.

A further examination of the Burkina Faso data by Saul (1987) corroborates the earlier finding that the largest part of total marketed grain reaches the market in the post-harvest season. However, the author points out that this trade may not be based on disposable surplus, but rather on the phenomenon of farmers overselling after harvest and having to buy back later in the year (Saul, 1987). This sell-now buy-later behavior, according to Saul, largely depends on whether the household farm operation is large or small in terms of cereals production.

Not all farmers are invariably in favor of high price of coarse grains. Large farmers, who might be described as net producers, "take into consideration prices when they make their cropping decisions and, unlike the majority of farmers, are favorable to interseasonal price variations because they can store a larger part of their marketable grain until they can sell it for a higher price" (Saul, 1987, p.91). Smaller farmers, on

the other hand, tend to be net consumers and thus perceive prices both in terms of the income they receive from their post-harvest sales as well as expenditures they must make for home consumption needs. Thus for these small farmers, the effect of coarse grain prices will be measured in terms of the net balance between post-harvest income and expenditures.

Thus Saul finds that farmer attitudes towards grain sales are largely dependent on the scale of their operation, which tends to be highly differentiated in Burkina Faso. Saul largely attributes the timing of sales to a lack of "withholding capacity." This can be due to farmers' inaccessibility to major roads and markets and the need for cash for big purchases or to deal with price movements in big expenditure items. Saul finds that medium and small farmers are the least endowed with such a withholding capacity. These farmers not only must meet calculated expenditures on equipment, credit repayment, work groups and taxes, but also they must have the required cash to meet the unexpected expenditures. Often these emergencies, social obligations and unexpected cash expenditures necessitate "distress sales" at low prices. And so these sales "contribute to grain price fluctuations and (are) an intrinsic part of them" (Saul, 1987 p.92).

Saul finds that grain that appears on the market after harvest is coming not only from the head of the household but also from other sources. Because grain is exchanged for work and distributed to relatives and dependents after the harvest, such

grain often appears at village markets as an important contribution to the post-harvest glut. Thus non-market transactions in grain are found to be an important determinant of aggregate marketed supply and must certainly influence market prices, especially in the post harvest period when prices tend to be depressed anyway.

Another cause of the vulnerability of medium and small farmers, found in the Burkina Faso study, is that their only source of cash tends to be receipts from grain sales, which often cannot be timed to coincide with high prices during the rainy season. Large farmers, many of whom are involved in cotton production, depend on cotton sales (at supported prices) to meet their immediate post-harvest cash needs. For these farmers, cotton figures significantly in their food security strategies by enabling them to avoid distress sales of coarse grains which they might have to buy back later in the season.

In this study, Malian farmers are hypothesized to be differentiated in much the same way found in Burkina Faso. Their differentiation is based on location, and consequently on the physical environment: rainfall, soil fertility, etc. These farmers differ also in their endowment in land, labor, capital, and management skills. Finally, their differences are also based on the institutional environment in which farmers find themselves: their access to credit, inputs, equipment, and extension services through rural development operations. As a

result of this differentiation, Malian farmers do not all face the same food crop-cash crop cultivation opportunities, and their access to markets for these products and the prices they receive are not the same. This rural differentiation is hypothesized to be at the root of the different grain production and coarse grain allocation behavior evinced in the analysis to date of the MSU - CESA survey data from southern Mali. As in Burkina Faso, some farm households are clearly net consumers of coarse grains, while others are net producers.

Figure 3.1 shows a conceptual model of coarse grain allocation decisions, and how they are linked to consumption and therefore food access/availability issues in Mali. Household production and consumption of coarse grains are connected by two chains of transactions: market and non-market. Marketed household coarse grain production flows out of farm households to both the state grain marketing board and rural markets. At this point, a certain part of the coarse grains collected by either the state board or private traders is sold to other rural households who are purchasing grains to meet their consumption needs. Non-marketed household production of coarse grains goes either into home storage for eventual direct consumption or into barter and gifts. The grain exchanged as barter or gifts either becomes part of a household's grain receipts and is consumed by the household or it crosses over to the market channel, appears on rural markets, and is purchased for consumption by other households.

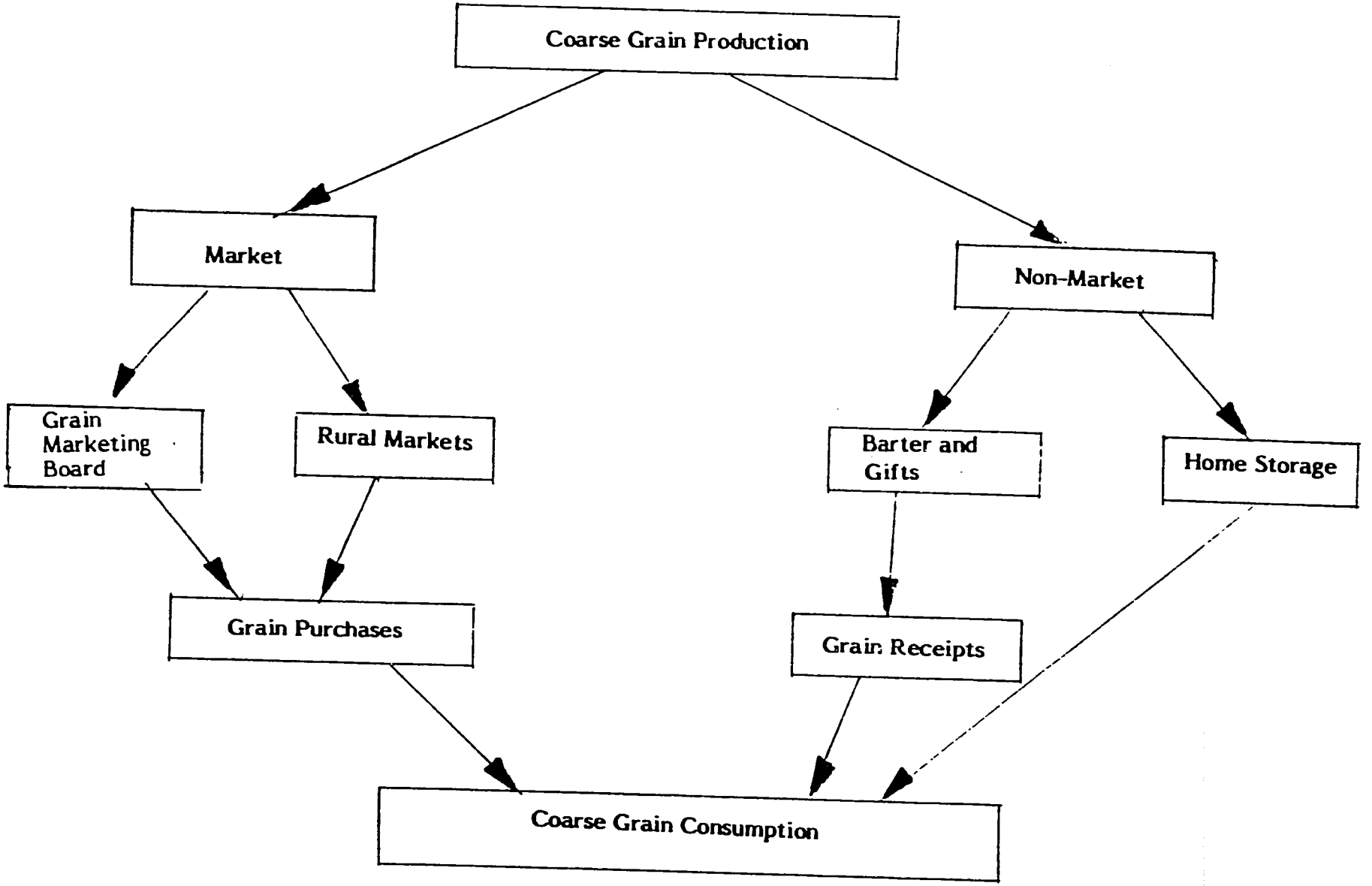

Figure 3.1 Conceptual Model of Coarse Grain Transactions

The approach of this study is to examine the extent to which variation in grain production and transactions, both market and non-market, is explained by differential endowments of physical, productive (i.e., land, labor and capital) and institutional resources. Particular emphasis is placed on the heterogeneity of rural farm households. This study is based on the premise that a better understanding of farm household coarse grain production and transaction patterns in Mali can be gained through an appreciation of this structural differentiation and its influence on farmer food security strategies. This in turn may help the design and implementation of agricultural policy.

CHAPTER 4

AGRICULTURAL CHARACTERISTICS OF THE SURVEY AREA

Outlining the principal characteristics of agriculture in the CMDT and OHV zones is a necessary preliminary to an analysis of farm household decisions concerning coarse grain production and allocation. This chapter will provide a brief background on the physical environment, the cropping patterns and the institutional environment of the CMDT and the OHV zones. An analysis of the characteristics of the sixteen survey villages will follow to situate the survey within the two zones. Finally, major farmer characteristics will be analyzed and compared using secondary data obtained from the OHV and the CMDT and data collected during the MSU - CESA farm household census.

Physical Environment

Climate

The OHV zone roughly occupies the area between Bamako and the Guinea border. More specifically, the OHV is a part of the Bamako and Koulikoro "cercles", and the entire Kangaba "cercle". It has a total area of over 7,500 square kilometers on both sides of the Niger River. The climate is divided into a rainy season from May to October, and a dry season throughout the rest of the year. Average annual rainfall can vary from 700 millimeters in

the extreme north, to 1200 millimeters in the extreme south. However, average rainfall has been declining and the mean annual rainfall over the period 1981-1985 ranged between about 905 mm. in Kangaba, the southernmost area, and 600 mm. in Banamba, the northernmost area (OSCE, 1985).

The CMDT zone is located south of the Niger in the regions of Sikasso, Segou and Koulikoro. The CMDT zone has a total area of about 92,000 square kilometers and borders Burkina Faso in the east, and Côte d'Ivoire in the south. As in the OHV, the climate is divided into a rainy season from May to October and a dry season during the rest of the year. Rainfall varies between 700 mm. in the northeast to about 1200 mm. in the southeast, although average rainfall over the last five has shown a declining trend. Over the period 1981-1985, average annual rainfall was 957 mm. in Sikasso in the southern portion of the CMDT, and 576 mm. in San, towards the northeast of the zone (OSCE, 1985).

Soils

The northern area of the OHV zone (north bank of the Niger River) is considered sudano-sahelian and characterized by light sandy soils, most appropriate for millet and groundnuts. The area of the OHV to the southwest of Bamako is considered sudano-guinean, and soils there are clay-lime soils, which are medium-rich and more suited for sorghum cultivation.

Much like the northern OHV, the north-eastern areas of the CMDT are considered sudano-sahelian with light sandy soils.

Moving southwesterly, the vegetation of the CMDT becomes sudano-guinean and guinean in the extreme southwest near Côte d'Ivoire.

What emerges from this examination of agroclimatic data concerning the OHV and the CMDT is a pattern that distinguishes the northern areas of both zones from the southern areas. This north-south distinction is further corroborated by agroclimatological and pedological studies undertaken in Mali (Vallet, 1987; Sivakumar, Konate, and Virmani, 1984; Republique du Mali, 1986; OSCE, 1985).

Vallet, through a simulation model using data on rainfall, drainage, evapo-transpiration rates, and water content of the soil, delineates seven agroclimatic reference zones with similar agricultural potentials. Vallet's Zone II corresponds to the southern zones of the OHV and CMDT from which part of the sample of this study was drawn. The rainfall of Zone II over the period 1970-1985 falls between 850 and 1000 mm. with a probability of 0.5. Zone IV corresponds to the northern areas of both the OHV and the CMDT, from which the remainder of the sample used in this study was selected. The rainfall of Zone IV over the period 1970-1985 falls between 550 and 760 mm. with a probability of 0.5. The similarity between the northern and southern zones of the CMDT and the OHV, and thus the ability to match these two institutional zones on the basis of agroclimatic characteristics, was instrumental in the selection of the two research areas.

Cropping Patterns

Land Tenure

In both the OHV and the CMDT, land is not owned, but households have usufructuary rights to land. Land is acquired either through patriarchal inheritance or through borrowing unused land from the family that has the usufructuary rights to the land. For new settlers in villages in these zones, land is obtained from the village head, whose responsibility it is to find the new family fields and land for the construction of a home. The village head has the power to settle all land tenure disputes.

Farm Size

Farmers in the OHV cultivate an average of 2.8 hectares per family, though this figure varies widely according to location. In the southern zone of Kangaba, for example, the average area cultivated per family is 2.9 hectares, of which .3 is devoted to cotton. In the northernmost Banamba sector, the average area cultivated per family is 5.5 hectares. The average number of members in a farm family is 11.2, ranging from 14 in the south, to 9 in the north (OHV Service Statistique, 1985).

Farmers in the CMDT cultivate an average of 4.6 hectares per farm family, of which 1.5 hectares is in cotton, and the remainder is in coarse grains and cowpeas. The average family size is about 12, and usually includes 3 to 4 male adults (World Bank, 1983).

Principal Crops

In the OHV and CMDT zones, almost all crops are rainfed. In the OHV cereals are the most important crops and account for about 94% of surface cultivated (OHV Service Statistique, 1985). This figure is lower in the southern areas of the OHV where, because of a more favorable climate, farmers have the opportunity to cultivate a greater variety of crops. In Kangaba in the south, 89% of total cultivated areas is in cereals, and in Banamba in the north, 99% of total cultivated area is in cereals. In the south, maize constitutes an important cereals crop, about 40% of total cereals production, according to OHV statistics[1]. However, in the north maize accounts for only 0.4% of total cereals production (OHV Service Statistique, 1985).

Groundnuts were an important cash crop for northern OHV under the "Operation Arachide et Cultures Vivrieres" (OACV); however, since the parastatal closed operations in 1982, groundnuts have fallen significantly in importance. Groundnut area in 1983/84 fell by 27% from 1982/83 levels, and production fell by 35% over the same interval (OSCE, 1987).

The principal crops in the CMDT zone are millet, sorghum, maize, cowpeas and cotton. Millet and sorghum dominate foodcrop cultivation in the north, whereas areas in the south yield a more varied output. Of lesser importance is rice cultivation, which occurs along the Niger and Bani Rivers and in the south in

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[1]Results from preliminary analysis of MSU-CESA data for the OHV-South indicate that maize constitutes only about 20% of total cereals production.

lowland areas. Yams and other tubers are grown in the south as well. Groundnuts are grown to a limited extent in the drier northern zones of the CMDT.

In general, farmers in the CMDT tend to grow three or four major crops, whereas farmers in the OHV tend to be more diversified in their crop mix. This pattern probably reflects a risk avoidance strategy because markets are less reliable in the OHV.

At the national level, as can be seen in Tables 4.1 and 4.2, the contributions of both the OHV and the CMDT differ significantly in terms of area planted to different crops and production.

TABLE 4.1 -- PERCENTAGE OF NATIONAL CROP AREA CULTIVATED BY ODR (1986-87)

	All area	Mi/So/Fo[1]	Maize	Cotton	Groundnuts
OHV	6	6	10	4	10
CMDT	28	23	43	96	21
ZHO[2]	28	33	20	0	4
OTHER ODRs	38	38	27	0	65
TOTAL	100	100	100	100	100

1 Millet, sorghum and fonio
2 Zones Hors Operation: Zones outside of Rural Development Operations
SOURCE : Office Statistique des Communautes Europeenes, 1987

The percentage of millet, sorghum and fonio area cultivated in the OHV is 6%, while it is 23% in the CMDT. One third of all millet, sorghum, and fonio area is reported to be in areas where there are no rural development operations (called Zones Hors

Operation, ZHO). Seven percent of national production of these cereals comes from the OHV, 26% from the CMDT and 34% from the ZHO.

TABLE 4.2 -- PERCENTAGE OF NATIONAL CROP PRODUCTION BY ODR (1986-87)

	Mi/So/Fo[1]	Maize	Cotton	Groundnuts
OHV	7	8	3	11
CMDT	26	58	97	20
ZHO[2]	34	13	0	4
OTHER ODRs	33	21	0	65
TOTAL	100	100	100	100

1 Millet, sorghum and fonio
2 Zones Hors Operation: Zones outside of Rural Development Operations
SOURCE : Office Statistique des Communautes Europeenes, 1987

The CMDT has the largest share of both total maize area as well as total maize production, 43% and 58% respectively. The OHV cultivates only 10% of total maize area and produces 8% of total maize production.

As might be expected, the CMDT cultivates 96% of cotton area and produces 97% of cotton production. The OHV is the only other cotton-producing region. It has 4% of total cotton area and 3% of total cotton production.

Twenty-one percent of groundnut area is cultivated in the CMDT, and 20% of groundnut production comes from this zone. Ten percent of total groundnut area is cultivated in the OHV, and 11% of groundnut production comes from this zone.

Overall, the CMDT emerges as a heavyweight in terms of national agriculture, contributing at least 25% of area and 20% of production of all crops grown in Mali. The OHV's contribution is more modest, with an average of 6% of all area and 3 to 11% of all production.

Yields

Tables 4.3 through 4.5 indicate the area, production and yields of principal crops in the OHV and CMDT zones.

TABLE 4.3 -- TOTAL AREA OF PRINCIPAL CROPS CULTIVATED BY ODR IN HECTARES (1984-86)

	1984-85			1985-86		
	Mi/So/Fo[1]	Maize	Cotton	Mi/So/Fo	Maize	Cotton
OHV	87,024	12,811	6,202	108,962	13,030	6,724
CMDT	350,000	38,167	113,198	399,022	49,272	139,218
ZHO[2]	191,640	866	0	605,054	25,156	0

1 Millet, sorghum and fonio
2 Zones Hors Operation: Zones outside of Rural Development Operations
SOURCE : Office Statistique des Communautes Europeenes, 1987

In the OHV, average yields of millet, sorghum and fonio were 888 kilograms per hectare in 1984-85 and 916 kg/ha in 1985-86. This masks the variance between the south and the north however. In the southernmost area, Kangaba, average yields over the period 1981-1985 were 937 kg/ha. In the northernmost area, Banamba, yields over the same period averaged 567 kg/ha. In the CMDT, millet, sorghum and fonio yields were lower, at about 571 kg/ha in 1984-85 and 886 kg/ha in 1985-86.

TABLE 4.4 -- PRODUCTION OF PRINCIPAL CROPS BY ODR IN METRIC TONS (1984-86)

	1984-85			1985-86		
	Mi/So/Fo[1]	Maize	Cotton	Mi/So/Fo	Maize	Cotton
OHV	77,277	14,220	5,638	99,782	15,967	6,449
CMDT	200,000	50,000	139,100	353,688	106,065	169,557
ZHO[2]	69,030	405	0	436,120	19,922	0

[1] Millet, sorghum and fonio
[2] Zones Hors Operation: Zones outside of Rural Development Operations
SOURCE : Office Statistique des Communautes Europeenes, 1987

TABLE 4.5 -- YIELDS OF PRINCIPAL CROPS BY ODR IN KG./HA (1984-86)

	1984-85			1985-86		
	Mi/So/Fo[1]	Maize	Cotton	Mi/So/Fo	Maize	Cotton
OHV	888	1,110	909	916	1,225	959
CMDT	571	1,310	1,229	886	2,153	1,218
ZHO[2]	360	468	NA	721	792	NA

[1] Millet, sorghum and fonio
[2] Zones Hors Operation: Zones outside of Rural Development Operations
SOURCE : Office Statistique des Communautes Europeenes, 1987

Maize yields, on the other hand, are much higher in the CMDT than in the OHV. In 1984-85, OHV yields were 85% of CMDT yields, and in 1985-86, OHV yields were only 57% of CMDT yields.

The cotton yields tell a similar story. In 1984-85, OHV yields were 74% of CMDT yields, and in 1985-86 the figure was 79%.

Thus the CMDT appears to have a yield advantage in cotton and maize. The OHV had a yield advantage in millet, sorghum and

fonio in 1984-85, but in 1985-86 that advantage fell to only 3%. These statistics are not surprising since both cotton and maize are considered fertilizer-responsive crops and there is greater fertilizer availability in the CMDT than in the OHV. Millet and sorghum yields, on the other hand, depend more on rainfall.

Equipment

In the OHV, an average of 43% of farms are considered equipped, while 57% are considered non-equipped (OHV Service Statistique, 1985).[2] Ownership of animal traction, a multi-purpose plow, oxen, a seeder, and a cart distinguish those farmers at the upper bounds of modern farming in this zone. The more traditional farms use the daba--a short handled hoe--as well as the pick and machete for land clearing, plowing and harvesting.

Equipment is usually acquired by OHV farmers in one of four ways. Some farmers purchase equipment with their own resources, which in some cases involves the sale of livestock or cash earned in wage labor. Equipment is also sometimes provided by members of the family who have migrated. Some equipment is acquired through bank loans, though this system is not well developed or used. Finally, an important source of equipment is the OHV,

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[2]These figures represent official estimates. The MSU-CESA 1985 farmer census, in which approximately 1,300 farm households were interviewed, revealed that fully equipped households represent only 16% of the population. The divergence in these figures may reflect differences in definition. The official statistics divide all farmers into only two categories: equipped and non-equipped, whereas the MSU-CESA statistics include a third category of semi-equipped farmers.

which provides credit for equipment and inputs. However, this credit is available almost exclusively to those cultivating cash crops (cotton or tobacco).

The general level of equipment in the CMDT is widely acknowledged as being higher than in any other zone of Mali. Those farmers cultivating cotton intensively are usually characterized by ownership of animal traction and the associated equipment. Also used by these farmers to a great extent are sprayers and inorganic fertilizers.

Equipment in the CMDT, like in the OHV, is acquired through farmers' resources, gifts from migrant family members, and, to a lesser extent, bank loans. The most important source is the CMDT itself, which provides credit for equipment purchases as well as inputs. This credit is closely tied to cotton production.

Institutional Environment

Agricultural extension, training and credit as well as rural development activities in the zones of study fall under the responsibility of the Opération Haute Vallée in one zone and the Compagnie Malienne de Developpement des Textiles in the other zone.

Agricultural Extension

The OHV extension and training services are generally recognized as being neither as developed nor as effective as those of the CMDT. Part of the problem of the OHV is thought to be due to under-trained, inexperienced, and under-motivated field

extension agents (Lebeau, 1986; Jolly, Maiga, and Gadbois, 1987). The quality of extension is also considered to be linked to the limited availability of new technology to improve productivity and the limited opportunities for diversification into cash crops with assured markets (Lebeau, 1986; Jolly, Maiga and Gadbois, 1987). The only cash crops undertaken in the OHV are cotton and tobacco in the southern part of the zone.

The CMDT zone, on the other hand, is highly regarded for its rural extension, rural development and marketing networks, which have been in place since the Compagnie Francaise de Developpement des Fibres Textiles (CFDT) began cotton cultivation in this area in 1952 (World Bank, 1983). Since 1975 the CMDT, which had previously only been responsible for agricultural extension and cotton ginning, has extended its activities to other crops (maize, rice and groundnuts) and animal husbandry. The CMDT has promoted the growing of cereals in rotation with cotton to take advantage of the residual effect of fertilizers applied to cotton. This approach has continued and is credited with the quadrupling of cereals area under cultivation from 1975-1980 and with increases in maize production over the same period (World Bank, 1983).

The CMDT has also been vigorous in supporting the development of village associations in an attempt to transfer responsibilities for input distribution, cotton marketing, and credit recovery to the village. These village associations have also been encouraged to adopt basic training in functional

literacy and accounting and to undertake social investments such as child-birth clinics and pharmacies (World Bank, 1983). The CMDT has also introduced other services such as blacksmith training and support for women's activities.

Production/productivity successes in this zone have been attributed to the efficient input distribution and well-organized extension and monitoring system of the CMDT. This system is based on investment in human capital and farm capital, and is linked to cotton, a cash crop with a well-developed technology, an assured market, and a guaranteed price.

Credit

Agricultural credit in the OHV is tied to the production of two cash crops: cotton and tobacco. Credit is handled by the OHV extension agents and is available to farmers in Kangaba, Bancoumana, Ouelessebougou, Kati and southern Koulikoro (Jolly, Maiga, and Gadbois, 1987).

OHV credit is in the form of farm implements and inputs such as fertilizer, fungicides, pesticides and insecticides, which are usually distributed at the beginning of the agricultural season. Though some cash-crop farmers have managed to obtain additional fertilizer for cereals cultivation (mainly maize), the OHV, as a matter of policy, does not provide credit to farmers cultivating only cereals because of the risk of non-repayment.

Oxen for animal traction equipment have not been included in the OHV credit program since 1981-82 (Jolly, Maiga, and Gadbois, 1987). Because oxen are available in a limited supply and because

there is no mortality insurance, the purchase of oxen is considered risky, and farmers who have purchased oxen have encountered difficulties repaying their loans. According to a rapid reconnaissance survey conducted in the OHV, this has limited animal traction in the OHV to about 35% of farmers (Jolly, Maiga, and Gadbois, 1[illegible]7). In the southern OHV areas, animal traction is obtained for cotton production exclusively, whereas in the northern OHV most animal traction in existence was acquired through the no-longer-existing OACV credit program for peanut production.

The CMDT is responsible for distributing inputs and providing farmers with credit, especially for cotton. The CMDT usually extends short-term credit for seeds, fertilizers, insecticides and herbicides for cotton as well as for other crops such as maize, groundnuts and rice. This credit is for only one agricultural season and must be repaid during the cotton marketing period.

The CMDT also extends longer-term credit for equipment such as plows, seeders, and sprayers. Repayment is spread over three years at a 10% interest rate.

According to a 1983 World Bank report, the CMDT has never reported an agricultural credit repayment rate of lower than 95% for short-term loans or 92% for long-term loans.

Survey Villages

Table 4.6 provides a listing of the sixteen villages chosen for the survey in north and south CMDT and OHV. Also presented are several key village indicators.

The first village in each subzone is the market village in which the price data on millet, sorghum and maize were collected. Although smaller markets are found in other villages, these four market villages are the most important markets in the survey areas. Sougoula, in the southern OHV, is the only survey village, beside the four principal market villages, which has both a ZER agent and an important market.

For the most part, with the exception of Dougouolo, all villages in the CMDT zone are predominantly Minianka. In the OHV, the Bambara proved to be the dominant ethnic group in all the survey villages except Sirakorola, which has a greater diversity of ethnic groups and is predominantly Sarakole.

Almost all CMDT villages reported cotton production in 1984, though the northern CMDT villages produced far less total cotton than those villages in southern CMDT. The southern OHV villages reported cotton production in 1984 as well, while northern OHV produced almost no cotton.

Many villages in both zones reported resident cereals merchants in their villages, an indication of how extensive the cereals market network is in the rural areas. In many instances, these merchants are the first-handlers for farmer cereals transactions, especially in non-market villages. These merchants

are almost always available for purchases and sales of coarse grains in the villages and thus provide an all-season ready outlet for those wishing to sell cereals.

TABLE 4.6 -- OHV AND CMDT SURVEY VILLAGE CHARACTERISTICS

ZONES	DISTANCE TO MKT.	DOMINANT ETHNIC GROUP	IMPT. MARKET	1984 COTTON PROD(KG)	CEREALS[1] MERCHANT	REG[2]. TRANS.	REC3 TON
CMDT-SOUTH							
Zangasso	0	Minianka	Yes	113,720	Yes	Yes	Yes
Sounkolo	10	Minianka	No	334,000	Yes	Yes	Yes
Ntosso	7	Minianka	No	317,553	No	No	No
Bleindo	18	Minianka	No	129,290	No	No	Yes
CMDT-NORTH							
Dougouolo	0	Bambara	Yes	NA	Yes	Yes	Yes
Kemeny	4	Minianka	No	46,258	Yes	No	Yes
Petesso	6	Minianka	No	47,060	No	No	No
Kampolloso	15	Minianka	No	66,880	Yes	No	Yes
OHV-SOUTH							
Ouelessebougou	0	Bambara	Yes	30,000	Yes	Yes	No
Sougoula	18	Bambara	Yes	54,872	No	Yes	Yes
Tenemambougo	11	Bambara	No	NA	Yes	No	No
Sanancoro	40	Bambara	No	16,272	No	Yes	NA
OHV-NORTH							
Sirakorola	0	Sarakole	Yes	NA	Yes	Yes	No
Ngabacoro	7	Bambara	No	NA	Yes	Yes	Yes
Chola	14	Bambara	No	107	No	No	No
Katiola	50	Bambara	No	0	No	No	No

[1] Presence of one or more resident cereals merchants in the village.
[2] Village frequented by regular transport in the form of bush taxis or trucks.
[3] The presence of a village association (ton) recognized by either the CMDT or the OHV.
SOURCE : Statistics drawn from MSU-CESA village survey, 1985

The availability of transport, in the form of covered pick-up trucks, bush taxis or large trucks, also provides an

indication of the relative accessibility of the village. Fifty percent of the villages in each subzone have no regular transport available to them and thus are relatively more isolated than the others.

Finally, the presence of a village association (known as a "ton villageois") provides one indication of the organization and cohesion of the village. Whether the village association is recognized by the OHV and the CMDT is essential in determining whether that association has access to Banque Nationale du Developpement Agricole (BNDA) credit programs for cereals purchases, or other programs targeted especially to village associations.[3] However, the presence of a "recognized" village association does not necessarily mean that the village is more socio-politically organized than a village in which the village association is not recognized. Recognition of a village association by the OHV or the CMDT implies only that the particular association has rights to certain credit schemes and other development programs.

Farmer Characteristics from the Census

A complete census was taken of all farm households in the initial eighteen survey villages, of which two villages were later dropped, in order to draw a representative sample. Approximately 1,300 farm households were interviewed. Several

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[3]In 1987, the first year of the BNDA credit program, no village associations in the OHV had access to this credit.

farm characteristics which emerged from the census are shown broken down by zone and subzone in Tables 4.7-4.14.

Equipment

From the census, the equipment levels of the south and north subzones of the CMDT are very similar: both subzones show a relatively high proportion of equipped farmers, about 40% and 52% respectively. About one-third of farmers in these areas are semi-equipped and approximately one-fourth or less are non-equipped.

TABLE 4.7 -- PERCENTAGE OF CENSUS FARMS BY EQUIPMENT LEVELS

ZONES AND SUBZONES	EQUIPPED	SEMI-EQUIPPED	NON-EQUIPPED
CMDT-SOUTH	40.3	34.5	25.2
CMDT-NORTH	51.8	31.6	16.6
OHV-SOUTH	16.4	43.1	40.5
OHV-NORTH	15.8	33.2	51.0

SOURCE: MSU-CESA Food Security Project Farm Census (1985)

In contrast, in the OHV zones only 16% of farm households in both the south and the north are fully equipped. Forty percent of farmers in the south are non-equipped and 51% of farmers in the north are non-equipped.

Thus a very clear picture emerges of farm households in the sixteen survey villages: a higher proportion of farmers who are equipped and semi-equipped are found in the CMDT than are found

in the OHV. This is probably due, in part, to the fact that most equipment is obtained on credit from the two rural development operations, and that the CMDT farmers, because of their cotton cultivation, are in a better position to obtain this credit than are farmers in the OHV.

Credit

Again, echoing the equipment levels above, those who have access to formal credit in the CMDT far outnumber those in the OHV. Ninety-nine percent of farm households in southern CMDT and 85% in northern CMDT have access to formal credit. In southern OHV, 49% have access to formal credit, whereas only 17% have such access in northern OHV.

TABLE 4.8 -- PERCENTAGE OF CENSUS FARMS BY ACCESS TO FORMAL CREDIT

ZONES AND SUBZONES	ACCESS TO CREDIT	NO ACCESS TO CREDIT
CMDT-SOUTH	99.4	0.6
CMDT-NORTH	85.1	14.9
OHV-SOUTH	49.5	50.5
OHV-NORTH	17.3	82.7

SOURCE: MSU-CESA Food Security Project Farm Census (1985)

Thus, overall levels of credit availability are markedly different in the OHV and CMDT zones, which is undoubtedly a reflection of the institutional differences between these two areas due in large part to the widespread differences in the

extent of cotton cultivation. A south-north difference also exists within the CMDT and the OHV, with a lower percentage of farmers in northern subzones having access to credit. This is probably an indication of the different agricultural potential of the northern and southern subzones of both regions and thus the concentration of credit investments in the more fertile southern areas. The northern zones are characterized by lower rainfall and hence less cotton production, which is the main means of credit recovery.

Land

Expansion of Crop Area

In both southern subzones of the CMDT and OHV, between 70 and 73% of farm households had extended their cultivated land area over the last five years. In northern CMDT about 35% had extended their cultivated area, compared to 35% in northern OHV.

TABLE 4.9 -- PERCENTAGE OF CENSUS FARMS EXPANDING LAND

ZONES AND SUBZONES	EXPANDED LAND DURING LAST 5 YEARS	DID NOT EXPAND LAND DURING LAST 5 YEARS
CMDT-SOUTH	70.5	29.5
CMDT-NORTH	34.7	65.3
OHV-SOUTH	73.4	26.6
OHV-NORTH	45.4	54.6

SOURCE: MSU-CESA Food Security Project Farm Census (1985)

This appears to indicate that farmers in the southern zones of both the OHV and the CMDT are in a better position to extend the size of their farms. This might be because of a greater availability of arable land in these areas or a tendency for farm households in the southern regions to have a greater capital (equipment) endowment with which to exploit the land. In any instance, the farm expansion in the south appears to indicate a more dynamic agriculture in these areas, which might have its roots in better soil fertility, greater rainfall, higher levels of equipment, lower labor migration, or other factors. This finding indicates that land, in most cases, is not the binding constraint to production and hence emphasis should be placed initially on relieving labor and/or capital constraints rather than land constraints.

Farm Size

Surprisingly, among the southern CMDT and OHV farmers, 47% classified their farm size as "small" , while only 28% of the northern CMDT and OHV farmers gave a like classification. One possible explanation is that farms in the northern zones are large because of poor soils, difficult rainfall conditions, and the overall riskiness of their environment, all of which requires them to engage in more extensive farming. On the other hand, farmers in the southern zones might be expected to engage in more intensive farming and thus have smaller farms.

One must be careful in interpreting these results too definitively since the question asked concerning farm size

TABLE 4.10 -- PERCENTAGE OF CENSUS FARMS BY FARM SIZE[1]

ZONES AND SUBZONES	LARGE	MEDIUM	SMALL
CMDT-SOUTH	24.9	27.7	47.4
CMDT-NORTH	29.5	42.5	28.0
OHV-SOUTH	14.4	38.5	47.2
OHV-NORTH	21.4	50.5	28.1

[1] Farm size classification was based on farmers' own perceptions of their farm size.

SOURCE: MSU-CESA Food Security Project Farm Census (1985)

called for a subjective appreciation of the size of farm on the part of the head of the household. Thus the answers were certainly colored by what the farmers perceived to be "small" and "large". These perceptions as to what constitutes different-sized farms can be expected to vary not only among individual farmers and their villages, but also between the zones and subzones of the study.

Labor

Family Size

It is difficult to make a strong statement about differences in farm family size in the study area given the magnitude of the standard deviations shown in Table 4.11. The mean farm-family labor force (actifs) during the 1985 agricultural season in the southern zones of the CMDT and the OHV appears to be lower than that of the northern zones. The mean number of non-workers per farm appears to be greater in the OHV than in the CMDT. It is

not clear to what extent the lower number of farm workers in the southern zones of the OHV and CMDT reflect young men migrating to Bamako or the Côte d'Ivoire in search of work.

TABLE 4.11 -- MEAN FARM FAMILY SIZE OF CENSUS FARMS

ZONES AND SUBZONES	FARM FAMILY WORKERS PER HOUSEHOLD	NON-WORKERS PER HOUSEHOLD
CMDT-SOUTH	3.7 (2.9)	6.4 (5.0)
CMDT-NORTH	4.7 (2.6)	6.8 (5.0)
OHV-SOUTH	3.2 (2.3)	8.5 (7.2)
OHV-NORTH	6.5 (5.8)	7.7 (6.8)

Note: standard deviations in parentheses
SOURCE: MSU-CESA Food Security Project Farm Census (1985)

Food Situation

Overall, the CMDT zone reflects a more food-secure situation than does the OHV zone. In the southern and northern zones of the CMDT, respectively 63% and 58% of farm households are considered either surplus or self-sufficient. In the southern subzone of the OHV the figure is about 30% and in northern OHV it is 32%. This rating of the household food situation was obtained from the village extension agent and was not a self-evaluation by the farmers themselves. It was hoped that by asking the village extension agent for such an assessment some degree of consistency, if not objectivity, would be gained.

TABLE 4.12 -- PERCENTAGE OF CENSUS FARMS BY HOUSEHOLD FOOD SITUATION

ZONES AND SUBZONES	SURPLUS	SELF-SUFFICIENT	DEFICIT
CMDT-SOUTH	18.3	44.9	36.8
CMDT-NORTH	20.4	38.0	41.7
OHV-SOUTH	3.2	26.4	68.4
OHV-NORTH	0.5	31.6	67.9

SOURCE: MSU-CESA Food Security Project Farm Census (1985)

These figures indicate that almost twice as many farmers in the CMDT as in the OHV are considered food-secure. This observation undoubtedly has many sources, one of which might be the cultivation of a cash crop in the CMDT, which permits cereals to be grown more for home-consumption than for sale to meet household expenditures (including taxes). The cereals of CMDT farmers are less subject to the possibility of being sold out of the family food stock to meet urgent cash needs. In addition, farm size appears to be much larger in the CMDT than in the OHV, which may reflect the effect of the greater level of equipment in the CMDT. This might be expected to contribute positively to household food security.

Non-agricultural Activities

From the census it appears that a greater percentage of farms in the OHV than in the CMDT are engaged in some form of

non-agricultural activity. Non-agricultural activities include commerce, gardening, apiculture, the making of shea nut butter, hunting, herding, charcoal-making, as well as professions such as blacksmith, mason, watch repairer, and mechanic. In the CMDT south and north, respectively 31% and 22% of farms have one or more family members engaged in activities off the farm. In southern and northern OHV the figures are 44% and 54%, respectively.

TABLE 4.13 -- PERCENTAGE OF CENSUS FARMS ENGAGING IN NON-AGRICULTURAL ACTIVITIES

ZONES AND SUBZONES	% OF FARMS WITH NON-AGRICULTURAL ACTIVITIES	% OF FARMS WITHOUT NON-AGRICULTURAL ACTIVITIES
CMDT-SOUTH	30.8	69.2
CMDT-NORTH	21.7	73.3
OHV-SOUTH	43.8	55.7
OHV-NORTH	53.6	45.4

SOURCE: MSU-CESA Food Security Project Farm Census (1985)

What this perhaps indicates is the need for OHV farmers to diversify their households' activities outside farming, either to insure against a crop failure, or because even in a good year, farming alone cannot provide the family with an adequate source of revenue to meet family needs. CMDT farmers are more able to rely on farming to meet their needs: cereals farming for home consumption and cotton farming for their monetary needs. The CMDT farmers do not have the need of OHV farmers to diversify their

family enterprises in order to hedge against risk and supplement their farm income.

Cereals Market Participation

The figures presented in Table 4.14 are based on one-year recall by farmers of their sales during the 1984/85 crop year, which was a year of drought. The cereals marketing data analyzed in Chapter 5 for 1985/86 differ substantially from the 1984/85 figures in that they were based on monthly recall data and hence are more accurate. Nonetheless the same patterns shown in Table 4.14 are confirmed in the analysis of the 1985/86 market transactions presented in Chapter 5.

In the two most important sorghum producing areas, the percent of farmers having sold any sorghum during the 1984/85 season was 50% (southern CMDT) and 7% (southern OHV). In northern CMDT only about 4% of farmers sold sorghum, and in northern OHV, no farmers engaged in sorghum sales.

TABLE 4.14 -- CEREALS MARKET PARTICIPATION OF CENSUS FARMS

ZONES AND SUBZONES	SORG. PROD. SOLD			% MIL. PROD. SOLD			% MAIZE PROD.SOLD		
	None	<50%	>50%	None	<50%	>50%	None	<50%	>50%
CMDT-S	49	50	0.3	99	0.9	0	88.5	11.5	0
CMDT-N	96	3.6	0	86	14	0	100	0.3	0
OHV-S	92	4.6	2.6	96	3	0	100	0	0
OHV-N	100	0	0	99	1	0	100	0	0

SOURCE: MSU-CESA FOOD SECURITY PROJECT FARM CENSUS (1985)

Overall, millet was far less commercialized than sorghum during the 1984/85 crop year. Only about 1% of farmers in southern CMDT and 14% of northern CMDT farmers sold any millet. In southern OHV, 3% of farmers sold millet, and in the north that figure was only 1%.

Only in the CMDT, the principal maize growing zone, did farmers market any of their maize production during the 1984/85 season. Eleven percent of southern CMDT farmers marketed some of their maize, whereas only 0.3% of any northern CMDT farmers marketed their maize.

Overall then, the crop which the greatest percentage of farmers tended to market to some degree was sorghum. Millet followed sorghum in importance, and maize was the least important in terms of market participation on the part of farmers. However, the percentage of farmers indicating any coarse grains sales whatsoever was relatively low across the board. Such low levels of sales was probably due to the fact that 1984/85 was an exceptionally poor harvest year and hence there was little available surplus production for the market. Market involvement, as indicated by this data, must be evaluated carefully, as many farmers reported selling none of their coarse grains production at all.

Conclusion

Several characteristics emerge from the census to distinguish between the CMDT and the OHV zones. The CMDT, endowed with a well-

managed agricultural institution having responsibility for both cash crop and cereals crop activities, is the zone with the greatest proportion of equipped and semi-equipped farmers, the highest percentage of farmers with access to credit, and a population which, in 1984/85, was either self-sufficient or surplus in cereals. The CMDT also appears to have a less elevated level of emigration and less of a need to diversify into non-agricultural activities.

On the other hand, the OHV, which has less of an institutional resource base, has a much smaller proportion of equipped and semi-equipped farmers, a lower percentage of farmers with access to credit, and a population of which only one-third was ranked food self-sufficient or surplus. The OHV also appears to have a relatively large number of households to whom emigration is a relevant issue, and greater diversification into non-agricultural activities.

Also indicated in the census data is a north-south difference across both institutional zones. The southern zones of both the OHV and the CMDT, which are characterized by high rainfall and relatively rich soils, appeared to have greater access to credit and a larger percentage of farms that had extended their area planted to crops over the previous five years. More southern farmers appeared to estimate their farms as being "small" and "medium" sized, and overall these farm households reported a smaller farm-family labor force than did farmers in the north.

In contrast, the farmers in the northern subzones of both the OHV and the CMDT, which are located in the sudano-sahelian zone with lower rainfall and sandier soils, had far less access to formal credit than did farmers in the southern subzones. Only one-third of the northern farmers reported extending their cultivated area during the previous five years, although on the whole these farmers evaluated the size of their holdings as "medium" and "large".

In 1984/85, market involvement, measured in terms of gross cereals sales, was low overall for both the CMDT and the OHV, as well as between the north and south across both zones. While the percentages of farmers involved in marketing coarse grains did vary slightly according to crop and region (which are correlated), the overall pattern that emerges is one of low market involvement among the farmers in the census.

CHAPTER 5

FARM HOUSEHOLD LEVEL ANALYSIS OF COARSE GRAIN PRODUCTION AND TRANSACTION BEHAVIOR

Preliminary Results

Before embarking on the econometric analysis of the farmer production and transaction data collected during the MSU-CESA study in 1985/86, a summary of the principal findings of the preliminary analysis of the data conducted by Dione (Dione, 1987) will be presented. Dione's analysis of the 189 farm households' production and transactions behavior is essentially descriptive, relying on statistical means and correlations of variables for the CMDT and OHV, the northern and southern subzones, and the different equipment level strata outlined in Chapter 1. Dione uses these statistics to make interzonal, inter-subzone, and inter-strata comparisons of farm households' cereals production, purchases, sales, gifts and barter. His conclusions not only describe the cereals transactions and the consequent food security positions of CMDT and OHV farmers, but also suggest the major determinants of farmer food-security strategies. Dione's analysis has been instrumental in generating the hypotheses upon which the econometric analysis presented in this chapter is based and thus is a necessary precursor to it.

Production

Table 5.1 shows weighted population estimates of coarse grain production by farm households in the OHV and CMDT zones in 1985. Dione found that mean production levels varied strongly between the two zones of the study in 1985, a finding which he credited to institutional differences between the CMDT and the OHV. Mean production levels also varied significantly between the northern and southern subzones, which likely has its explanation in rainfall and soil differences. Even across the households themselves, Dione found heterogeneous mean production figures which support the hypothesis concerning the diversity of Malian farmers.

TABLE 5.1 -- COARSE GRAIN PRODUCTION BY FARM HOUSEHOLDS IN THE OHV AND CMDT ZONES IN 1985

ZONES SUB-ZONES STRATA	PRODUCTION PER FARM				PRODUCTION PER FARM WORKER(KG)	PRODUCTION PER CAPITA(KG)
	KG	% MILLET	%SORGHUM	%MAIZE		
CMDT	3666	48.7	36.8	14.5	701	285
OHV	1493	64.7	31.9	3.3	363	118
SOUTH	3519	39.9	41.1	19.0	760	292
NORTH	2399	67.2	29.0	3.9	473	178
EQUIPPED	4799	49.1	39.5	11.5	695	263
S.E.N.D.	3295	55.2	29.4	15.4	659	259
S.E.D.	1698	53.1	32.2	14.8	427	158
NON-EQ.	1127	55.2	33.0	11.8	413	155

S.E.N.D. = Semi-equipped non-deficit
S.E.D. = Semi-equipped deficit

SOURCE : MSU-CESA Food Security Project Farm Surveys (1985/86).

Thus three variables emerged to explain the variation in total cereals production in 1985: the zone, the subzone and the equipment stratum in which the farm household is located. Dione suggested that variation in cereals production attributable to the variable "zone" is a reflection of the difference in the institutional environments of the CMDT and the OHV. Agricultural extension, training, credit, inputs and rural development activities fall largely under the responsibility of the two institutions responsible for agricultural development which, as shown in Chapter 4, differ significantly in terms of their management efficiency.

Variation in cereals production attributable to the variable "subzone" was hypothesized to be primarily a reflection of the agroclimatic differences between the northern and southern subzones. Rainfall ranges from 700 millimeters in the north to 1200 millimeters in the south, and soil quality varies between light sandy soils in the northern sudano-sahelian areas to clay-lime soils in the southern sudano-guinean areas.

Farm equipment levels incorporated in the variable "strata" were important indicators of cereals production in 1985 as well. Dione hypothesizes that the position of the farm household in terms of equipment level reflects family size, farm size, household wealth and other aspects of the farm household's resource endowment. This complex of factors, evident in the equipment level of the household, determines, to a certain extent, agricultural production and household food security.

As for the production of individual cereals, Dione found that strikingly different patterns emerged across zone and subzone, which he again suggested was due to the institutional variation in these different areas and the different rainfall needs of millet, sorghum and maize. On the other hand, his results showed that the crop mix did not vary significantly across the different equipment strata, which indicated relatively homogeneous preferences for cereals across farmers and the lack of an equipment-related technological constraint to the production of any of these three cereals.

Cereals Sales

The cereals marketing findings cited in the presentation of Dione's survey findings as well as the data used in the later econometric analysis refer to the 1985/86 crop year, which was the first year of relatively good rainfall following three years of drought. For the country as a whole, coarse grain production in 1985/86 was 72% above the 1981/82-1984/85 average (Dione and Staatz, 1987). Because 1985/86 was a relatively good year following a series of drought years, cereals marketing behavior might have been strongly influenced by the farmers' desire to rebuild on-farm grain stocks and their need to sell cereals to repay debts. Consequently, these results should only be generalized to other years with caution.

Table 5.2 presents the weighted population estimates of coarse grain sales in the OHV and CMDT zones during the year 1984/85. Dione found that average cereals sales varied according

to zone, with the CMDT zone farmers selling 3.6 times the average amount of OHV farmers. The equipment/food security strata of farm households also explained mean cereals sales, with the average cereals sales of equipped farmers being 80% higher than those of the semi-equipped non-deficit farmers, 7.7 times higher than those of semi-equipped deficit farmers, and 4.9 times higher than those of non-equipped farmers. The north- south dichotomy reappeared in terms of mean cereals sales as well: the average cereals sales of southern farmers constituted 2.2 times that of farmers in the north.

TABLE 5.2 -- COARSE GRAIN SALES BY FARM HOUSEHOLDS IN THE OHV AND CMDT ZONES DURING 1985/86

ZONES SUB-ZONES STRATA	PERCENT. OF FARMS SELLING	AVERAGE SALES PER FARM (KG)	PERCENTAGE PRODUCTION SOLD	PERCENTAGE OF TOTAL NET SALES
CMDT	66.4	309	8.4	90.3
OHV	52.7	86	5.8	9.7
SOUTH	66.9	327	9.3	73.6
NORTH	62.4	150	6.2	26.4
EQUIPPED FARMS	79.9	433	9.0	70.4
SEMI-EQUIPPED NON DEFICIT	77.3	241	7.3	18.0
SEMI-EQUIPPED DEFICIT	45.4	56	3.3	2.6
NON-EQUIPPED FARMS	52.9	89	7.9	9.0

SOURCE : MSU-CESA Food Security Project Farm Surveys (1985/86).

Cereals sales as a percentage of total cereals production also varied between zone, subzone and across strata. The weighted population estimate for the average percentage of cereals production sold was 8 percent. In the CMDT 8.4% of total cereals production was sold, and in the OHV the figure was 5.8%. In the southern subzones of both the CMDT and the OHV, farmers' total sales as a percentage of their total production was 9.3%, whereas in the northern subzones this figure was 6.2%. As for the different strata of farmers, Dione found that the semi-equipped deficit farmers sold the lowest percentage of their production at 3.3%, but otherwise the percentage of cereals production sold varied little from one stratum to another: 9% for the equipped farmers, 7.3% for the semi-equipped non deficit, and 7.9% for the non-equipped.

As for the relative importance of different cereals in these sales figures, Dione found that sorghum was the cereal marketed the most. Total sorghum sales represented 66.1% of total cereals sales as opposed to 27% for millet and 7.3% for maize. In terms of sales as a percentage of production, 14.6% of sorghum production was sold, compared to 4.2% of millet production and 4.6% of maize production. Dione attributed the low figure for marketed maize production to the use of the relatively early maize harvest for home consumption during the last months of the hungry season before the sorghum and millet harvests are in. As for the weighty position of sorghum in total cereals sales, Dione explained this as due to the poorer preservation qualities of

sorghum vis-à-vis millet as well as a taste preference for millet for home consumption.

Dione also examined the timing of coarse grain sales across the year, and found that the timing varied greatly across both zone and subzone. Table 5.3 shows the seasonal distribution of grain sales by farmers in the OHV and CMDT based on weighted population estimates. Dione found that 58% of CMDT sales occurred during the rainy season (from June to October), a period when coarse grain supplies are usually low and market prices are high. In stark contrast were OHV sales, about 86% of which

TABLE 5.3 -- SEASONAL DISTRIBUTION OF GRAIN SALES BY FARM HOUSEHOLDS IN THE OHV AND CMDT ZONES DURING 1985/86

ZONES AND SUB-ZONES	PERCENTAGE OF TOTAL SALES		
	NOV.-MARCH	APRIL-MAY	JUNE-OCT.
SOUTH-CMDT	29.4	5.1	65.5
NORTH-CMDT	49.7	19.1	31.2
SOUTH-OHV	88.2	0.0	11.8
NORTH-OHV	83.4	16.6	0.0
CMDT TOTAL	39.8	12.2	48.0
OHV TOTAL	85.7	8.8	5.5

SOURCE : MSU-CESA Food Security Project Farm Surveys (1985/86)

occurred right after harvest (from November to March), a period during which markets tend to be flooded and farm-gate prices are at their lowest. In Mali, this post-harvest period coincides with the period during which the head tax and other rural taxes are

collected. Not coincidentally, Dione found that the first motive for cereals sales given by 71% of OHV farmers was the payment of taxes (Table 5.4). Dione suggested that the timing of sales pattern observed across the two zones of the study reflects the timing of monetary pressures imposed on farm households as well as the means with which these households are able to meet their cash obligations. In particular, CMDT farmers are able to rely on their cash income from cotton sales to pay taxes during the post- harvest season, whereas OHV farmers, who have few cash cropping opportunities, are obliged to rely on sales of their cereals to meet their tax payments.

TABLE 5.4 -- MOST IMPORTANT REASON GIVEN FOR COARSE GRAIN SALES BY SAMPLE HOUSEHOLDS IN THE OHV AND CMDT ZONES DURING 1985/86 (PERCENTAGE OF FARMERS REPORTING SALES)

ZONES AND SUB-ZONES	PURCHASE OF FOOD SUPPL. (CONDIMENTS)	HEAD TAX PAYMENT	LOAN REPAYMENT	PURCHASE OF AGR. EQUIPMENT	SOCIAL EVENTS
SOUTH-CMDT	76.1	12.0	12.0	0.0	0.0
NORTH-CMDT	84.6	0.0	4.0	7.4	4.0
SOUTH-OHV	30.7	51.3	18.0	0.0	0.0
NORTH-OHV	3.4	91.6	5.0	0.0	0.0

SOURCE : MSU-CESA Food Security Project Farm Surveys (1985/86).

Another important finding from Dione's analysis is the high concentration of coarse grain sales among a small percentage of farmers (see Table 5.5 and Figure 5.1). In 1985/86, about 92% of net sales were made by 30% of farm households in the CMDT and OHV

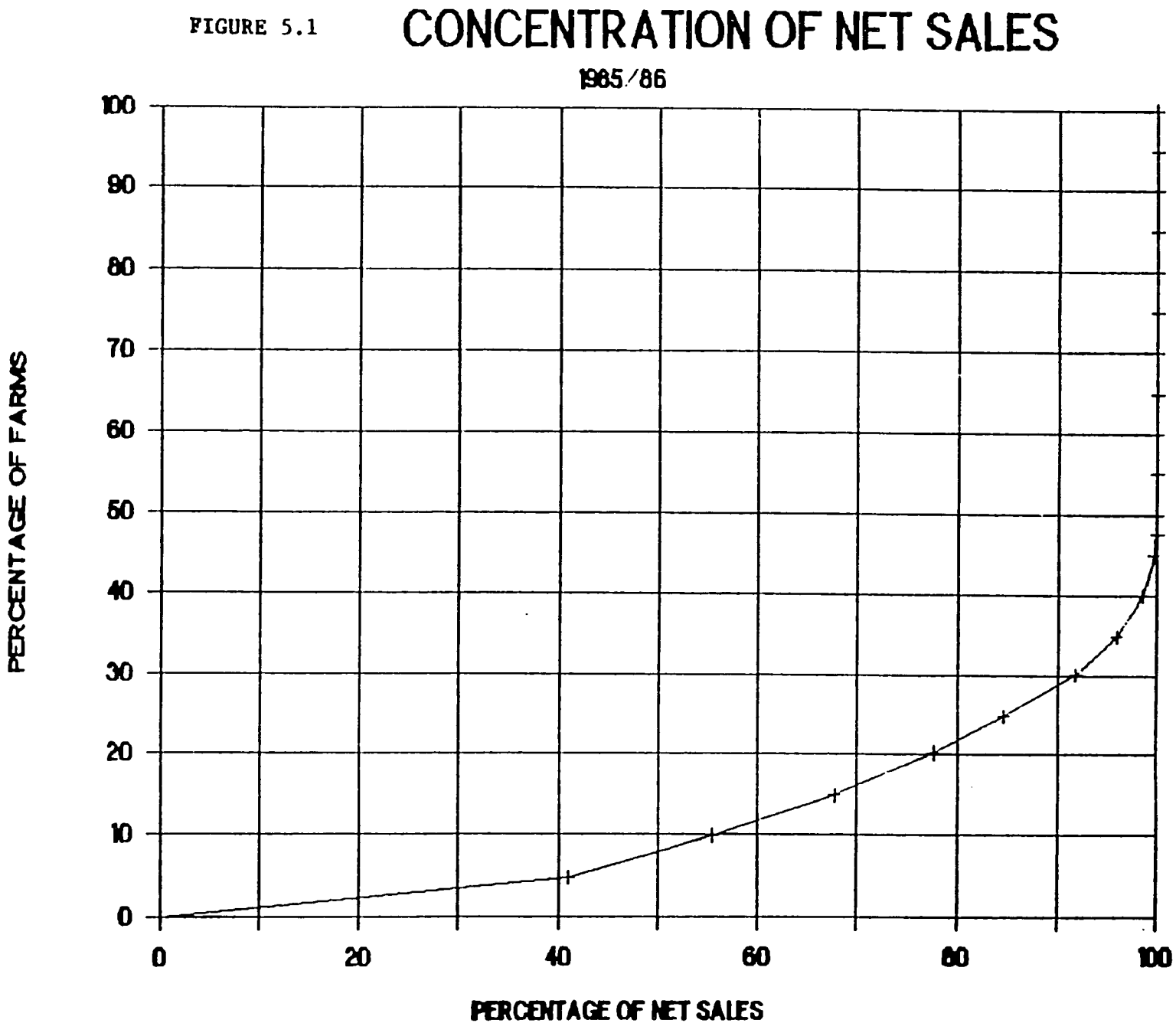
TABLE 5.5 -- ESTIMATED CONCENTRATION OF COARSE GRAIN SALES BY FARM HOUSEHOLDS IN THE OHV AND CMDT ZONES DURING 1985/86

GROSS SALES		NET SALES	
PERCENT. OF FARMS	PERCENT. OF SALES	PERCENT. OF FARMS	PERCENT. OF SALES
4.7	36.1	4.7	41.0
9.9	49.9	9.9	55.5
14.9	60.9	14.9	67.7
20.4	69.8	20.4	77.6
24.9	67.4	24.9	84.7
30.1	84.4	30.1	91.9
35.3	89.9	34.9	95.9
39.7	93.0	40.0	98.5
45.1	95.5	45.0	99.7
49.9	97.7	47.6	100.0
55.1	99.1		
59.9	99.9		
64.3	100.0		

SOURCE : Dione, 1987

zones. About 74% of net sales came from southern CMDT and OHV, compared with only 26% from the northern subzones of these regions. Finally, only 48% of the population were net sellers of coarse grains, while 39% were net buyers (Dione, 1987). When examined in conjunction with the previous discussion on the timing of sales across the year, these findings have important implications for the incidence of any policy resulting in an alteration of market prices in the coarse grains sector. It is apparent from Dione's analysis that increases in cereals prices directly benefit a relatively small percentage of farm households. For example, only about ten percent of farm households make over 50% of net sales, and most of these are in the southern regions. To what extent these "net sellers" benefit

FIGURE 5.1



SOURCE: Dione and Staatz

from price increases largely depends on how the period of sales corresponds with when in the year the policy affects prices. Higher cereals prices are, to varying degrees, to the detriment of the almost 40% of rural households that are net buyers of coarse grains, which goes counter to conventional wisdom that all farmers benefit from higher farm prices. Again, how these households are hurt by higher prices depends on how the timing of their purchases corresponds with when in the year the policy affects prices.

Thus zone, subzone, and stratum, indicators of institutional differences, agro-climatic differences and farm equipment levels respectively, appeared appropriate for analyzing the variation in actual cereals sales, as well as cereals sales as a percentage of production. The sales of a particular coarse grain as a percentage of that grain's production appeared to be more a question of timing of the harvest, storability of the particular grain, and taste preferences. Finally, the timing of sales, the timing of taxes, and cash cropping opportunities were shown to be key variables in explaining cereals sales, revenues from these sales and consequently the different food security positions of the sample households.

Cereals Purchases

Table 5.6 shows estimated coarse grain purchases by farm households in the OHV and CMDT during 1985/86. Dione found that while 64% of the farm households in the two zones sold grain; only 45% bought grain. In the CMDT, 41% of household were

purchasers of grain, and in the OHV, 53% purchased grain in 1985/85. This confirmed an earlier finding indicating a higher proportion of food-deficit farm households in the OHV compared to the CMDT. The difference between the CMDT and the OHV was even more marked when mean purchases were considered. In the CMDT, coarse grain purchases in 1985/86 averaged 169 kg. per household, whereas the OHV had mean coarse grain purchases of 310 kg.

TABLE 5.6 -- ESTIMATED COARSE GRAIN PURCHASES BY FARM HOUSEHOLDS IN THE OHV AND CMDT ZONES DURING 1985/86

ZONES SUB-ZONES STRATA	PERCENT. FARMS BUYING	AVERAGE PURCHASES PER FARM (KG)
CMDT	40.7	169
OHV	71.6	310
SOUTH	20.5	122
NORTH	64.1	304
EQUIPPED FARMS	27.9	182
SEMI-EQUIPPED NON DEF.	36.7	109
SEMI-EQUIPPED DEFICIT	68.1	381
NON-EQUIPPED FARMS	54.7	229

SOURCE : Dione, 1987

The north-south difference in coarse grain purchases was also significant. In the southern subzones only 20.5% of farm households purchased coarse grains, whereas 64.1% of northern farmers did. Mean coarse grain purchases were about 122 kg. per

household in the southern subzones compared to 304 kg. in the northern areas.

The importance of the equipment level also emerged as a significant finding in Dione's analysis. In 1985/86, equipped farmers participated the least in cereals purchases (28%), whereas semi-equipped deficit and non-equipped households were the most involved (68% and 55% respectively). Equipped households purchasing grain bought an average of 181 kg.; semi-equipped non-deficit households, 109 kg.; semi-equipped deficit households, 381 kg.; and non-equipped households, 229 kg.

TABLE 5.7 -- MOST IMPORTANT REASON GIVEN FOR COARSE GRAIN PURCHASES BY SAMPLE HOUSEHOLDS IN THE OHV AND CMDT ZONES DURING 1985/86 (PERCENTAGE OF FARMERS REPORTING PURCHASES)

ZONES AND SUB-ZONES	IMMEDIATE CONSUMPTION	STOCK BUILDING	PROCESSING AND LOCAL SALES	COMMER-CIAL SALES
SOUTH-CMDT	57.5	0.0	17.0	25.5
NORTH-CMDT	42.2	57.8	0.0	0.0
SOUTH-OHV	100	0.0	0.0	0.0
NORTH-OHV	89.4	4.2	0.0	6.4

SOURCE : MSU-CESA Food Security Project Farm Surveys (1985/86).

Table 5.7 presents the most important reasons given for coarse grain purchases among those sample farmers having reported purchases. In the CMDT, 57% of those households in the south and 42% of them in the north purchased coarse grains primarily for immediate consumption. In the southern CMDT, other important

reasons for purchasing coarse grains were to process the grain and sell it later, and to sell the grain commercially. In the northern CMDT, 58% of buyers gave the building of stocks as the most important reason for their purchases.

In the OHV, almost all farmers responded that the most important reason for purchasing coarse grains was to satisfy immediate consumption needs.

TABLE 5.8 -- PRINCIPAL REVENUE SOURCE USED TO FINANCE COARSE GRAIN PURCHASES MADE BY SAMPLE HOUSEHOLDS IN THE OHV AND CMDT ZONES DURING 1985/86 (PERCENTAGE OF FARMERS REPORTING PURCHASES)

ZONES AND SUBZONES	PERCENTAGE OF FARMS BY SOURCE OF REVENUE								
	COTTON	OTHER	SHEA	AN.	COMM.	ARTIS.	NAS	EMIG.	LOAN
S.-CMDT	41.5	0	0	0	42.5	16.0	0	0	0
N.-CMDT	33.6	1.8	0	19	4	29.6	4	4	4
S.-OHV	0	0	10.7	75	3.9	0	7	3.9	0
N.-OHV	0	0	0	58	1.9	4.2	14	10.6	10.5

Cotton = cotton sales
Other = other agricultural products
Shea = shea butter sales
An. = animal sales
Comm. = petty commerce
Artis. = artisanal activities
NAS = non-agricultural salaries
Emig. = emigrant gifts
Loan = loans

SOURCE : MSU-CESA Food Security Project Farm Surveys (1985/86).

Table 5.8 indicates the principal sources of revenue used to finance coarse grain purchases. Dione finds a significant difference between the CMDT and the OHV: farmers in the CMDT

rely most heavily cotton sales, while a large percentage of farmers in the OHV use receipts from animal sales as a principal revenue source to finance coarse grain purchases.

Other important sources of revenue to finance cereals purchases in the CMDT are petty commerce, artisanal activities, and animal sales. In the OHV, other important sources aside from animal sales include shea butter sales, non-agricultural salaries, emigrant remittances and loans.

Non-monetary Transactions

While roughly 65% of the sample's farm households sold cereals during 1985/86, 57% engaged in non-monetary transactions of cereals.

Non-monetary transactions include both gifts and barter, although in this study barter is thought to have been underestimated and subsumed under gifts. This confusion between giving and bartering coarse grain revolves around the distinction between a transaction with and without a counterpart. Gifts often have some sort of exchange implied between giver and receiver, and thus for the purposes of the econometric analysis presented in this chapter, gifts and barter of cereals are combined under non-market transactions.

Across the sample, net gifts of cereals averaged 153 kg/household, which represent about 68% of gross cereals sales. Net gifts of cereals represent 5.2% of total production. According to Dione's analysis, there appears to be a very strong

TABLE 5.9 -- COARSE GRAIN GIFTS AND BARTER BY FARM HOUSEHOLDS IN THE OHV AND CMDT ZONES DURING 1985/86

ZONES SUB-ZONES STRATA	PERCENT. OF FARMS HAVING GIVEN AND/OR BARTERED	AVERAGE NET OUTGOING BARTER (KG)	AVERAGE NET OUT-GOING GIFTS	NET OUTGOING GIFT AS A	
				PERCENTAGE OF GROSS SALES	PERCENTAGE OF PRODUC-TION
CMDT	59.0	0	202	65.4	5.5
OHV	45.3	0	57	66.3	3.8
SOUTH	65.2	1	190	58.1	5.4
NORTH	50.7	-1	119	79.3	4.9
EQUIPPED	57.1	-2	277	64.0	5.8
S.E.N.D.	63.1	14	142	58.9	4.3
S.E.D.	52.4	6	88	157.1	5.2
NON-EQUIP PED FARMS	55.2	-8	44	49.4	3.9

SOURCE : MSU-CESA Food Security Project Farm Surveys (1985/86).

association between gifts and the household's zone, subzone, and equipment level, with gifts being more prevalent in the CMDT than in the OHV, in the south than in the north, and among the equipped than among the other three strata. Dione also finds that the timing of gifts reveal a marked pattern, with an average of 75% of all gifts occurring in the post-harvest period across the north and south of both zones. One possible explanation for this might be that gifts in coarse grains constitute a form of payment for labor during the agricultural season.

Summary

Almost without exception, Dione suggests that the zone, subzone and level of equipment of the farm households are significant in explaining patterns of household production, monetary and non-monetary transactions. In addition to these three variables, Dione hypothesizes that the timing of taxes, timing of revenues, cash cropping opportunities and non-agricultural activities are important determinants of levels of market and non-market transactions among farm households in the sample.

Given the findings and the hypotheses generated by Dione's preliminary analysis of the farm household production and transaction data, two groups of models were constructed. The first group attempts to explain coarse grain production and agricultural value generated per farm family laborer. The second group provides a closer examination of the determinants of market and non-market transactions: gross cereals sales, non-monetary transactions, gross cereals purchases, net cereals sales, and cereals marketing patterns across the year.

Econometric Methods

Criteria for choosing the best specifications of the models presented in the following sections of this chapter were based on recommendations set forth in econometrics texts (Pindyck and Rubinfeld 1981; Kennedy, 1985). The omission of relevant variables, the inclusion of irrelevant variables, the non-normal

distribution of disturbances and the misspecification of the functional form are all hazards associated with finding the "best" specification of the relationships under study. Kennedy notes that no "true" model can ever be found; rather, what a researcher must hope to find instead is an adequate approximation for the purpose of the analysis in question.

For the empirical analysis undertaken in this chapter, the "adequate approximation" of the true models was based on a thorough understanding of the agricultural system under study. Through discussions with farmers, extension agents and other informants, as well as an extensive review of the relevant theoretical and empirical literature, hypotheses were generated as to the relevant variables for inclusion in the models. In this way it was hoped that no irrelevant variables would be included and no relevant variables omitted.

Incorrect specification of the functional forms of the models was also carefully considered. A double logarithmic function was estimated (see Appendix A) which did not perform better than the linear specification. For this reason, the linear specification is included in the text and the double-log version in the appendix. For the econometric analysis of the transactions data, the classic linear regression model was used. This model is based on the following five assumptions outlined in Kennedy: that the dependent variable is a linear function of a set of independent variables plus a disturbance term, that the expected value of the disturbance term is zero, that the

disturbance terms all have the same variance and are uncorrelated, that the observations on the independent variables can be considered fixed in repeated samples, and that there are no linear relationships between the independent variables (Kennedy, 1985). Because there is no a priori reason to assume any particular shape for the relationship among the variables, the classic linear formulation was selected for simplicity.

Because of the selection of the classic linear regression model for almost all the equations specified in this chapter and because the models do not include endogenous variables which are simultaneously determined by an interrelated series of equations, the ordinary least squares estimator (OLS) was the optimal estimator. According to Pindyck and Rubinfeld, of all estimators "which are linear in the independent variable and which yield unbiased estimates, the estimates from the OLS estimator have the minimum variance" and are therefore considered "best".

In the interpretation of the econometric results, focus is placed on hypothesis-testing using t-tests, and the magnitude of the coefficients of the variables. The R^2 represents the proportion of the variation in the dependent variable explained by variation in the independent variables. The adjusted R^2, which corrects for degrees of freedom, is included for all equations. In the production equations the adjusted R^2 hovers around .50, whereas for the transactions equations the adjusted R^2 ranges between .11 and .27.

Specification of the Cereals Production Models

The two models specified in this section examine agricultural production from two perspectives. The first model uses total coarse cereals production as the dependent variable. This variable is a gross volume measure of a farm household's production of millet, sorghum and maize and is of interest given that greater cereals production is often associated with greater household food security. The second model uses agricultural value generated per farm family worker from both cereals and cotton cultivation as the dependent variable. This is intended to be a measure of labor productivity. Labor productivity is of interest especially as far as conclusions about the effect of different levels of equipment on production per farm family worker are concerned.

The models for total production of millet, sorghum and maize and labor productivity relate production and productivity to three broad categories of factors: land, labor and capital. Since no detailed cost-route data were collected on the farming system itself, proxies have been used to approximate the relationship between total cereals production and labor productivity on the one hand and the factors of production on the other. Neither model is intended to be used in estimating a production function; rather, they are meant to reveal some of the important determinants of cereals production and labor productivity among the farm households in the sample.

Independent Variables

(An alternative formulation of the model is presented in Appendix A)

Land

Institutional Environment (REGION)

Given the differences in the the agricultural support and extension agencies operating in the two zones of study, a dummy variable was introduced in several equations to reflect the effect on total production and labor productivity of being under the OHV versus the CMDT system. The variable was coded 1 for farmers located in the OHV (both north and south) and 0 for both subzones of the CMDT.

Soil and Rainfall Conditions (NS)

To take into account the distinct rainfall and soil conditions characteristic of the southern and northern zones of both the OHV and CMDT, a dummy variable was included in several equations. The variable takes the value of 1 for the northern subzones of both the OHV and the CMDT, and thus represents the areas with the relatively lower rainfall and poorer soil conditions in the study.

Fertilizer-Rainfall Complementarity (RSINT)

The effect on production of the rainfall differences between the north and the south of each institutional zone is hypothesized to be greater in the CMDT than in the OHV. Rainfall and fertilizer are complementary; together they have a stronger effect on cereals production than either one does alone. Because

fertilizer is more widely available in the CMDT than in the OHV, this interaction will be more strongly felt in the CMDT.

The variable RSINT, an interaction term created as the product of REGION and NS, was included in the production equations. RSINT takes the value of 1 if the observation is in northern OHV and 0 otherwise. The hypothesized sign of the coefficient is positive since the effect on production of the rainfall difference between the north and the south is less in the OHV than in the CMDT because in southern CMDT farmers capture the complementarity between fertilizer and rainfall, due to the more effective delivery system for fertilizer in this region. When used in the equation to estimate value generated per farm worker, RSINT picks up the difference between cotton production in the south and north CMDT, and is more an indicator that there are not short-cycle cotton varieties adapted to the shorter rainfall cycle of the north.

Farm Expansion (LANDEX)

Actual farm size was not measured in this study, but farm households which had extended their land under cultivation during the previous five years were noted. In Mali, farming systems studies have revealed that for coarse grain, any increases in total production are usually due to increases in land area rather than better yields (Jolly, Maiga, and Gadbois, 1987; Lebeau, 1986). Therefore, one would expect that whether or not a farmer has expanded his cultivated area will reflect his ability to increase his cereal production.

A dummy variable LANDEX was coded as 1 for farmers who had extended the size of their holdings and 0 for those who had not. It is hypothesized that this variable will have a positive coefficient. In other words, farmers who expanded their land can be presumed to be not facing a land constraint or a lack of the complementary resources with which to farm the increased area under cultivation.

Labor

Farm Family Labor Force (ACTIFS)

In Mali, almost all agricultural tasks involved in cereals production are undertaken by farm household members. Field preparation, planting, weeding and harvesting are done by the "active" farm members: men and women over the age of 14 and under the age of 60. Thus the variable ACTIFS, which is the size of the farm household labor force, was included to account for labor input in the production of cereals.

Although the labor force of the household might consist of hired labor in addition to family labor, hired labor is generally a minor input, and there are no data from the survey to measure its use. Hired labor, including village work associations as well as individuals from outside the village, is perhaps a more important input to cotton production (particularly at harvest), and the exclusion of a hired labor variable from the analysis perhaps biases the results, especially for the labor productivity equations. Omission of a hired labor variable probably overstates the labor productivity in the cotton zone.

It is hypothesized that in Malian agricultural systems, t marginal product of another farm member is positive. It is suggested that this holds because of a labor constraint, which exists especially during peak agricultural labor periods such weeding. Thus it is expected that the relationship between cereals production and active farm members will be positive an reflected in the coefficient of ACTIFS.

Capital

Equipment Ownership (ST1, ST2)

The amount of fixed or investment capital available to a farm household in Mali is thought to have a positive influence total production. Given that labor is a recognized constraint peak labor periods during the agricultural calendar, any equipment that is labor-saving necessarily relaxes this constraint and permits a farm household to increase area under cultivation and thereby increase total production (though not necessarily yields).

It is hypothesized that the relationship between equipment and cereals production is positive, that is, cereals productior increases as the amount of equipment owned by the farm househol increases. In this model, the dummy variables ST1 and ST2 represent the semi-equipped and the non-equipped farm household respectively. The expected signs of the coefficients of these variables are negative, given that the equipped farmers are reflected in the constant, and that production might be expecte

to fall from the equipped to the lesser-equipped to the non-equipped.

Labor Productivity (ACTST1, ACTST2)

The importance of equipment in increasing cereals production is related, to a certain extent, to the number of farm workers available to the farm household. Holding the location of the farm and other variables constant, it is hypothesized that the labor productivity of farm workers is higher at higher levels of equipment. In other words, the marginal product of an additional unit of labor falls as the equipment level of the farm household falls. Such a result would indicate the value of equipment, in terms of increasing labor productivity, for cereals cultivation.

The variables ACTST1 and ACTST2 are interaction terms between the variables ACTIFS and the variables representing equipment levels, ST1 and ST2. The signs of the coefficients of these variables are expected to be negative.

Equipment Rental (RENT)

Access to equipment through rental or borrowing is a factor which one would normally expect to increase total production since it reflects the ability to obtain and use equipment by those who don't own already own it. In Mali, access to equipment usually takes the form of borrowing from equipped neighbors. Though this borrowing can be compensated for in cash, usually non-equipped or semi-equipped farmers pay their equipment rental in terms of their own labor, which they agree to give to the lending farmer when he requires it. Borrowing equipment thus

puts one farmer in debt to another and the coin in which the rental must be paid is the borrower's own labor time. The timing of this "payment" tends to be at periods in the agricultural calendar that are the most critical in terms of labor demand. Therefore, the borrowing farmer is plowing, planting or weeding for equipped farmers at the optimal time, and this implies that he might be forced to neglect the proper cultivation of his own fields.

The question that arises then is whether, for semi-equipped and non-equipped farmers, increases in production when these farmers rent or borrow agricultural equipment offset the negative effect on production of their having to pay back this rental in labor.

A dummy variable RENT was coded 1 to indicate those semi-equipped and non-equipped farmers with access to equipment via rental or borrowing. Presumably fully-equipped farmers do not need to rent or borrow equipment, so these as well as other farmers not renting or borrowing equipment were coded as 0. The coefficient of RENT is hypothesized to be positive, that is, renting equipment increases the cereals production of the semi-equipped and non-equipped farmers, ceteris paribus.

Cash Crop Cultivation

Cotton Production (QC)

There is an acknowledged strong complementarity between cotton production and cereals production, especially maize (World Bank, 1983). First, cotton production finances the purchases of

animal traction equipment which, by relaxing the labor constraint, allows extension of cereals cultivation. In addition to enabling farm households to extend their land planted to cereals and consequently to augment their cereals production, animal traction equipment increases the timeliness of agricultural activities such as sowing and weeding. Being able to respect the optimal times for such activities can result in higher yields.

Second, on a regional level, cotton cultivation has financed all the market infrastructure in the CMDT, which has greatly improved the facility of cereals exchange and input supply as well as extension services.

A third positive influence of cotton production on cereals production is due to the farmers' practice of rotating sorghum and millet on their cotton fields to take advantage of the residual effect of cotton fertilizers. According to informal discussions with farmers in the survey area, the residual effect of cotton fertilizers on their cereals is the most important determinant of cereals yields and one of the main benefits of cotton cultivation. Thus cotton cultivation provides an indirect subsidy for cereals production.

Finally, cotton revenues allow farmers growing cotton to time their coarse grain sales later in the year, when prices are typically higher. Cotton farmers thus are provided with a cereals withholding capacity that non-cotton farmers do not have.

While there are no data from the survey on acreage planted to cotton or cereals, or on yields of either crop, the quantity of cotton produced per farm household is known. Thus, the quantity of cotton produced was used as a proxy for area of cotton under cultivation. It is hypothesized that cotton production will have a positive effect on the quantity of cereals produced.

It is necessary to point out that the difficulty in drawing conclusions from such an estimation is that what is being measured is the effect of the quantity produced of a cash crop on total production of cereals, rather than the effect of acreage planted to a cash crop on yields of cereals crops.

Non-agricultural Activities (NAG)

Non-agricultural activities are a source of external capital for farm households and as such provide farmers with the possibility of purchasing agricultural equipment, fertilizer, and other inputs to the benefit of cereals production. It is hypothesized that the participation of one or more family members in non-farm activities will positively influence coarse grain production. Conversely, households not participating in non-agricultural activities will be expected to have lower levels of cereals production since the household's sources of revenue with which to invest in agricultural production are fewer.

Therefore the dummy variable NAG, which takes the value 0 for those households not participating in non-agricultural

activities and 1 for those participating, is included in the models and the sign is hypothesized to be positive.

Empirical Results: Production and Labor Productivity Equations

Total Cereals Production

Table 5.10 presents estimated coefficients for two alternative specifications of the production equations. In the equation 5.1, where the variables REGION and NS are used respectively as institutional and climatic proxies, the signs are negative and statistically different from zero, as hypothesized. Therefore, being in the northern subzone as well as being in the OHV lowers total cereals production vis-à-vis the constant which encompasses the southern subzones and the CMDT. The dummy variable NS indicates that there is a production fall of 834 kg in the northern subzones relative to the southern CMDT. The dummy variable REGION indicates that cereals production is 1,082 kg lower in the OHV relative to southern CMDT. Therefore, coarse grain production in north CMDT is 834 kg. below that of south CMDT, coarse grain production in south OHV is 1082 kg. below that of south CMDT, and coarse grain production in north OHV is 1916 kg. below that of south CMDT. Expected coarse grain output follows a declining balance as one moves from the south CMDT to the north OHV, ceteris paribus.

The magnitude of the coefficients is greater for the variable REGION than for the variable NS, suggesting that, holding all other factors constant, the influence of the

TABLE 5.10 -- ESTIMATED EQUATIONS FOR TOTAL CEREAL PRODUCTION: OHV AND CMDT REGIONS OF MALI, 1985

Equation 5.1
Dependent Variable is TPROD

Adj.R^2.=.50
F = 21.83 Signif F=.0000
Degrees of Freedom = 177

Variable	B	Beta	T	Sig T
(Constant)	3240.4		6.66	.000
NS	-833.9	-.18	-3.15	.002
REGION	-1081.9	-.23	-3.66	.000
ST1	-1373.0	-.30	-4.13	.000
ST2	-1801.7	-.35	-4.22	.000
RENT	-247.3	-.05	-.81	.421
LANDEX	266.2	.06	1.02	.310
ACTIFS	210.5	.27	4.09	.000
QC	.24	.12	1.83	.068
NAG	522.1	.11	1.92	.056

Equation 5.2
Dependent Variable is TPROD

Adj. R^2.=.51
F = 18.31 Signif F=.0000
Degrees of Freedom = 175

Variable	B	Beta	T	Sig T
(Constant)	2702.9		4.63	.000
NS	-804.4	-.17	-3.05	.003
REGION	-1062.5	-.23	-3.61	.000
ST1	-599.4	-.13	-.93	.356
ST2	-777.6	-.15	-1.08	.281
ACTST1	-135.6	-.15	-1.31	.191
ACTST2	-285.7	-.16	-1.54	.125
RENT	-239.6	-.05	-.78	.434
LANDEX	276.0	.06	1.06	.291
ACTIFS	280.1	.36	4.23	.000
QC	.26	.14	2.02	.045
NAG	533.3	.11	1.97	.050

institutional zone within which the household is located plays a more important role in determining cereals production than do the physical characteristics (soil and rainfall) of the area. That is, other things equal, being in the OHV depresses expected cereals production more than being in a northern area versus a

southern area. One might explain this by the presence of a more active and better-trained extension service in the CMDT zone and the benefits of cotton cultivation on cereals production, in terms of rural infrastructure and access to equipment and fertilizer.

The equipment endowment of the farm household also appears strongly to influence total cereals production. Given the magnitude of the coefficients of the different equipment level variables (ST1, ST2), the equipment position of the farm household appears to play a relatively more important role than either the region or the subzone in explaining total cereals production. Both among the semi-equipped and the non-equipped farm households, total cereals production tends to be significantly lower than that of the equipped farm households. The coefficient of ST1 (semi-equipped households) indicates that, holding all other variables constant, the semi-equipped farmers have an expected output which is 1,373 kg lower than that of equipped farmers. The negative coefficient of ST2 indicates that the non-equipped farmers have an expected output 1,802 kg lower than that of equipped farmers. Thus, the data confirm a progressive decline in total production from the equipped to the semi-equipped to the non-equipped farm households, ceteris paribus.

The variable RENT, reflecting semi-equipped and non-equipped farm households with access to equipment through rental or borrowing, was not statistically significant. Therefore, holding

all other factors constant, being able to rent or borrow equipment does not seem to influence cereals production of semi-equipped and non-equipped farm households. This finding might be explained by the rigidity of the agricultural calendar in Mali and the problem of timeliness in use of agricultural equipment. Those farm households borrowing equipment are usually using it after the equipment owners have used it, and therefore not at the optimal time for land preparation, sowing or weeding. This result indicates that sharing equipment through rental, borrowing, or even collective ownership has limits in the Malian agricultural sector. The results suggest that for some equipment, individual ownership is needed to ensure timeliness in responding to optimal agricultural conditions, such as the first rains for land preparation. An important policy issue then is what are those pieces of equipment that are the most useful when owned by individual families, and what are the possible interventions to assist farmers in obtaining this equipment.

Although the significance level of the variable for land extension over the last five years is low, the sign is positive, suggesting that perhaps farmers who had extended their land in recent years have a higher cereals production level than those who have not. Given the low statistical significance of this variable, a stronger conclusion is not possible.

As hypothesized, the number of farm family workers (ACTIFS) in a household is positively related to total cereals production of that household. This is expected since labor is a major input

to cereals production and more family workers mean more available labor for land extension, land preparation, sowing, weeding and other critical production activities. More family workers also means more mouths to feed, which is also a positive influence on the level of household cereals production. The coefficient of ACTIFS reveals that, holding other factors constant, the marginal product per farm worker is 210 kg, which is greater than the per capita consumption requirement of about 175 kg. That is, the labor contribution of each farm worker produces enough to feed her/himself and makes a contribution of about 35 kg to feed the dependents of the household.

The quantity of cotton produced by a household is positively related to that household's cereal production, ceteris paribus. That is to say, the greater the quantity of cotton produced by a household, the greater that household's cereals production. The magnitude of the coefficient indicates that for every additional ton of cotton produced, coarse grain production rises by 240 kg.

A possible explanation for this is the residual effect of cotton fertilizer on yields of cereals planted in rotation with cotton. From this finding it appears that cash crop/cereals crop decisions are complementary rather than competitive decisions.

Another finding is that the participation of one or more household members in non-agricultural activities appears to positively influence household cereals production. Families with non-agricultural activities tend to have higher levels of cereals production than families not involved in such activities. The

magnitude of the coefficient of NAG indicates that, holding all other variables constant, families with non-agricultural activities have an expected output which is 522 kg higher than those without non-agricultural activities. This finding supports the hypothesis that non-agricultural activities are a potential source of external capital and provide households with the revenue to purchase inputs that have a positive effect on coarse grain production.

Equation 5.2 further refines the analysis of total production by including the variables ACTST1 and ACTST2, indicators of marginal labor productivity associated with different equipment levels. While neither variable was statistically significant at the ten percent level, the signs of the coefficients were both negative as hypothesized. Given the low statistical significance, no strong conclusions can be drawn about the signs or the magnitude of the coefficients.

The variable RSINT did not prove to be a statistically significant explanatory variable for total production in either equation 5.1 or 5.2.

Value of Agricultural Production Per Farm Worker

Table 5.11 presents the estimated equation for the total value of cotton and cereals production per active farm member, which provides an idea of the determinants of labor productivity on the sample farms.

In the analysis of agricultural value generated per farm worker, both variables for institutional zone (REGION) and agro-

climatic subzone (NS) were statistically significant and had negative signs. This is likely to be due to both the lower production levels in the northern subzones because of poorer soils and lower rainfall, as well as the absence of cotton production in the OHV.

TABLE 5.11 -- ESTIMATED EQUATIONS FOR VALUE GENERATED PER FARM WORKER: OHV AND CMDT REGIONS OF MALI, 1985

Equation 5.3 — Adj. R^2.=.39
Dependent Variable is VALACTIF — F = 16.22 Signif F=.0000
Degrees of Freedom = 179

Variable	B	Beta	T	Sig T
(Constant)	95299		12.00	.000
NS	-37858	-.53	-6.45	.000
REGION	-48605	-.68	-8.37	.000
RSINT	37711	.45	4.56	.000
ST1	-12187	-.17	-2.26	.025
ST2	-24891	-.31	-3.82	.000
LANDEX	6930	.10	1.56	.121
ACTIFS	-3752	-.32	-4.69	.000
NAG	8066	.11	1.76	.080

The constant, reflecting the expected value of coarse grain and cotton production per farm worker on a fully-equipped farm in the southern CMDT, is approximately 95,300 FCFA, ceteris paribus. The dummy variable REGION indicates that there is a fall in the expected value of agricultural production per farm worker of 48,605 FCFA, or about 50%, in the OHV compared to southern CMDT. The dummy variable NS indicates that in the northern subzones, the expected value of agricultural production per farm worker is 37,858 FCFA lower than for the southern CMDT. Therefore, the

expected value of coarse grain and cotton production in north CMDT is 37,858 FCFA below that of south CMDT, the expected value in south OHV is 48,605 FCFA below that of south CMDT, and the expected value in north OHV is 86,463 FCFA below that of south CMDT. Expected value of coarse grain and cotton production follows a declining balance as one moves from the south CMDT to the north OHV, ceteris paribus.

The importance of the institutional zone in determining the value of agricultural production per farm worker is not surprising since cotton production in the CMDT adds a substantial amount of value to overall agricultural production, which is not the case in the OHV. The important role of the agro-climatic environment in which the farm household operates is also expected. Soil fertility and rainfall are obviously key determinants of yields and coarse grain and cotton production, and consequently contribute substantially to agricultural value generated per farm worker.

The variable representing fertilizer-rainfall complementarity (RSINT) is statistically significant and the coefficient is positive as hypothesized. The magnitude of the coefficient indicates that there is little difference in agricultural revenue generated per farm worker between north and south OHV, holding other factors constant. Whereas agricultural value generated per farm worker in the southern OHV is 47,695 FCFA, it is almost the same in the northern OHV when the interaction term is included. This can be explained by the fact

that no cotton is grown among the farmers in the OHV sample, and therefore, the value of agricultural production is a measure of the value of cereals production only. The value of cereals production per farm worker is similar in both north and south OHV, ceteris paribus, because similar production techniques are used in both subzones. Nonetheless, the value of cereals production per worker under-measures the value of agricultural production per farm worker in southern OHV because it excludes other important crops. In the CMDT this north/south difference is more apparent because although both subzones grow cotton, far less is grown in the north than in the south. RSINT reflects the difficulty of growing cotton in the northern subzone due to the lower rainfall level.

The coefficient of the variable ACTIFS indicates diminishing labor productivity, which is consistent with production theory as far as where one would expect farmers to operate on the production function. The long-term implication of this finding is that Malian farmers are running into a farm expansion constraint--either a lack of quality land or a lack of resources and equipment with which to farm it. This indicates that farmers cannot expand costlessly in order to maintain labor productivity. To maintain labor productivity, farmers must expand the complementary resources fast enough to preserve the current land/worker and capital/worker ratios (with existing technology), or provide new technology that increases labor productivity.

The above finding is supported by the results concerning the variables ST1 and ST2. These indicate that the expected agricultural value generated per farm worker falls as equipment level falls, ceteris paribus. This fall of the magnitude of approximately 12,000 FCFA among the semi-equipped farm households, and 25,000 FCFA among the non-equipped households. This result is similar when the same regression is run within the OHV and the CMDT separately. This indicates that equipment is a means of increasing labor productivity in terms of agricultural value generated per farm worker. This further reinforces the strong complementarity between cotton and cereals production since cotton cultivation is an important source of investment capital.

The variable LANDEX, while not statistically significant at the ten percent level, does provide an indication as to the effect of land extension on agricultural value generated per farm worker. The magnitude of the coefficient indicates that, holding all other variables constant, farm households having extended their land have an expected agricultural value generated per farm worker which is 6,930 FCFA higher than those families who have not. This finding supports the hypothesis that land extension permits farm households to reach a higher level of agricultural value per farm worker.

The sign of the variable for non-agricultural activities (NAG) is positive, indicating that farm households that have one or more members participating in non-agricultural activities have

a higher expected agricultural value generated per farm worker than farm households who do not, ceteris paribus. The magnitude of the coefficient shows that households participating in non-agricultural activities have an expected agricultural value per farm worker which is 8,066 FCFA higher than those who haven't. This finding supports the hypothesis that non-agricultural activities are a source of revenue which provide the farm household with the revenue to purchase inputs which positively influence the agricultural value generated per farm worker.

Specification of the Cereals Transactions Models

Dependent Variables

The models specified in this section examine cereals transactions from different angles. The first equation uses gross cereals sales as the dependent variable (QVSUM). This variable is a volume measure (in kilograms) of the total annual sales of millet, sorghum and maize by farm household. Gross cereals sales are therefore a direct measure of the volume of cereals entering the monetary market and of interest given that a major objective of the Malian cereals policy reform is to increase marketed cereals volume.

The second equation has the gross outflow of non-monetary transactions as the dependent variable (NMTOUT). Non-monetary transactions include outflows of both gifts and barter. Analysis of gross non-market transactions provides another part of the

larger picture of farm household behavior vis-à-vis coarse grain transactions.

The third equation uses all outflows of cereals as the dependent variable (ALLOUT). This variable is the sum of both market and non-market outgoing transactions in coarse grains. This analysis allows a more complete view of coarse grain outflows.

The fourth equation provides an examination of the factors determining coarse grain purchases (QASUM). The coarse grain purchasing behavior of farm households is a critical element in understanding the dynamics of the coarse grain sector in Mali. The magnitude, timing, and determinants of farm household grain purchases have important implications for food security among rural households.

The fifth equation has net cereals sales as the dependent variable (QVNET). Net cereals sales are annual cereals sales less annual cereals purchases for each farm household. This variable therefore reflects a certain household food security position since farmers tend to be either net sellers or net buyers. Understanding the determinants of net cereals sales permits an appreciation of the incidence of a cereals price support policy or any factors that raise food prices (e.g., cereals shortage due to drought) and thus the distributional consequences of such price behavior.

The sixth equation has cereals availability per consumer as the dependent variable (DISPCON). Cereals availability is

measured as home cereals production plus incoming cereals from either purchases or gifts/barter less outgoing flows of cereals from either sales or gifts/barter. On a per consumer basis, this variable reflects the relative food security position of the farm household, the determinants of which are critical for the design of food policy. Initial stocks and inventory changes are also important in determining cereals availability, however no quantitative data were obtained on these.

The seventh set of equations examines more closely the cereals sales patterns of farm households across the year. The dependent variable in these equations is the percentage of annual cereals sales made in each trimester of the year (PCTQV). The timing of cereals sales across the year has important implications for both price and fiscal policy. Cereals price trends, which tend to show low post-harvest price levels gradually rising to high pre-harvest price levels, examined in conjunction with the timing of cereals sales will reveal the characteristics of farmers who are and who are not able to take advantage of price cycles.

Independent Variables

A brief description of the independent variables as well as the hypotheses underlying their inclusion in the models will be provided below.

Production per Consumer (PRODCON, PCDV)

As mentioned earlier, cereals are largely produced for home consumption and to a lesser extent used for gifts and other non-

initially go into satisfying household cereals demand rather than appear on the market. Therefore, while increases in coarse grain production per consumer are expected to increase the marginal propensity to sell cereals of all farmers, it is hypothesized that the increased sales will be occurring at a slower rate for non-cotton farmers than for cotton farmers.

Cereals Stocks (STOCK)

A farm household's cereals stocks before harvest plus the harvest determines the total quantity of coarse grains available to the household for either consumption, sales, gifts, or other uses. One might also expect those households with stocks to be also among those with higher annual cereals production per consumer unit. Especially in years of bad harvest, farm households with cereals stocks are those that have produced enough to meet the consumption needs of the household as well as to constitute stocks. Because of this it is hypothesized that farmers without cereals stocks before the harvest will tend to market less than farmers with cereals stocks, both in terms of gross sales and net sales.

A dummy variable was coded 1 for those farm households with cereals stocks before the 1985 harvest and 0 for those without. The sign of the coefficient of this variable was expected to be positive.

Market Access (MKTVIL)

The location of a farm household in a market village is expected to increase the degree of market participation of that

household in terms of net coarse grain sales. The issue is one of market accessibility. It also must be recalled that markets are not only outlets for cereals production after harvest, but also sources of cereals later in the year. Thus farm households in market villages can be expected to be more integrated in buying and selling.

The variable MKTVIL was coded 1 for those households in a major market village, which were the villages of Zangasso, Dougouolo, Ouelessebougou, Sougoula, and Sirakorola in our sample. MKTVIL was coded 0 for those households in villages without an important market. The hypothesis was that market access is an important determinant of sales, and that farm-gate prices in market villages tend to be higher than in other villages.

It was not clear as to what sign the coefficient of MKTVIL would have in the equation with net sales as the dependent variable since it depends on one's assumptions as to the factors motivating coarse grain sales. The PRMC, for example, assumes that higher cereals prices result in increases in net marketed supply, i.e., that marketed supply of cereals is positively price elastic. This view supposes that farmers regard their cereals transactions decisions in a commercial manner, and if prices are "right" they will provide the necessary incentive to farmers to increase their marketed supply. In this case, the sign of the coefficient will be indeterminate since it will depend on whether the positive sales effect of a higher price in a market village

outweighs the negative purchase effect of a higher price, and vice versa.

However, one might adhere to the assumption that farmers have a minimum target cash income, and are not interested in cereals sales as a means of accumulating capital. In other words, one might assume that farmers make some estimate of their cash needs for the year and sell their cereals as a function of this need and as a function of their other sources of cash. If this is the case, then farmers in a market village would respond to higher prices with a decrease in marketed volume, since a smaller amount of cereals at a higher price yields the same amount of cash as a greater amount of cereals at a lower price. In other words, this view supposes that the price elasticity of marketed supply is negative -- the higher the price, the less the farmer must sell. In this case, the expected sign of the coefficient of MKTVIL would be unambiguously negative for the equation with net sales as the dependent variable.

In general, evidence of negative supply response is weak throughout the world (Paarlberg, 1988). In Mali, there is no empirical evidence that suggests farmers as a group are either negatively or positively responsive to price, or that they are indifferent to price in their cereals sales decisions. One might speculate that the price responsiveness among these farmers depends on the volume of their own production, the household's food security position, the importance the household attaches to maintaining large stocks, sources of cash revenue, and other

factors. Given that these factors vary greatly among households in Mali, one might observe different types of price responsiveness among different types of farmers.

It was also expected that the coefficient of MKTVIL would be positive in the equation with gross purchases as the dependent variable. Dione's analysis indicated the prevalence of farm households that were net buyers of coarse grains in 1985/86. This finding was further supported by informal discussions with farmers in 1987 in which farmers claimed that the facility with which they were now able to purchase grain was one of the principal advantages of cereals market liberalization. In these discussions, farmers indicated that before liberalization it was very difficult to obtain cereals throughout the year from OPAM. These difficulties were associated with the inaccessibility of OPAM selling centers, which sometimes necessitated that a farmer abandon his fields for several days while he made the trip and waited in line to purchase grain. A further difficulty encountered by farmers was OPAM's requirement that cereals be paid for in cash. Farmers mentioned that with liberalization, they were now able to buy back more readily in local markets throughout the year, they were able to obtain credit for these purchases from local merchants, and they were able to buy in smaller quantities at more regular intervals.

Therefore the importance of markets in assuring a backflow of cereals during deficit periods of the year as well as during

drought years is captured in the variable MKTVIL, and the expected sign of the coefficient is positive.

Reasons for Selling Cereals (TOTPAY86)

In an examination of the principal determinants of marketed volume, one must not only pay attention to the physical and institutional environments which condition farmers' cereals transaction decisions, but also examine the reasons why farmers sell grain when they do and the alternatives to selling grain that these farmers have at their disposal. In Mali, a country plagued with extreme annual rainfall variation and production fluctuations, many farmers prefer to store rather than sell the surplus of good production years in order to assure their family's food needs over the long term. Because selling grain means lowering the farm household's security stock margin, grain sales are often resorted to when no other source of cash exists.

Among the sample farmers, an often-cited reason for selling grains was to pay taxes (Dione, 1987). Because of this finding, it is hypothesized that the total tax obligation of a farm household, including the head tax and other local taxes, will positively influence the volume of cereals marketed. That is to say, the farm households with the greatest tax burden, and thus the greatest need for cash, will be those obligated to sell the greatest volume of cereals in order to meet these tax payments. For this reason, the variable TOTPAY86, which is the sum of all tax payments of each farm household in 1986, is included in the model.

Alternatives to Selling Cereals (TAXCOTDV, NAG, QC, QCTPROD)

The variable TOTPAY86 only takes into account the total tax obligation of the household and not the ability of the family to use sources of revenue other than cereals sales receipts. It is hypothesized that farmers cultivating cotton have cotton revenue to pay taxes, whereas farmers with no cotton production are more likely to have to pay their taxes out of cereals receipts. Based on this hypothesis, the interaction term TAXCOTDV is included in the trimester sales model. TAXCOTDV is the product of the cotton production dummy variable (equal to 1 for non-cotton producers and 0 for cotton producers) and the total tax payment variable (TOTPAY86). Because this variable represents the tax burden payable out of cereals production, it is expected that the sign will be positive. The larger a farmer's tax burden that has to be paid out of revenues other than cotton, the more cereals he will have to sell to meet his tax obligation.

Other variables to account for the cultivation of cotton were included in the different models. Actual volume of cotton produced (QC) as well as the ratio of cotton production to cereals production (QCTPROD) were used. It is hypothesized that the greater a farm household's cotton production is, or the more important it is relative to cereals production, the less that farm household must rely on cereals sales to meet its cash obligations and therefore the smaller the quantity of cereals it will sell.

Because non-agricultural activities are an additional source of revenue for farm households, it is hypothesized that the participation of one or more family members in non-farm activities will negatively influence cereals sales. Conversely, a lack of household participation in non-agricultural activities will be expected to positively influence cereals marketings since the household's sources of revenue are fewer. Therefore the dummy variable NAG, which takes the value 1 for those households participating in non-agricultural activities and 0 for those not participating, is included in the models and the sign is hypothesized to be negative.

1986 Harvest (TPROD86)

In Mali, usually by August or September the agricultural season is well underway and farmers can make fairly accurate estimations of their coarse grain harvests. It is hypothesized that during this period of the year, farmers take into account the potential harvest in making their marketing decisions. That is, if the rains have been good and the crops are doing well, a farmer might be more likely to sell out of his old stocks before the new harvest is in than if the agricultural season has been bad. Because of this hypothesized interaction between expected harvest and rainy-season cereals sales, a harvest expectations proxy was included in the model for third trimester sales. The expectations proxy is the actual 1986 harvest, since by the third trimester, farm households already had a fairly good idea as to the volume of the incoming crop.

Empirical Results: Cereals Market and Non-Market Transactions

Gross Cereals Sales

Table 5.12 presents the estimated equation for annual gross cereals sales, which shows that farm households cereals production per consumer (PRODCON) is a positive determinant of annual gross sales of millet, sorghum and maize. All farmers sell more as their production per consumer increases, which indicates that farmers sell only after having assured some minimum level of per capita cereals supplies. At the same time, the production per consumer of non-cotton producing farmers (PCDV) is also a positive determinant of annual gross sales although this variable has a relatively low statistical significance. The coefficients of these variables suggest that gross cereals sales of non-cotton farmers increase at a slower rate than among the cotton producers.

The magnitude of the coefficients for these two variables indicates that for each additional 100 kg of grain produced per consumer, cotton producers sell 46 kg. For non-cotton producers, each additional 100 kg of grain produced per consumer increases gross sales by approximately 26 kg. Perhaps cotton producers treat increases in cereals production per consumer more commercially because of a greater willingness to hold reserves in the form of cash rather than grain due to better functioning grain markets in cotton areas than in non-cotton areas.

The quantity of cotton produced by the farm households (QC) was not statistically significant and thus does not explain

annual gross cereals sales, ceteris paribus. The effect of cotton on gross sales is presumably already reflected in the variables PRODCON and PCDV.

TABLE 5.12 -- ESTIMATED EQUATION FOR GROSS COARSE GRAIN SALES BY SAMPLE FARMERS: OHV AND CMDT REGIONS OF MALI, 1985/86

Dependent Variable is QVSUM

Adj. R^2.=.21
F = 10.76 Signif F=.0000
Degrees of Freedom = 182

Variable	B	Beta	T	Sig T
(Constant)	27.68		.70	.486
PRODCON	.46	.35	4.41	.000
PCDV	-.20	-.10	-1.31	.191
QC	.01	.04	.43	.665
NAG	- 52.10	-.07	-1.01	.313
STOCK	173.49	.22	3.01	.003

Although the coefficient on the variable for non-agricultural activities (NAG) is not highly significant, the results suggest that farm households participating in non-agricultural activities had lower gross cereals sales than those not participating in non-agricultural activities, ceteris paribus. This suggests that non-agricultural activities provide a source of cash which allows farmers to forestall their sales from the household grain supplies. Farmers with revenue alternatives to cereals sales (i.e., income generated in non-agricultural activities) may first resort to those alternatives before they turn to cereals sales, whereas farmers with no other revenue sources may have to use sales of cereals to obtain necessary cash.

Not surprisingly, the results show that farmers with cereals stocks prior to the time of the 1985 harvest tended to have higher gross cereals sales. The magnitude of the coefficient indicates that those farm households with cereals stocks had an expected annual gross cereals sales that were 173 kg higher than those families without stocks, ceteris paribus. That is, having cereals stocks at the outset of the year exerted a strongly positive influence on the year's gross coarse grain sales, holding other factors constant. Approximately 80% of the sample reported having no cereals stocks before the 1985 harvest.

The variables REGION and NS were included in another specification of the equation to account for the effect of institutional and agro-climatic conditions on sales. Neither variable had any explanatory power, which indicates that for households with equal production per consumer, the physical location of the household does not influence gross sales. The extent to which there are regional differences in gross sales is reflected in the coarse grain production per consumer of the household.

The variable MKTVIL was also included in another specification of the equation to account for the effect of location in a market village on gross cereals sales. MKTVIL was not statistically significant in the equation, which contradicts what was hypothesized to be a positive association between sales and market access. This result is interesting in light of often-cited complaints concerning the lack of market outlets for

farmers' products as one of the primary marketing constraints for rural households. The preceding analysis indicates that this is not likely to be the case for the farmers in this study. The results for gross purchases, presented later, provide a possible explanation for why MKTVIL was not found to be statistically significant in the preceding equation.

Non-Monetary Transactions

In addition to gross coarse grain sales, a large outflow of cereals occurred as non-monetary transactions in the form of gifts and barter.

TABLE 5.13 -- ESTIMATED EQUATION FOR NON-MONETARY TRANSACTION BY SAMPLE FARMERS: OHV AND CMDT REGIONS OF MALI, 1985/86

Dependent Variable is NMTOUT

Adj. R^2.=.20
F = 13.04 Signif F=.0000
Degrees of Freedom = 183

Variable	B	Beta	T	Sig T
(Constant)	77.00		3.32	.001
PRODCON	.13	.18	2.43	.016
PCDV	-.19	-.17	-2.43	.016
STOCK	145.89	.31	4.33	.000
NAG	75.55	.17	2.56	.011

The regression results in Table 5.13 indicate that production per consumer of cotton producers is a positive determinant of gross outgoing non-monetary transactions, and production per consumer of non-cotton producers decreases outgoing gifts and barter. For a 100 kg increase in cereals production per consumer among cotton producers, outgoing non-

market transactions rise by 13 kg, whereas among non-cotton producers these non-market transactions fall by 5 kg, ceteris paribus. This result suggests that non-cotton producers are less able to give cereals, whereas cotton producers have the resources to do so. Therefore, not only is the surplus production in the agricultural sector coming from cotton producers, but also much of the market and non-market transactions are coming from these farmers as well. This further reinforces the positive association between cereals and cotton.

The positive sign of the dummy variable for cereals stock indicates that those families with a cereals carryover stock have an expected level of non-market transactions which is about 146 kg higher than those without stocks. This finding supports what one might expect the relationship to be between stocks and gifts: those with more give more, ceteris paribus.

Non-agricultural activities also increase a farm household's propensity to give or barter cereals. The magnitude of the coefficient of NAG indicates that those families with non-agricultural activities have an expected level of non-market transactions which is 75 kg higher than those farm households not participating in such activities. Taken in conjunction with the findings from the gross sales regression in which the coefficient of NAG was negative, one might conclude that although farm households participating in non-agricultural activities have relatively lower gross sales than those not participating, they

make up for relatively lower market involvement by having higher levels of gifts and barter.

Outgoing Market and Non-Market Transactions

Summing both gross coarse grain sales and outgoing non-market transactions in cereals yields the variable ALLOUT, which signifies the annual outflows of coarse grains from farm households.

The results presented in Table 5.14 indicate that farm household production per consumer unit is a positive determinant of annual outflows of cereals, but that the influence of this

TABLE 5.14 -- ESTIMATED EQUATION FOR TOTAL CEREALS OUTFLOWS BY SAMPLE FARMERS: OHV AND CMDT REGIONS OF MALI: 1985/86

Dependent Variable is ALLOUT

Adj.R^2.=.27
F = 18.30 Signif F=.0000
Degrees of Freedom = 183

Variable	B	Beta	T	Sig T
(Constant)	106.7		2.11	.036
PRODCON	.61	.35	5.04	.000
PCDV	-.42	-.16	-2.46	.015
STOCK	322.6	.30	4.40	.000
NAG	28.5	.03	.44	.658

variable is lower among non-cotton producers than cotton producers (i.e., the coefficient of PCDV is negative). The magnitude of the coefficient for PRODCON indicates that outgoing transactions increase by 61 kg for an additional 100 kg increase in production per consumer among cotton producers, ceteris paribus. Non-cotton producers also show an increase in outgoing

transactions as production per consumer increases, but the increase is 19 kg for an additional 100 kg of cereals production per consumer, which is far less than the rate for cotton producers.

Farm households with stocks have an expected level of outgoing transactions which is 323 kg higher than those without stocks, holding other factors constant. The magnitude of this coefficient is large, indicating the importance of cereals stocks in influencing farmer decision-making vis-à-vis their coarse grains transactions.

The variable signifying household participation in non-agricultural activities was not statistically significant. Because non-agricultural activities positively influence non-market transactions but negatively influence market sales, ceteris paribus, the effect of non-agricultural activities on total outflows of coarse grains has likely been cancelled.

Gross Purchases

Table 5.15 presents the estimated gross purchase equation. Production per consumer was found to be a negative determinant of coarse grain purchases. The magnitude of the coefficient PRODCON indicates that for every 100 kg increase in cereals production per consumer, gross purchases fall by 30 kg, holding all other variables constant. This fall in purchases indicates a strongly negative response of household demand to increases in household cereals supply, which is as one might expect.

Farm households with cereals stocks have a much lower expected level of cereals purchases than those without stocks, ceteris paribus. The magnitude of the coefficient indicates that those families with cereals stocks purchase 217 kg less than those families without stocks. This confirms the preceding finding vis-à-vis the negative response of household cereals demand to household cereals availability.

TABLE 5.15 -- ESTIMATED EQUATION FOR GROSS CEREALS PURCHASES BY SAMPLE FARMERS: OHV AND CMDT REGIONS OF MALI, 1985/86

Dependent Variable is QASUM — Adj. R^2.=.11
F = 5.434 Signif F=.0001
Degrees of Freedom = 182

Variable	B	Beta	T	Sig T
(Constant)	288.6		4.89	.000
PRODCON	-.3	-.18	-2.33	.021
STOCK	-217.3	-.21	-2.68	.008
MKTVIL	134.8	.13	1.89	.060
NAG	157.4	.16	2.23	.027
QC	1.7	.00	.06	.953

Families participating in non-agricultural activities have a higher level of cereals purchases than those not participating, ceteris paribus. Those families engaging in non-agricultural activities have expected purchases of 157 kg more than those not participating in non-agricultural activities. Perhaps this indicates that those families engaging in such activities have the extra revenue with which to make cereals purchases, whereas those without this extra revenue source do not.

The location of the farm household in a major market village also appears to increase cereals purchases. Those households in a major market village have an expected level of purchases about 135 kg higher than those not located in a major market village. This result shows the importance of market access in assuring a backflow of cereals, via the market, to deficit households. In other words, being in a market village facilitates farm household purchases. Taking into consideration the observation of farmers cited earlier that a major benefit of liberalization was the ability to buy cereals when needed, it becomes evident that cereals purchases and the facility of these purchases are critical elements of household food security. An important policy implication then is the role of the market in strengthening food security among deficit farm households.

It is also likely that participation in and income from non-agricultural activities is higher in market villages than in non-market villages. This might contribute to observed higher levels of cereal purchases.

The quantity of cotton produced by the farm household does not emerge as a significant explanatory variable. This indicates that other things being equal, the quantity of cotton produced does not influence gross cereals purchases.

Net Cereals Sales

Net cereals sales are coarse grain sales less purchases. The variables influencing net sales are the same as those influencing gross sales and gross purchases with the magnitude of

their coefficients reflecting the combined effect of these variables on both gross sales and gross purchases.

Table 5.16 presents the estimated equation for net sales. Annual net cereals sales are positively influenced by cereals production per consumer levels. This positive relationship between cereals production and cereals sales is expected given that at higher levels of cereals availability per consumer one expects the commercializable surplus to be greater.

The coefficient of PRODCON indicates that for a 100 kg increase in production per consumer, farm households will increase net sales by 73 kg, ceteris paribus. This increase is quite large, reflecting a large marginal propensity to sell at higher levels of cereals availability, once household food needs are met. To what extent this reflects greater price responsiveness of marketed supply among farmers at higher levels of cereals availability is not clear.

TABLE 5.16 -- ESTIMATED EQUATION FOR NET CEREALS SALES BY SAMPLE FARMERS: OHV AND CMDT REGIONS OF MALI, 1985/86

Dependent Variable is QVNET

Adj. R^2.=.25
F = 16.42 Signif F=.0000
Degrees of Freedom = 183

Variable	B	Beta	T	Sig T
(Constant)	-262.6		-3.59	.000
PRODCON	.73	.31	4.64	.000
STOCK	404.7	.28	4.09	.000
NAG	-216.3	-.16	-2.50	.013
MKTVIL	-164.2	-.12	-1.87	.063

As expected, having cereals stocks at the outset of the year has a positive influence on net sales. The coefficient of STOCK indicates that those farm households with stocks had expected net sales of about 405 kg more than those without stocks, ceteris paribus. This is not surprising since farmers with stocks are starting out the market year at a higher overall level of available cereals. Again, the magnitude of the coefficient is an indicator of the importance of stocks in understanding farm household cereals transactions decisions.

Having family members participating in non-agricultural activities tended to decrease farm household net cereals sales. This result is due to the negative effect of participation in non-agricultural activities on gross sales and the stronger positive effect of participation in non-agricultural activities on gross purchases. Such a configuration would lead to negative net sales, or positive net purchases. The magnitude of the coefficient of NAG indicates that those households participating in non-agricultural activities have an expected level of net sales which is 216 kg lower than those not engaging in non-agricultural activities, ceteris paribus. This might be explained again by the cash position of the farm which allows these households to make large purchases relative to their sales.

The estimation results show that those farm households located in market villages had lower levels of net sales than those located in villages without major markets. The coefficient of MKTVIL indicates that farm households in major market villages

had expected levels of net sales 164 kg lower than those not in major market villages, ceteris paribus. This result probably stems from the earlier findings of higher gross purchases among farmers in market villages, which would make net sales lower for these households. Again, this shows the importance of market access in assuring a backflow of food to deficit households.

Cereals Availability per Consumer

Table 5.17 presents the estimated equation for cereals availability per consumer. The three variables which emerge as significant determinants of household food availability are the institutional zone, REGION; the agroclimatic environment, NS; and the 1985 cereals stocks, STOCK.

The variable REGION is negative as hypothesized. This means that being in the OHV lowers per consumer cereals availability vis-à-vis the constant, which encompasses the southern subzone of the CMDT. The magnitude of the coefficient indicates that for both northern and southern OHV, per consumer cereals availability is about 159 kg. lower than for the southern CMDT.

The coefficient of the dummy variable NS, a proxy for the agroclimatic environment, is negative. The magnitude of the coefficient indicates that there is a fall of 94 kg. in per consumer cereals availability in the northern areas of the CMDT and the OHV relative to the southern CMDT, ceteris paribus.

That cereals availability should depend so heavily on the location of the farm household in either institutional and/or

climatic zone is probably a reflection of the differences in cereals production attributable to these variables.

Whether or not the household had cereals stocks before the 1985 harvest appears to be an important determinant of per consumer cereals availability. Those households with stocks had an expected level of cereals availability per consumer about 74 kg higher than those households without stocks, ceteris paribus. This result is expected given that stocks are not subsumed in the dependent variable as a part of overall cereals availability.

The variables for the equipment levels of the farm households (ST1, ST2) were not significant explanatory variables for cereals availability per consumer, holding all other factors constant.

TABLE 5.17-- ESTIMATED EQUATION FOR CEREALS AVAILABILITY PER CONSUMER: OHV AND CMDT REGIONS OF MALI, 1985/86

Dependent Variable is DISPCON — Adj.R^2.=.18
F = 9.220 Signif F=.0000
Degrees of Freedom = 183

Variable	B	Beta	T	Sig T
(Constant)	384.1		8.50	.000
NS	-93.8	-.20	-3.00	.003
REGION	-155.9	-.33	-4.76	.000
ST1	4.7	.01	.12	.906
ST2	9.9	.02	.22	.828
STOCK	74.3	.14	1.91	.058

Trimester Sales

From the results presented above emerges the central finding that gross and net cereals sales are significantly influenced by

the cash obligations of the household and the household's access to other revenue sources besides sales of millet, sorghum and maize (namely cotton and non-agricultural activities).

In order to understand the implications of cash needs and cash resources for cereals sales, the data were disaggregated into trimesters. The first trimester covers the post-harvest months from November to March, when prices tend to be at their lowest and when taxes are collected in the rural areas. The second period, April-July, is considered the dry season and is an interim period between the post-harvest and rainy season periods. The third period of August-October is the "soudure" period and corresponds to the most difficult period in terms of meeting the family's food needs. The third period is often called the hungry season, as farm households tend to have low cereals stocks at this time and those who are net buyers must purchase cereals, if they are able, at high pre-harvest prices.

Again, it must be signalled that the 1985/86 price cycle did not correspond to the low post-harvest, high pre-harvest price pattern mentioned here[1]. However, it is assumed that many farmers do not take into account prices when making coarse grain transactions. Many farmers tend to sell grain when they need

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[1]Our data indicate that 1985/86 exhibited a peculiar price cycle due to OPAM's one-time entry in the market at a relatively high "minimum price guarantee" in the immediate post-harvest season (Graph 1, Appendix B). However, due to the inelastic supply response of Malian farmers to coarse grain prices and their liquidity constraints at certain times of the year, it is hypothesized that the unusual 1985/86 price cycle did not significantly alter farmers' selling behavior during the year.

money and buy grain when they have no more cereals in stock, regardless of the price cycle. Given the timing of sales and the concentration of net sales presented at the beginning of this chapter, it would seem reasonable to conclude that only a small portion of the sample farm households were in a position to be "price-responsive." For this reason it is thought that the following analysis is relevant, despite the fact that the data used were taken from an aberrant price year.

In order to focus more closely on the implications of cereals sales for price and fiscal policy, the equations estimated will be for the first and third trimesters.

First Trimester

Table 5.18 presents the estimated sales equation for the first trimester. The percent of annual cereals sales made in the first post-harvest period is expressed as a function of the cereals tax burden of the household, the cereals production per consumer, and the ratio of cotton production to cereals production.

Household production per consumer is a negative determinant of the percent of coarse grain sales made in the first trimester. The greater a household's cereals production per consumer unit (therefore the more food-secure the family), the smaller the percentage of annual sales are made in this post-harvest period. The magnitude of the coefficient of PRODCON indicates that for an additional 100 kg of cereals production per consumer, the percent of total sales occurring in the first trimester will fall by

2.7%. Conversely, for a fall in production per consumer of 100 kg, the percent of total sales occurring in the first trimester will increase by 2.7%. Thus it appears to be those at the lowest levels of production per consumer who are making the largest share of their annual sales during this period when prices tend to be at their lowest but cash needs are the most severe.

TABLE 5.18 -- ESTIMATED EQUATIONS FOR FIRST TRIMESTER SALES OF COARSE GRAINS BY SAMPLE FARMERS: OHV AND CMDT REGIONS OF MALI, 1985/86

Dependent Variable is PCTQV

Adj. R^2.=.13
F = 6.764 Signif F=.000
Degrees of Freedom = 109

Variable	B	Beta	T	Sig T
(Constant)	.6		9.28	.000
PRODCON	-.00027	-.20	-2.22	.028
TAXCOTDV	.000005	.20	2.00	.048
QCTPROD	-.14	-.15	-1.59	.115

The percent of annual cereals sales made in the first trimester appears to be positively related to the level of the tax obligation for the non-cotton farmers. The greater the amount of tax due for these farmers, the greater the percentage of annual cereals sales are made in the first trimester. The magnitude of the coefficient of TAXCOTDV indicates that for an additional 10,000 FCFA of tax obligation for non-cotton producers, the percent of sales made in the first trimester increases by 5%. This appears to indicate that those farm households with no major revenue source other than their own cereals are obliged to effect a larger share of their annual

cereals sales during the first trimester than farmers who sell cotton. These sales occur during the post harvest period when prices tend to be at their lowest, but when one of the most important cash demands of the year is made.

Further confirming this finding is that the lower the ratio of cotton to cereals production, the greater the share of sales are made during the first trimester. The magnitude of the coefficient of QCTPROD indicates that if the ratio of cotton to cereals production increases by 100%, the percent of sales made in the first trimester will fall by 14%. Thus farmers with the lowest cotton to cereals ratio (including those growing no cotton), and thus a smaller or non-existent source of additional cash revenue outside of cereals sales, are making a greater percentage of their sales during this post-harvest period.

Third Trimester

The percent of annual cereals sales made in the third trimester (July to October) is expressed as a function of cereals production per consumer, the ratio of cotton production to cereals production, and the 1986 cereals harvest (Table 5.19). The last variable is included since it is the outcome of the rainy season, during which third trimester sales decisions are made. It is hypothesized that good or bad rainfall influences a farmer's perception of the coming harvest and his willingness to sell cereals out of carryover stocks.

Third trimester sales as a percentage of annual sales appear to increase as cereals production per consumer increases. The

magnitude of the coefficient PRODCON indicates that a 100 kg increase in coarse grain production per consumer unit will yield a 2% increase in the percentage of annual cereals sales made in the third trimester. Therefore, those families with the highest levels of cereals per consumer are those who tend to sell a higher share of their annual cereals sales during the third trimester higher-price period.

TABLE 5.19 -- ESTIMATED EQUATION FOR THIRD TRIMESTER SALES OF COARSE GRAINS BY SAMPLE FARMERS: OHV AND CMDT REGIONS OF MALI, 1985/86

Dependent Variable is PCTQV

Adj. R^2.=.14
F = 7.170 Signif F=.000
Degrees of Freedom = 109

Variable	B	Beta	T	Sig T
(Constant)	.05273		1.04	.302
PRODCON	.00019	.19	2.12	.037
QCTPROD	.22923	.30	3.42	.001
TPROD86	.00001	.14	1.60	.113

The ratio of cotton to total production appears to be a positive determinant of third trimester shares of annual cereals sales. That is, as the ratio of cotton production to cereals production increases, so does the percentage of annual sales made in the third trimester. The magnitude of the coefficient of QCTPROD indicates that if the ratio of cotton to cereals increases by 100%, the percent of sales made in the third trimester will increase by 23%. This corroborates the hypothesis that the capacity to withhold from selling cereals until the price cycle becomes favorable is related to the household's other

revenue sources and the relative importance of these other revenue sources. In this case, a larger ratio of cotton to cereals means that the farm household has a significant source of cash revenue outside cereals. This enables these farmers to withhold selling their cereals until the price cycle turns upwards or until cash needs require them to sell their cereals.

The 1986 coarse grain harvest was used in the equation with production per consumer unit and the ratio of cotton to the 1985 cereals harvest. It was found that while not as statistically significant as the other two variables, the sign of the coefficient was positive. The magnitude of the coefficient of TPROD86 indicates that for a one ton increase in the 1986 harvest, the percent of sales made in the third trimester increases by 1.1%. This perhaps indicates the positive influence of the 1986 rainy season on third trimester sales, although the influence is not very strong.

What emerges then from the study of trimester sales patterns is that non-cotton producers and non-equipped farmers without the capacity to withhold their cereals sales until seasonal prices are high are those who are forced to sell, regardless of price, in order to relieve their liquidity problems. On the other hand, cotton producers and more equipped farmers have other sources of income to help them manage their cash flow difficulties and are able to wait until later in the year when prices are typically high. The tax collection period coincides with the low price level post-harvest period. A farm household's total tax

obligation thus provides a possible explanation as to why and for whom the percentage of annual cereals sales made in the post-harvest period is significant.

CHAPTER 6

CONCLUSIONS AND IMPLICATIONS

The econometric analysis of the farmer transaction data presented in the previous chapter sought to establish some of the determinants of total coarse grain production, market and non-market coarse grain transactions, household food availability, and the periodicity of coarse grain sales for farm households in the OHV and the CMDT regions of Mali. While each of these areas was examined separately, certain common factors were expected to emerge linking coarse grain production, transactions and the pattern of sales across the year to different levels of household food security. It was hoped that the interconnectedness of coarse grain production and transactions might illuminate the differences in cereals marketing behavior among the sample farmers and that this in turn might assist discussion as to the effects of current cereals policy and other policy interventions on the food security positions of Malian farmers.

Summary of Findings

Total Cereals Production

The results for total cereals production primarily point to variation in the factors of production as explaining variation in total cereals production. Proxies for land, labor and capital all emerge as significant and with the appropriate signs. The

expansion of land under cultivation and the level of equipment both positively influence total cereals production levels. Farm workers were shown to have a positive marginal product, although in terms of labor productivity per farm worker, marginal productivity was decreasing.

The institutional and climatic environments within which farm households are located are also significant explanatory variables, with the expected signs. Being in the CMDT zone tends to raise cereals production levels vis-à-vis the OHV zone, reflecting the positive influence of a well-developed agricultural extension service, the cultivation of a cash crop, and the availability of credit for equipment and inputs on production of coarse grains. Being in the northern subzones tends to lower cereals production levels vis-à-vis the southern subzones, the likely effect of less favorable agro-climatic conditions.

Finally, two variables representing sources of cash income, namely cotton production and non-agricultural activities, were found to positively explain cereals production. Coarse grain production was found to increase as the quantity of cotton produced by the farm household increased. The participation of one or more household members in non-agricultural activities was found to positively influence total production. Therefore, farm households engaging in cotton cultivation and/or non-agricultural activities, both indicators of diversified on-farm and off-farm enterprises as well as sources of non-cereals revenue, were shown

to have higher levels of production of millet, sorghum, and maize.

Cereals Transactions

The results from the analysis of marketed cereals volume indicate that those farm households with the greatest cereals production per consumer were marketing the largest amounts of millet, sorghum and maize, both in terms of gross sales and net sales. This is hardly surprising, as one would expect the larger producers and those with the higher levels of food availability in terms of cereals per consumer to be those with the greatest opportunity of having a marketable surplus.

However, the result for gross sales was reversed for those farm households engaging only in cereals production. For non-cotton farmers, the larger their cereals production per consumer, the lower their marginal propensity to sell coarse grains vis-à-vis cotton farmers. In other words, for those farmers without cotton to rely upon as a cash source, increases in cereals production per consumer are met with lower levels of coarse grains sales than the levels for cotton farmers. This result suggests that cotton farmers treat increases in cereals production more commercially than do farmers cultivating only coarse grains. Possibly non-cotton growers are operating at a much lower level of production per capita than cotton growers, so that the increments in production are consumed rather than sold. The value attached to higher levels of cereals

availability per consumer differs considerably among these two groups.

Another finding is that those with cereals stocks at the outset of the 1985 harvest were selling more grain than those without stocks, in terms of both net and gross sales. Again this result was expected, as those with cereals stocks before the harvest were at an initial cereals advantage at the beginning of the marketing year.

The variable approximating other sources of income, non-agricultural activities, was found to be a negative determinant of gross and net sales volume. For those farm households participating in non-agricultural activities, gross and net cereals sales were lower. Therefore, although participation in non-agricultural activities positively determines total cereals production, it negatively explains marketed volume. What this result seems to indicate is that non-agricultural activities have a positive influence on cereals production because they provide off-farm revenue for agricultural investment, but these off-farm activities have the opposite effect on cereals sales. By providing a ready source of cash to meet the household's monetary expenses, these activities permit cereals production to be retained by the farm household, thus reducing levels of marketed cereals. Therefore participation in non-agricultural activities appears to assure a diversified farm revenue, which in turn permits farm households to reduce their dependence on cereals sales for cash.

The location of a farm household in a market village negatively influences net cereals sales. This result probably stems from findings concerning coarse grain purchases, which are positively dependent on the household being in a major market village. This is explained both by the greater purchasing power of households in villages with major markets as well as by lower levels of coarse grain production by households located in major market villages, which necessitate complementary cereals purchases. Informal discussions with sample farmers suggest also that market villages facilitate coarse grain purchases by providing a decentralized and convenient opportunity to buy.

Other factors determining cereals purchases were levels of production per consumer and cereals stocks--both of which were negatively related to levels of cereals purchases as expected. Participation in non-agricultural activities has a positive influence on coarse grain purchases that is probably explained by the cash revenue provided by these activities, enabling such purchases. Perhaps also those households engaging in non-agricultural activities rely less on own production and more on cash from non-agricultural activities to purchase cereals. These households appear to be more commercial in their cereals acquisition behavior.

Cereals Marketing Patterns Across the Year

When cereals marketing patterns were disaggregated by trimester, several variables emerged that were significant in explaining the variation in the percentage of annual sales made

per trimester. The analysis was directed to the first and third trimester specifically to take into account the likely effects of seasonal price cycles and the timing of tax payments.

For the percentage of annual sales made in the first trimester, the three independent variables were household cereals production per consumer, the tax obligation of the farm households growing only cereals, and the ratio of cotton to cereals production.

The results indicated that as cereals production per consumer decreased, the percentage of annual sales made in the first trimester rose. Therefore, it appears that first trimester sales as a percentage of annual sales were dominated by farmers at lower levels of household food security. One might expect that larger cereals farmers were able to withhold their cereals sales for periods later in the year while the smaller cereals farmers had a more urgent cash constraint and needed to make the largest share of their annual cereals sales in the post-harvest period.

For those farmers producing only coarse grains, the share of annual sales made in the first trimester increased as their tax obligation increased. There thus appears to be a strong positive association between first trimester sales and the magnitude of the tax obligation for non cotton farmers. This result supports the hypothesis that the revenue from cereals sales made early in the marketing year is intended to meet tax payments. For farm households with no recourse to cotton revenue to meet their tax

obligation, selling cereals is largely a first trimester activity.

The ratio of cotton to cereals production proved to be a negative determinant of the percentage of annual sales made in the first trimester. The more important is cotton relative to cereals for the farm household, the smaller the share of annual cereals sales made in the first trimester. This result confirms the importance of cotton as an alternative to cereals as a source of cash. It also suggests that cotton is critical in providing the farm household with a withholding capacity that permits the household to avoid first trimester, post-harvest cereals sales when prices tend to be at their lowest.

Analysis of third trimester cereals sales reveals a completely reversed situation relative to first trimester sales. The percent of annual sales made during the third trimester was found to be related positively to cereals production per consumer unit. This finding, in contrast to the results for the first trimester, indicates that as total cereals production per consumer unit increases, so does the percentage of sales made in the third trimester. Thus the farm households in a more cereals-secure position are those able to withhold their coarse grain sales until the more price favorable third trimester. The ratio of cotton to cereals production was also a positive determinant of third trimester sales. The more important is cotton relative to cereals, the greater is the household's cash revenue source. It is the farm households in such a cash position which are able

to withhold until the third trimester to make the bulk of their cereals sales.

Overall then, the marketing pattern emerging from the data revolves around coarse grain availability per consumer, the diversification of the household in terms of on-farm (i.e., cotton) and off-farm activities, and the cash needs of the farm household.

Policy Implications

This section discusses what the above results tell us about how coarse grain production and production allocation decisions can be influenced by policy, and what the equity impacts of such policies in terms of household food security would be. In order to examine these issues, policies directed at increasing production and further supporting market liberalization will be examined separately.

Production Policy

Emerging from the results concerning coarse grain production is the importance of labor and capital as complementary resources to land. Although the results presented in Chapter 5 tentatively indicate that land is not a binding constraint to coarse grain production, the same results suggest that complements in terms of equipment, inputs, and labor are. This finding suggests that agricultural research directed at farmers in these areas might aim at improving extensive strategies of production. This implication, however, runs counter to the current emphasis in

Malian agricultural research which puts heavy emphasis on increasing yields per unit area. Such an approach to agricultural production raises two issues: whether this is appropriate given current relative factor endowments of Mali, and what are the short-run/long-run implications of an intensive strategy. In the long-run, with rapid population growth, higher yields will be needed as population pressure on the land grows. Currently, however, Mali needs research, extension and credit strategies adapted to relative availability of land and labor. Research on extensive strategies of production might be complemented by investment in agricultural extension and credit programs for the purchase of equipment and inputs. The importance of such institutional development is underlined by the findings concerning the influence of the institutional zones on coarse grain production. That the location of a farm household in either the OHV or the CMDT should play such an important role in determining coarse grain production has clear implications for the importance of a strong agricultural research and extension service.

Another result that has implications for coarse grain production policy is the importance of on-farm (cotton) and off-farm activities. Diversification by a farm household is shown to increase expected coarse grain output. One reason for this is that such activities provide sources of investment capital. Another reason is that some of these activities are part of farming techniques that complement coarse grain production, such

as the rotation of cereals crops on cotton fields to pick up the residual effect of cotton fertilizers, and the use of animal manure from herding activities as organic fertilizers to increase soil fertility. In other words, our research indicates that interventions aimed at encouraging or increasing farm diversification are likely to have indirect positive effects on coarse grain production.

Finally, these results clearly imply that for Malian households cash crop and cereals crop enterprises are complementary rather than competitive in terms of food security goals. In Mali, the cultivation of cotton along side cereals permits the use of resources (i.e., equipment and inputs) and techniques which are made available only through participation in cotton production schemes. Cotton also provides a ready source of revenue for investment in agriculture, meeting cash obligations for which cereals otherwise would have had to be sold, and purchasing cereals for either home consumption or speculation. Thus, the idea that the food-cash crop relationship is an adversarial one is not supported by the research results for Mali.

Price Support Policy

In the Malian cereals market restructuring program (PRMC) launched in 1981, one of the most important reforms directed at farmers was to increase official cereals prices. In practice, this was a price support policy which took the form of a guaranteed minimum price for millet, sorghum and maize. A

discussion of the implementation of the guaranteed minimum price policy and the macro-economic problems associated with such a price support program is beyond the purview of this chapter and has been undertaken elsewhere (Humphreys, 1986; Wilcock, Roth, and Haykin, 1987). However, the objectives and probable impact of this policy will be examined here in light of the results of the econometric analysis presented in the previous chapter.

The objectives of the PRMC's guaranteed minimum price policy to cereals farmers was twofold. The PRMC sought to increase producer prices to encourage grain production and to improve the purchasing power of the rural population. The objectives are rooted in the basic premise of pricing liberalization which holds that higher producer prices will result in a substantial increase in cereals production and an improvement in national food security (Wilcock, Roth, and Haykin, 1987).

Two questions come to mind in contemplating the probable effects of higher producer prices on production decisions and food security. The first is whether or not high producer prices are an incentive to coarse grain production. That is to say, is the price elasticity of coarse grains supply significantly positive among Malian cereals farmers? Although no acreage data with which to measure changes in acreage planted in response to changes in price were collected in the MSU-CESA survey, there is perhaps an alternative way of examining price responsiveness among the sample farmers. Farmers most likely to be price responsive in their coarse grain production decisions are those

with the greatest productive capacity in terms of resource endowment (land, labor and capital) and agro-climatic environment. It is those farmers in more resource-rich positions and farming under more favorable agro-climatic conditions who will be the most likely to make their coarse grain production decisions taking prices into account. On the other hand, the production decisions of the resource-poor farmers and those farmers in unfavorable agro-climatic environments will be determined largely by circumstances other than government price policy.

The second question concerns the PRMC's food security objective. Will higher farm-gate prices for coarse grains increase availability of and access to cereals for all Malian farmers through either production effects or income effects? In other words, what are the equity implications of higher cereals prices? With a fair degree of certainty one can postulate that those farmers who will receive the greatest income transfer from a pan-seasonal price support policy will be those making the largest net sales volume of grain, while those farmers the most adversely affected by a price support are those farmers making the largest net cereals purchases.

In the first case of farmers who make large net grain sales, higher grain prices will have a strongly positive income effect only slightly dampened by the negative consumption effect classically associated with higher prices. In fact, the negative consumption effect from a cereals price increase might not even

be relevant if one assumes that marketed cereals volume is the residual after home consumption needs have been met. In such an instance then, the effect of a cereals price increase can be measured by the increase in income received from cereals sales alone.

In the second case of farmers who make large net grain purchases, the positive income effect of higher cereals prices will be minimal since these farmers are making more cereals purchases than cereals sales. The negative consumption effect will far outweigh the slightly positive income effect to yield an overall negative effect on consumption from a cereals price increase.

Therefore a price support policy affects the food security positions of different types of farmers differently. For farmers who can afford to be more commercial in their coarse grain market behavior (i.e., who have already assured home consumption needs) such a policy is likely to be beneficial. For farmers who are cereals deficit and therefore who are obligated to make high levels of coarse grain purchases, such a policy is likely to further endanger their already tenuous household food security positions. To provide an indication of what proportion of farmers might benefit from a price-support policy, according to results presented in Chapter 5, 10% of farm households made over 50% of net sales and 30% of farm households made 92% of net sales. This high concentration of coarse grain sales among a

relatively small percentage of farm households indicates that the benefits of a price-support policy are likely to be skewed.

In any event, the results discussed in Chapter 5 imply that higher producer prices are unlikely to override the importance of household food security needs in determining marketed volumes of coarse grains, although price was not tested because the analysis was based on annual data. Among the variables tested, the most important explanatory variable for both net sales and gross sales levels was the household's coarse grain production per consumer. As this level of household food availability increased, so did the marginal propensity to sell coarse grains. A second critical element in the coarse grain sales decisions undertaken by the sample farmers was the presence or absence of household level cereals stocks. A household with stocks sold significantly more than those without stocks.

These findings suggest that any attempt to influence the market behavior of farm households vis-à-vis coarse grains will first have to address the problem of assuring household food security, since only at higher levels of cereals availability per consumer (from both stocks and own production) do farmers demonstrate more commercial behavior with regards to their coarse grains supply. Relying only on price incentives to increase marketed volume of coarse grain is not only a costly proposition for the government but also neglects the importance farmers attach to meeting household consumption requirements both in the short and long term.

Another element influencing marketed supply and perhaps overriding any price effect is the different behavior evinced by household with more diversified on-farm and off-farm activities. Cotton farmers had a higher marginal propensity to sell coarse grains than did non-cotton farmers. And farm households engaging in non-agricultural activities sold less but purchased more coarse grains than did those not engaging in non-agricultural activities. Thus farm household diversification is instrumental in determining marketed volume as well as purchasing behavior, and might be a target for policy interventions. Diversification might also serve as an indicator of, or proxy for, household food security.

Liberalization Policy

Another part of the Malian coarse grain sector restructuring program (PRMC) to liberalize the cereals market was the legalization of private trade in coarse grains and the elimination of government regulations which added significantly to the costs of private sector involvement in the cereals market. Up until this point, the official government monopoly in coarse grains had been maintained by OPAM, although both before and after the PRMC it is estimated that the private sector handled 90% or more of marketed surplus of millet and sorghum (Wilcock, Roth, and Haykin, 1987). Because of the private sector's heavy involvement in the cereals market before as well as after legalization of private trade, "the main impact of liberalization

was less on the level of trade than on its efficiency" (Ibid., p.18).

The results outlined in Chapter 5 and informal discussions with the farmers in the MSU-CESA study support Wilcock's conclusion that market liberalization has increased the efficiency of private coarse grain trade. The results of the econometric analysis show that market access is important in assuring a backflow of coarse grains to the rural sector. While farmers located in market villages did not sell more cereals than those farmers located in villages more distant from the market, they did buy more coarse grains. This finding was corroborated by informal discussions with farmers during which they stated that the greatest benefit from market liberalization has been the increased access to coarse grains through private trade, which has facilitated coarse grain purchases and consumption credit. Thus, the results suggest that the liberalization policies followed by the Malian government have strengthened rural markets by removing many of the barriers and costs to private trade, and by doing so has reinforced household food security by assuring backflows of coarse grains to rural areas. Thus further support for liberalization of private trade in the coarse grains sector is suggested by the research.

Other Policy Measures

Overall, the results of the analysis presented in Chapter 5 indicate that one of the greatest threats to household food security is the inability of households to withhold coarse grain

sales due to pressing needs for cash.[1] Concurrent with this is the tendency for those farm households in the most precarious food availability positions to sell immediately post harvest at what tend to be unfavorable prices. The research results suggest one of the best indicators of high levels of food security is not only high levels of own production then, but also diversification into on-farm and off-farm enterprises which not only complement coarse grain production but also provide an additional source of revenue with which to meet the cash obligations of the farm household.

Therefore, not only are policies needed to increase coarse grain production to ensure greater food availability, but also policies are needed to address the issue of increasing the household's ability to withhold cereals sales which might jeopardize family food security. This latter point means either a) providing the means for a household to time its cereals sales to maximize revenue, b) encouraging interventions which would enable the household to diversify and thus obtain additional sources of revenue, or c) directly addressing the reasons why farm households with the least "withholding capacity" are making the largest share of their coarse grains sales post-harvest.

The PRMC Credit Program for Village Associations, implemented by the Banque Nationale pour le Developpement

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[1] It is important to note, however, that gross sales as a percentage of production varies between 3 and 9% across equipment strata and between 6 and 9% across zone and subzone. These ranges can only provide a very rough indication of how much households might actually lose through forced sales.

Agricole in 1987, is an initial step in providing farm households with the capacity to address immediate post harvest cash needs while at the same time allowing farmers collectively to stock and market cereals to take advantage of seasonal price variations. The PRMC credit program in theory basically extends credit to village associations to purchase cereals from village farmers post-harvest at the market price, to stock the cereals, and to sell out of stocks later in the year when prices tend to increase. This program thus enables farmers as a group to realize the benefits of seasonal price increases and either redistribute the profits to farmers or use the profits for village-level investments. While this credit program is very new and still undergoing modifications, the program objectives directly address the problems indicated in the analysis of farmer coarse grain transactions, namely disadvantageous post-harvest sales for households in the least food-secure positions because of their need for cash. (For a more detailed discussion of this program see Dembele and Steffen, 1987).

As outlined earlier, another means of increasing farm household food security indicated by the analytical results is to address the reasons why farm households in the poorest food security positions (as measured by production per consumer) make the largest share of their coarse grains sales post-harvest. The results presented in Chapter 5 indicate that farmers in the OHV have a far lower expected level of coarse grains production than farmers in the CMDT, holding other factors constant, and Dione's

results show that in the OHV 86% of coarse grains sales occur in the post-harvest period and 97% of farmers give tax payments as one of the principal reasons for these sales. These findings point to the gravity of the tax burden in terms of the food security of rural households in the least favorable coarse grains production conditions. Our results indicate further that farmers without cotton as an alternative revenue source sell a greater percentage of their coarse grains in the post-harvest period as their tax burden increases than those farm households with cotton. Thus, post-harvest sales and post-harvest taxes are unquestionably associated issues with grave repercussions for those farmers in the least food-secure positions in terms of overall production, production per consumer, and farm diversification. Therefore, revisions of current rural fiscal policy are likely to have an important impact on farm household food security strategies.

Areas for Further Research

The analysis of the MSU-CESA farm-level coarse grains production and transactions data has clearly provided a more detailed understanding of farm household behavior vis-à-vis coarse grain production and transactions decisions. At the same time it has suggested areas for further research that might broaden the applicability of the results or increase the level of understanding of farm household food security strategies.

One area that emerges from the analysis for further research is that of rural consumption. While the MSU-CESA study focused on farmer coarse grain production and transactions, rural consumption patterns, how consumption changes across time and across cereals, and how coarse grain production and transaction strategies both influence and are influenced by farm household consumption strategies are all issues associated with improving household level food security. To date no studies of agricultural production and transactions with a complementary rural consumption component have been undertaken in Mali (Sundberg, 1988). Therefore, the addition of complementary research on rural consumption to a study such as that undertaken by MSU-CESA would likely improve understanding of the food security strategies of rural households.

Another area that warrants further examination is non-market transactions. The MSU-CESA study collected basic data concerning these transactions and was able to show that these were indeed of significant magnitude when compared with market transactions. The timing of a very large percentage of these non-market transactions during the immediate post-harvest period raises many questions: Are non-market transactions used as post-harvest in-kind labor payments? Who receives non-market transactions in grain and how are these receipts used? If the recipients of non-market transactions sell this grain, how does this affect post-harvest market supply and consequently post-harvest market

prices? Do non-market transactions have a role in depressing market demand?

A third area emerging from the data that necessitates further examination is the association between household equipment levels and production of coarse grain. While the econometric results show that equipment is a positive determinant of coarse grain production, the direction of causality is not clear. We know that equipment tends to increase household production, but we also might hypothesize that production is higher for the better equipped because of a host of different reasons. Farmers with equipment might be the farmers with the better land in terms of location and soil quality. Equipped farmers might be farmers of a certain caste, or sociological and ethnic background, or they might be from families who were among the first settlers of the village. For any number of reasons equipped farmers might wield greater political power at the village level than other farmers and thus have better access to village resources. Thus the characteristics of farmers with and without equipment need to be better understood in order to establish causality and to identify policies to address the role of equipment in augmenting coarse grain production.

A fourth area for further research is that of the influence of fiscal policy on household level food security. This study, as well as previous analysis of the data by Dione, points out the importance of rural taxes in determining the volume and timing of coarse grain sales, and consequently household food security.

However, the issue of rural taxation warrants a more detailed analysis than that presented in this thesis. Actual tax levels, collection periods, possibilities of deferment, and other aspects of rural tax policy must be understood. The macro-economic ramifications of alterations in the rural tax code must also be explored in a discussion of fiscal reform.

Finally, two variables that play an important role in determining cereals transactions levels emerge from the econometric analysis and warrant a more detailed investigation. While we now know that household participation in non-agricultural activities plays a significant role in all aspects of coarse grain production and transactions, the exact nature of this role is still unclear. How important are the different non-agricultural activities listed by the sample households in terms of cash revenue? How is this revenue utilized? How do these activities complement coarse grain production? Which household members engage in which activities, and is revenue pooled at the household level or retained by individual family members?

Another variable which is clearly important in cereals transactions behavior yet for which sufficient data are not available is household cereals stocks. A dummy variable for those households with and without stocks was used in the regression equations in Chapter 5 and was statistically significant in all cases; however, a better measure of the actual level of household cereals stocks would refine the analysis further. To complement this would be needed information on

farmers attitudes on maintaining cereals stocks, how this attitude varies among different types of farm households, and how this attitude affects observed commercial behavior with regard to coarse grains.

APPENDIX A

ALTERNATIVE SPECIFICATIONS OF THE COARSE GRAIN PRODUCTION MODEL

Tables A.1 through A.3 present alternative specifications of the coarse grain production model. The models presented in tables A.1 and A.2 differ only slightly from the specifications presented in Chapter 5. The equation presented in Table A.3 uses a double logarithmic functional form to estimate total production.

In the first two models the variables for institutional and agroclimatic environments are combined in the same categories as Dione uses in his preliminary analysis of the data, rather than being separated into the variables REGION and NS as in equations 5.1 and 5.2 presented in Table 5.10. In the following tables A.1 and A.2 then, SZ1, SZ2, and SZ3 are the proxy variables for the physical environment (rainfall, soils), and the institutional differences hypothesized to be determinants of cereals production. The agroclimatic as well as institutional characteristics of each subzone are not separated in these variables.

SZ1, SZ2 and SZ3 are dummy variables coded such that SZ1 reflects the CMDT-North, SZ2 the OHV-South, and SZ3 the OHV-North. It is hypothesized that all three independent variables will have negative coefficients given that the constant reflects

the CMDT-South, the richest agricultural area under the most developed rural institution.

TABLE A.1 -- ALTERNATIVE ESTIMATION OF CEREALS PRODUCTION EQUATION: OHV AND CMDT REGIONS OF MALI, 1985

Equation A.1 — Adj. R^2 =.51
F = 20.20 Signif F=.0000
Dependent Variable is TPROD — Degrees of Freedom = 176

Variable	B	Beta	T	Sig T
(Constant)	3546.1		6.90	.000
SZ1	-1294.9	-.24	-3.49	.001
SZ2	-1602.6	-.30	-3.85	.000
SZ3	-2006.8	-.37	-4.75	.000
NAG	517.2	.11	1.92	.057
ST1	-1388.5	-.30	-4.20	.000
RENT	-268.2	-.05	-.88	.381
LANDEX	313.6	.07	1.20	.232
QC	.2	.09	1.23	.222
ACTIFS	213.5	.27	4.17	.000
ST2	-1850.4	-.36	-4.35	.000

As expected in equation A.1 the variables for farm location in terms of the northern CMDT and the northern and southern subzones of the OHV have negative coefficients because these areas are relatively less well off in terms of cereals production than the benchmark constant (the southern CMDT). The dummy variable SZ1 indicates that there is a production fall of 1,295 kg in the northern CMDT relative to the southern CMDT. The dummy variables SZ2 and SZ3 indicates that for southern and northern OHV coarse grain production falls 1,602 kg and 2,007 kg respectively relative to southern CMDT. The increasing magnitude of the negatives coefficients of these variables reflects the

progressive decline in cereals production as one moves from the southern CMDT to the northern OHV.

The signs and magnitudes of the other coefficients are very similar to the results found in equation 5.1.

TABLE A.2 -- ALTERNATIVE ESTIMATION OF CEREALS PRODUCTION EQUATION: OHV AND CMDT REGIONS OF MALI, 1985

Equation A.2
Dependent Variable is TPROD

Adj. R^2 =.51
F = 17.01905 Signif F=.0000
Degrees of Freedom = 175

Variable	B	Beta	T	Sig T
(Constant)	3286.3		6.12	.000
SZ1	-1279.6	-.24	-1.97	.051
SZ2	-1138.9	-.21	-1.89	.060
SZ3	-1305.3	-.24	-2.26	.025
ACTSZ1	-17.5	-.02	-.14	.886
ACTSZ2	-112.5	-.11	-.95	.346
ACTSZ3	-168.0	-.19	-1.57	.118
ST1	-1456.9	-.31	-4.55	.000
ST2	-2019.2	-.39	-5.17	.000
NAG	463.5	.10	1.71	.090
LANDEX	294.6	.06	1.11	.271
QC	.1	.06	.77	.441
ACTIFS	290.7	.39	3.42	.001

In equation A.2, variables for labor productivity were created as the interaction between ACTIFS and SZ1, SZ2 and SZ3. The hypothesis being tested was that labor productivity would vary according to subzone because of the different physical and resource base with which farm households must work. The signs of the coefficients ACTSZ1, ACTSZ2 and ACTSZ3 were hypothesized to be negative given that the greatest labor productivity would be expected in southern CMDT, the subzone with the richest resource base.

The variables testing for labor productivity differences among the four subzones did not prove to be statistically significant, and thus the hypothesis that there exist labor productivity differences among the subzones was rejected. However, at about the 90% confidence level the hypothesis that there exists a labor productivity difference between northern OHV and southern CMDT was not rejected. The coefficient indicates that there is a fall in the marginal product of labor of 168 kg going from southern CMDT to northern OHV. This is undoubtedly a reflection of the great difference in the resources which farm workers have at their disposal. While the coefficient of the variable ACTIFS is positive (indicating a positive marginal product of another farm worker for the sample overall), the observation that the marginal product of an additional unit of labor falls in northern OHV perhaps indicates that there is a lack of the necessary resources in this subzone to complement additional farm workers. In other words, farm households in northern OHV are running into a production constraint in the form of an inadequate resource base to complement additional farm workers.

Table A.3 presents the empirical results of the production equation estimated using the log-log functional form. This form was used to simulate stages II and III of a production function: the period of decreasing but positive marginal product for a factor of production and the period during which the marginal product of a factor becomes negative. The variable TPRODLOG is

the natural logarithm of the variable TPROD, ACTLOG is the natural logarithm of the variable ACTIFS, and QCLOG is the natural logarithm of the variable QC.

TABLE A.3 -- LOGARITHMIC SPECIFICATION OF CEREALS PRODUCTION EQUATION: OHV AND CMDT REGIONS OF MALI, 1985

Equation A.3
Dependent Variable is TPRODLOG

Adj. R^2=.50
F = 24.40 Signif F=.0000
Degrees of Freedom = 179

Variable	B	Beta	T	Sig T
(Constant)	7.806		36.93	.000
REGION	-.560	-.29	-3.07	.002
NS	-.377	-.19	-3.59	.000
ACTLOG	.325	.23	3.47	.000
ST1	-.532	-.28	-4.20	.000
ST2	-.940	-.45	-5.78	.000
NAG	.288	.15	2.63	.009
LANDEX	.113	.06	1.07	.286
QCLOG	.001	.01	.07	.942

The coefficient of ACTLOG is the elasticity of total coarse grain production with respect to labor input. ACTLOG has a positive sign as hypothesized and is statistically significant, indicating that cereals production is positively responsive to labor input although the elasticity is less than one. The magnitude of the coefficient indicates that for a ten percent increase in labor input, production will increase by three percent. This result confirms that sample farmers are operating in the second stage of the production function, that is the marginal product of labor is increasing but at a decreasing rate.

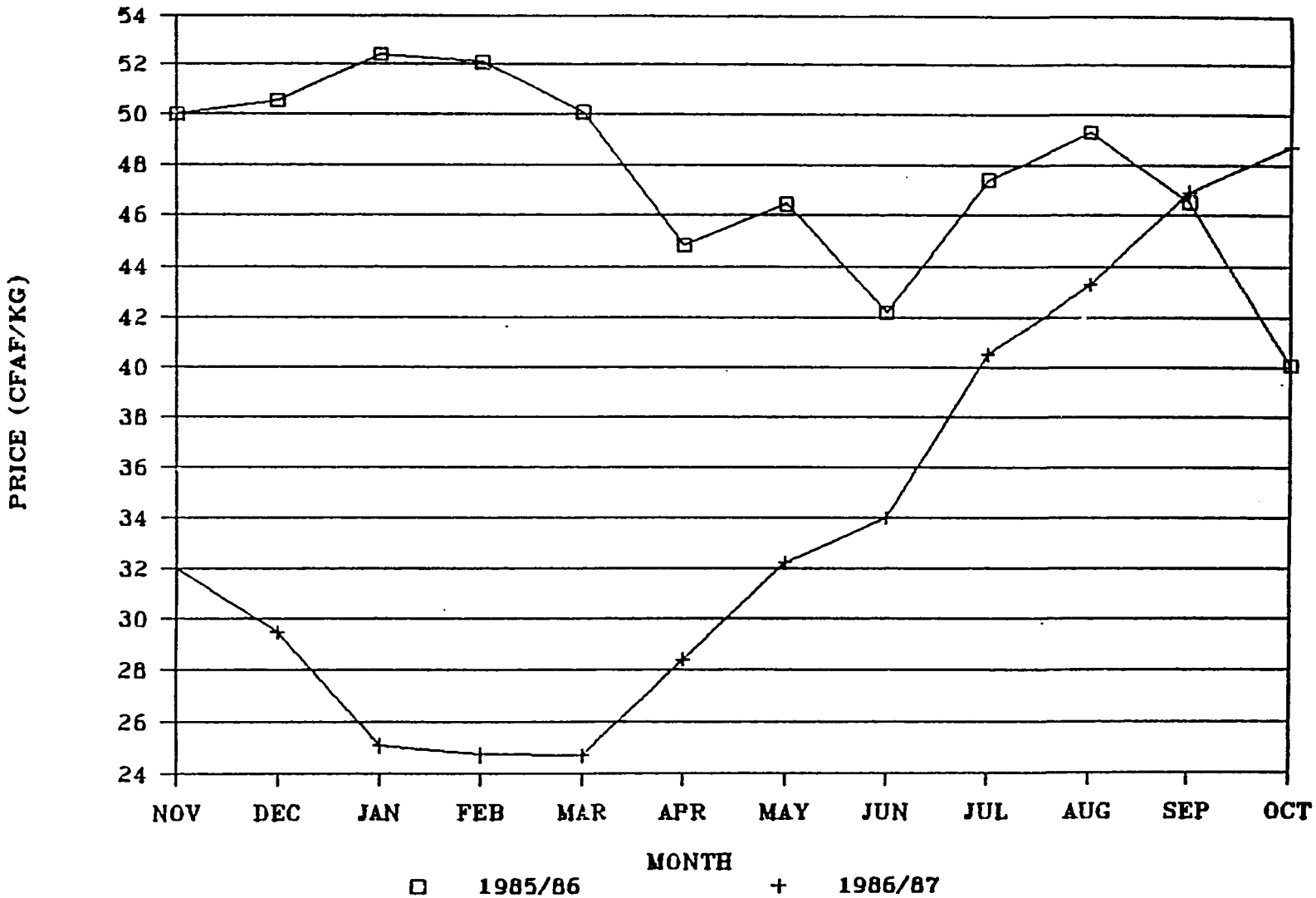
The coefficient of QCLOG is the elasticity of total coarse grain production with respect to the quantity of cotton

cultivated by the farm household. The t-statistic indicates that QCLOG is not statistically significant.

This logarithmic specification did not yield better estimates than the linear specification presented in Chapter 5.

APPENDIX B

1985/86 PRICE CYCLE: RURAL ASSEMBLY MARKET PRICE OF MILLET IN ZANGASSO (SOUTH CMDT)
NOVEMBER 1985 - OCTOBER 1987



SOURCE: CESA-MSU Market Surveys

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