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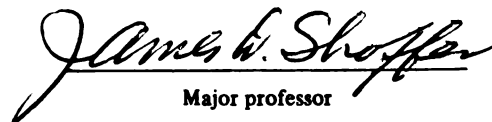
INFORMING FOOD SECURITY POLICY IN MALI:
INTERACTIONS BETWEEN TECHNOLOGY,
INSTITUTIONS AND MARKET REFORMS

presented by

Josué Dioné

has been accepted towards fulfillment
of the requirements for

Ph.D. _____ degree in Agricultural Economics


Major professor

Date May 19, 1989

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INFORMING FOOD SECURITY POLICY IN MALAWI

buy foodgrains when necessary. Rigid head taxes forced food-deficit farmers to sell cereals early when prices were low and buy later at higher prices.

ABSTRACT

INFORMING FOOD SECURITY POLICY IN MALI: INTERACTIONS BETWEEN TECHNOLOGY, INSTITUTIONS AND MARKET REFORMS

By

Josué Dioné

Interventions on the cereals market, and market regulations.

The purpose of this study was to examine empirically some major constraints to farmers' and private traders' capacity and willingness to invest so as to improve the overall performance of the coarse grain production and distribution system in Mali. The study relied on primary data collected between October 1985 and October 1987 at the level of a panel of 190 farm households and 118 cereal wholesalers. Coarse grain transaction data were collected through repeated interviews, weekly in rural markets and monthly for farmers and wholesalers. Several sets of one-shot questionnaires were used to collect basic information on farmer and trader characteristics and perceptions.

The study found that 43% of the farm households of two of the best agroclimatic zones (CMDT and OHV) were net buyers of cereals. Moreover, 90% of net grain sales came from only 28% of the sample farms. The net sellers of coarse grains were essentially large cotton farmers of CMDT, who owned a full set of animal traction equipment, and had an effective access to agricultural extension, credit, and input and output markets. Cash crops and nonfarm activities increased farm household food security by providing farmers cash to purchase improved inputs, pay taxes, and

buy foodgrains when necessary. Rigid head taxes forced food-deficit farmers to sell cereals early when prices were low and buy later at higher prices.

Direct head taxation and poor access to formal financing also constrained farmers' and traders' capacity to invest in improved technologies. Grain traders' investment was further constrained by uncertainties about coarse grain supply and demand conditions, public interventions on the cereals market, and market regulations.

The study recommended that rural development priorities and strategies be determined primarily according to their potential effects on the growth of total household income. Special attention should be paid to synergies between cash crops, food crops, and nonfarm activities on the one hand, and synergies between policy reform, technology adoption and capital formation on the other hand. The study also recommended that major research and policy efforts be made to reform fiscal and credit policies. Improved private trade policies and market information were recommended as complements to market liberalization.

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To my father, Bakary Dioné, who taught me to always face up to the challenges of my personal goals, and to my mother, Sita Berté, for her priceless love.

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I am very grateful to Dr. John M. Shaffer for his friendly and productive supervision, encouragement and advice throughout my field work in Mali and the drafting of my dissertation. I am a grateful tribute to Professor James O. Shaffer, Chairperson of my Academic Committee, whose invaluable expertise in institutional and policy analysis has critically contributed to shaping both my field research and my dissertation.

For their intellectual support and incitement, I sincerely thank the members of my Guidance and Thesis Committees: Drs. Lester Manderscheid, my course-work Major Professor, Carl Eicher, Eric Crawford, Norman Obst, Vernon Sorenson, and my Thesis Committee member, May Professor Carl K. Eicher find here an expression of my deepest appreciation for generously

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Dumbe. I am very grateful to Dr. John M. Staatz for his friendly and productive supervision, encouragement and advice throughout my field work in Mali and the drafting of my dissertation. I owe a special tribute to Professor James D. Shaffer, Chairperson of my Guidance Committee, whose invaluable expertise in institutional and policy analysis has critically contributed to shaping both my field research and my dissertation.

Diarra, Soubacar Kéita, Oumar Konaté, Longing, and others who have been

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CNAV	Commission Nationale d'Aide aux Victimes de la Sécheresse (National Commission for Drought Relief), Mali
CNAUR	Commission Nationale d'aide d'urgence et de Reconstruction (National Commission for emergency aid and reconstruction), Mali
CRED	Center for Economic Development, University of Michigan, Ann Arbor
CRSP	Cooperative Research Support Program of the U.S. Department of Agriculture
AAI	Associations Agricoles Indigènes (farmer associations), French Sudan
DAF/IER	Division Administrative et Financière (Administrative and Financial Division), Ministry of Agriculture, Mali
AV	Association Villageoise (village-level cooperative organization)
BCEAO	Banque Centrale des Etats de l'Afrique de l'Ouest (Central Bank of West African States)
BDM/IER	Banque de Développement du Mali (Development Bank of Mali)
BMCD	Banque Malienne de Crédit et de Dépôts (Savings and Loans Bank) (Division), Ministry of Agriculture, Mali
BNDA	Banque Nationale de Développement Agricole (Agricultural credit) (Direction Nationale de l'Agriculture (National Direction of Agriculture), Mali)
BOAM	Bank of Africa-Mali
CCCE	Caisse Centrale de Coopération Economique (French Economic Cooperation Fund) (Organizations), Mali
CESA	Commission Nationale de Suivi et d'Evaluation de la Stratégie Alimentaire, Mali (Food Strategy Commission), Mali
CFA	Communauté Financière Africaine (Financial Community of Western and Eastern Francophone African states, except Guinea and Mauritania)
DPE/IER	Division Planification et Evaluation (Division of Planning and Evaluation), Ministry of Agriculture, Mali
CFAF	CFA Francs (Currency unit of the CFA Zone)
CFDT	Compagnie Française pour le Développement des Fibres Textiles, (French Textile Development Company)
CICCONIG	Compagnie de Culture Cotonnière du Niger (Company for cotton production in the Central Delta of the Niger River)
CILSS/IER	Comité Inter-Etats de Lutte Contre la Sécheresse au Sahel (Organization of Sahelian States for coping with drought)
CMAV	Caisse Mutuelle des Associations Villageoises (Village-Association mutual fund)
FED	Fonds Européen de Développement (European Development Fund)
CMDT	Compagnie Malienne de Développement des Textiles (Malian Company for the Development of textiles)

CNAVS	Commission Nationale d'Aide aux Victimes de la Sécheresse (National Commission for Drought Relief), Mali
CNAUR	Commission Nationale d'aide d'Urgence et de Reconstruction (National Commission for emergency aid and reconstruction), Mali
CRED	Center for Economic Development, University of Michigan, Ann Arbor
GERDAT	Groupe d'Etudes et de Recherche pour le Développement de
CRSP	Cooperative Research Support Programs of the U.S. Department of Agriculture (USDA)
DAF/IER	Division Administrative et Financière (Administrative and Financial Division), IER, Mali
GR	Groupements Ruraux (farmer associations), Mali
DET/IER	Division des Etudes Techniques (Division of Technical Studies), IER
GRFSM	Groupements Ruraux de Production et de Secours Mutuels (farmer associations), Mali
DDI/IER	Division Documentation et Information, IER, Mali
ICRISAT	International Crop Research Institute for the Semi-Arid Tropics
DMA	Division du Machinisme Agricole (Agricultural Mechanization Division), Ministry of Agriculture, Mali
IDA	World Bank
DNA	Direction Nationale de l'Agriculture (National Direction of Agriculture), Mali
IER	Institut d'Economie Rurale (Agriculture) Research Institute)
DNACOOOP	Direction Nationale de l'Action Coopérative (National Direction of cooperative organizations), Mali
IFAD	International Fund for Agricultural Development
DNAE	Direction Nationale des Affaires Economiques (National Direction of Economics Affairs), Mali
IFDC	Development Center
DNSI	Direction Nationale de la Statistique et de l'Informatique (National Direction of Statistics and computing), Mali
DPE/IER	Division Planification et Evaluation (Division of Planning and Evaluation), IER, Mali
DRA	Direction Régionale de l'Agriculture (Regional Direction of Agriculture), Mali
DRA/IER	Division de la Recherche Agronomique (Division of agronomic research), IER, Mali
DACY	Operation Arachide et Culture
DRSPR/IER	Division de la Recherche sur les Systèmes de Production Rurale (Farming systems research Division), IER, Mali
OCFLM	Office des Céréales, des Fruits et des Légumes
FAC	Fonds d'Aide et de Coopération (French Development Fund), France
FED	Fonds Européen de Développement (European Development Fund)

FDV	Fond de Développement Villageois (Village development fund), Mali (Integrated rural development agency), Mali
FGR	Fédération des Groupements Villageois (Federation of village cooperatives), Mali (Integrated groundnuts and cereals development agency), Mali
FSR/E	USAID's Farming Systems Research/Extension Project, Mali (Operation de Développement Rural (rural development agency)), Mali
GERDAT	Groupe d'Etudes et de Recherche pour le Développement de l'Agriculture Tropicale (Tropical agricultural development research group), France (Niger River upper-valley development agency), Mali
GRA	Groupements Ruraux Associés (farmer associations), Mali (Office Malien du Bétail et de la Viande (livestock and meat agency), Mali)
GR	Groupements Ruraux (farmer associations), Mali
GRPSM	Groupements Ruraux de Production et de Secours Mutuels (farmer associations), Mali
ICRISAT	International Crop Research Institute for the Semi-Arid Tropics (agency)
IDA	International Development Agency of the World Bank (Operation Riz Secou (Semi-arid Rice development agency), Mali)
IDRC	International Development Research Center, Canada (Office Statistique des Communautés Européennes (Statistical agency), Mali)
IER	Institut d'Economie Rurale (Agricultural Research Institute), Mali (Projet Inventaire des Ressources Terrestres (Land-resource agency), Mali)
IFAD	International Fund for Agricultural Development
IFDC	International Fertilizer Development Center (Cereals market restructuring program), Mali
IRAT	Institut de Recherche en Agronomie Tropicale (Tropical agronomic research institute), France (Agence de Coopération (French rural development agency)), Mali
IRCT	Institut de Recherche sur le Coton et les Textiles (Cotton and textile research institute), France (Statistical division of rural development agency), Mali
IRHO	Institut de Recherche sur les Huiles et Oléagineux (Oilseed research institute), France (Institut d'Économie Rurale (Agricultural research institute), Mali)
MSU	Michigan State University (Unité de Input distribution agency), Mali
OACV	Opération Arachide et Culture Vivrières (Groundnut and food-crop development agency), Mali (Société d'Exploitation des Ponds de Poissons du Mali (livestock agency), Mali)
OCFLM	Office des Céréales, des Fruits et Légumes du Mali (Cereals and fruits and vegetables marketing parastatal), Mali (Société pour l'Exploitation des Ponds de Poissons du Mali (livestock agency), Mali)
OCS	Office des Céréales du Soudan (Cereals marketing agency), Sudan (Sociétés Indigènes de Production (Indigenous parastatals), French)

ODIK	Opération de Développement Intégré du Kaarta (Kaarta-region Integrated rural development agency), Mali
ODIPAC	Opération de Développement Intégré des Productions Arachidières et Céréalières (Integrated groundnuts and cereals development agency)
SOMIEY	Maliens d'Importation et d'Exportation (import-export)
ODR	Opération de Développement rural (rural development agency), Mali
OHV	Opération Haute Vallée (Niger River upper-valley development agency), Mali
OMBEVI	Office Malien du Bétail et de la Viande (Livestock and meat agency)
ON	Office du Niger (Niger River irrigated agricultural development agency), Mali
OPAM	Office des Produits Agricoles du Mali (Agricultural marketing agency)
ORS	Opération Riz Ségou (Ségou-region Rice development agency), Mali
OSCE	Office Statistique des Communautés Européennes (Statistical agency of the European Community)
PIRT	Projet Inventaire des Ressources Terrestres (Land-resource inventory project), Mali
PRMC	Programme de Restructuration du Marché Céréaliier (Cereals market restructuring program), Mali
SATEC	Société d'Aide Technique et de Coopération (French rural development agency)
SB	Secteur de Base (Bottom-level administrative division of rural development agencies), Mali
SCAER	Société de Crédit Agricole et d'Équipement Rural (Agricultural credit and input distribution agency), Mali
SEPAD	Société d'Exploitation des Produits Animaux du Mali (livestock products)
SEPOM	Société pour l'Exploitation des Produits Oléagineux du Mali (oilseeds)
SIP	Sociétés Indigènes de Prévoyance (farmer organization), French Sudan

SMECMA	Société Malienne d'Etudes et de Construction de Matériel Agricole (agricultural mechanization)
SOMBEPEC	Société Malienne des Peaux et Cuirs (hides and leather)
SOMIEX	Société Malienne d'Importation et d'Exportation (import-export)
SONATAM	Société Nationale des Tabacs et Allumettes du Mali (cigarette and match manufacturing)
SONEA	Société Nationale pour l'Exploitation des Abattoirs (meat processing)
ST/CESA	Sécrétariat Technique de la CESA, Mali
SRCJF	Section Recherches Cotonnières et Fibres Jutières (Cotton and textile research), IER
SRCSS	Section de Règlementation et Contrôle des Semences Sélectionnées (seed selection control), IER
SRCVO	Section Recherches Cultures Vivrières et Oléagineuses (food crop and oilseed research), IER
SRFM	Section Recherches Fruitières et Maraîchères (fruits and vegetable research), IER
SRTPN	Section Recherches Tabacoles et Plantes Nouvelles (tobacco and new crop research), IER
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WARDA	West African Rice Development Agency
ZAER	Zone d'Animation et d'Expansion Rurales (rural development administrative division), CMDT zone, Mali
ZER	Zone d'Expansion Rurale (rural development administrative division)

evaluation of PRMC achievements, this study addresses the no less important question: "Given the prevailing state of climatic, technological, institutional and policy factors, what are, with respect to food availability and distribution, the scope and the limits of the changes in the incentive system expected from the PRMC reforms?" Stated differently,

CHAPTER I

INTRODUCTION

This chapter presents the overall objectives, context, justification, and organization of this study of the implications of farm household behavior for food security policies in Mali. First, the objectives are spelled out. Second, the overall problem of food insecurity is presented within the global context of Africa's food crisis. Third, the research problem is more specifically defined in the policy context of Mali. Fourth, the definition and the dimensions of food security used are explicitly stated. Finally, the organization of the rest of the dissertation is outlined.

1.1. Study Objectives

The general purpose of the research reported herein is to generate and use farm-level and market data to inform a set of public-sector policies related to food security issues in Mali. Major emphasis is on the coarse grain subsector, which provides approximately 85% of total cereal calories or 60% of the total calorie intake in the country. Central to these policies is the Cereals Market Restructuring Program (PRMC), which was conceived with high hopes of inducing, through new market incentives, greater surplus foodgrain production and marketing. In the absence of appropriate data to carry out a "with versus without PRMC"

evaluation of PRMC achievements, this study addresses the no less important question: "Given the prevailing state of climatic, technological, institutional and policy factors, what are, with respect to food availability and distribution, the scope and the limits of the changes in the incentive system expected from the PRMC reforms?" Stated differently, the study focusses on the identification and analysis of technological, institutional and policy constraints, which, if not removed, would most likely inhibit some of the most significant expected effects of the PRMC on food production (availability) and distribution (accessibility or entitlement) in Mali.

More specifically, the objectives of this study are to:

1. Provide, through an analysis of primary data on farm household-level production and grain transactions, a better understanding of the climatic, technological, institutional and policy determinants of farmers' coarse grain production and marketing decisions and strategies, and their implications for a comprehensive formulation of food security policies in Mali.
2. Determine and discuss farm household-level food security strategies (production, transactions and storage), taking into account the interactions between cereals and non-cereals production activities, and their effects on coarse grain surplus production and marketing.
3. Provide empirical evidence on major institutional and policy constraints to farmers' investment in improved agricultural production technologies, through an evaluation of agricultural research and available technical packages for coarse grains and through an examination of primary data on farm household investment and disinvestment in animal traction.

4.11 Identify additional institutional and policy reforms required as complements to cereals market liberalization, in order to improve the overall performance of the food production and distribution system. Underlying this objective is an evaluation of current strategies and policies of rural development agencies with respect to development priorities, extension, credit and input distribution and output marketing; private trader behavior and constraints; and the extent of farmer organization and participation in the management of agricultural development. state planning advisers" (ibid., 459). Consistent with this

5. Suggest priority areas for future food policy-relevant research. ons of the African food production gap at the level of five key debates.

1.2. Background Problem Statement states have given a low priority to

1.2.1. Need for policy response to food security issues in Africa placed

heavy In its widely debated Accelerated Development in Sub-Saharan Africa, the World Bank reported that food production in Africa rose at an annual rate of only 2% in the 1960s and 1.5% in the 1970s (World Bank 1981, 47). In contrast, the annual growth of African population increased from 2.3% per year in the 1960s to 2.7% per annum during the 1970s. The resulting continuous decline in per capita food production at the annual rate of 0.3% in the 1960s and 1.2% in the 1970s is at the foundation of Africa's food crisis. Despite its relative abundance of arable land and the fact that at least 60% of its population is engaged in agriculture, Africa has emerged as the only continent that has increasingly failed to produce enough to feed its population. also not to be able to export the surplus

out In his influential article, "Facing up to Africa's Food Crisis", Professor Eicher observes that although the African food and hunger crisis

followed the prolonged drought of the early 1970s, weather is not the main cause of the food production gap and hunger problem. The problem is long-term in nature and has been building up for two decades (Eicher 1982, 453). Tracking the problem back from the colonial period, Eicher concludes that "the food production crisis stems from a seamless web of political, technical, and structural constraints which are a result of colonial surplus extraction strategies, misguided development plans and priorities of African states since independence, and faulty advice from many expatriate planning advisers" (Ibid., 459). Consistent with this comprehensive historical approach, Eicher highlights different dimensions of the African food production gap at the level of five key debates. First, post-independence African states have given a low priority to agriculture in development plans and budget allocations, which have placed heavy emphasis on foreign aid, industrial development, education and economic diversification. Second, these development plans have themselves been designed under the intellectual leadership of expatriate economists inspired either by Western neoclassical models of development without adequate adjustments to account for country-specific social, political, and structural issues, or by political economy (marxist) models without empirical African evidence to support their theoretical foundations. Third, ideological battles over agrarian capitalism versus socialism have often resulted in the neglect of the other major determinants of the outcome of agricultural development projects. Fourth, African states have used negative pricing and taxation policies to pump the economic surplus out of agriculture, thereby distorting incentives and reducing the capacity to invest for increased food and agricultural production.

Finally, attempts to transfer green revolution technology from other continents to Africa have failed because of a fundamental lack of location-specific research to develop suitable technical packages for staple food in each country.

Contrary to such a comprehensive understanding in an historical perspective, most analysts have failed to grasp the complexities of Africa's food problems and have been guided by single-input biases in proposing simplistic solutions often based more on ideological than economic rationales. Among such solutions, output market liberalization has been considered almost as a panacea by many experts, as a consequence of a disproportionate attention paid to market imperfections as one of the most important causes of the stagnation of food production in Africa. Parastatals and marketing boards have borne most of the blame as public sector instruments used to implement "wrongheaded government marketing policies" that distort agricultural incentives (Staatz 1984, 2). However, as Staatz notes, "given the nature of markets for many agricultural products, improving food system performance is more complex than simply eliminating (or increasing) parastatal and marketing board activities" (Ibid.). Although the African food crisis clearly calls for a policy response, this response should not be sought in the confined context of a static competitive-market equilibrium, but rather in the dynamic framework of how alternative market opportunities affect producers' long-term decisions and what mixes of public sector and private sector roles are appropriate to induce sustainable growth and reduce poverty.

1.2.2. Planning without facts

In fact, most of the failures of past agricultural development planning exercises in Africa can be related in some way to the lack of a thorough scientific knowledge-base on the agricultural and food systems of the various countries of the continent. As a direct consequence of severe shortages in human capital, the paucity of the data base on agriculture is probably the most common observation found in virtually all studies on the various aspects of the agricultural sector in African countries. Eicher provides a concise statement on the major data gaps on African agriculture by noting that:

Africa has a weak and uneven data base, and there is need to interpret official statistics with caution. For example, accurate data on acreage under cultivation and yields are available for only a handful of countries. Estimates of land under irrigation vary from 1 percent to 5 percent. Estimates of the size of national livestock herds are notoriously suspect because of cattle tax evasion. Even trade data must be carefully examined ... Data on rural income distribution are available for only a few countries. Agricultural statistical agents in most countries rely heavily on guesstimates from extension agents ... The combination of underdeveloped data and the case study nature of much of the research in the past decade makes it difficult to generalize about the sources of agricultural output and the causes of poverty, malnutrition, and lagging food production ... In summary, ... serious scholars eschew generalizing about even a subregion such as West Africa--an area as large as the continental United States (Eicher 1982, 456-57).

Surprisingly, neither African governments nor donor institutions cooperating with these governments have responded adequately to the well-known underdevelopment of the agricultural data base by giving a clear priority to the generation of a sound data bank on which to base project and program design, agricultural development planning and the policy decision process. In their urge to "start development" immediately in the face of very weak local human capital, these governments and donor agencies have relied heavily on expatriate advisers and consultants to

draft proposals hastily for multi-year development plans, crash production projects, and even the very parastatals and marketing boards that came so much under fire in the late 1970s and the early 1980s. Lacking appropriate background knowledge and having very little time and funds to invest in the search for reliable micro and even macro-level data, most of the planning efforts of these expatriate advisers and consultants remained (and continue to be) based on untested hypotheses and ideologies. Likewise, public policies followed by governments toward the agricultural and food systems are strongly influenced by official preconceptions about the organization and the behavior of various participants of the different agricultural subsectors. This dominant trend in policy formulation and analysis is eloquently characterized by Eicher and Staatz who state that "the lack of reliable data can lead to highly questionable empirical analyses or the formulation of food security policies solely on the basis of economic theory without knowledge of crucial parameters, such as the magnitude of demand and supply responses, and of institutional constraints that determine how theory works out in practice" (Eicher and Staatz 1985, 8). In addition, the propensity to collect too much detailed data prior to the processing and analysis stage has severely limited timely feedback of

1.2.3. Weaknesses of past attempts to generate policy-relevant micro-level data

Past attempts by social scientists to generate micro-level data to inform various policies related to food security in Africa have been plagued by several problems. First, many studies have been characterized by a lack of a systematic method of tying the type of micro-level information collected to the key policy issues. For instance, investigation methods seldom dealt directly with research hypotheses derived from

underlying policy assumptions about the incentive system, the investment capacity and the behavior of the participants of agricultural subsectors (producers, traders, consumers, public sector entities, etc.). Although some case studies on agricultural production and marketing may relate to each of these aspects, the tendency has been to treat them in isolation and as by-products rather than the main focus of individual micro-level investigations. (Riley and Staatz 1981). As will be discussed later, the

Second, in consequence of the above, past studies have tended to collect at the same time too much and not enough data to address key food-security policy issues. Micro-level research projects may collect several megabytes of detailed data on individual farming activities, consumer expenditures or trader operations and still fail to include information on such vital questions as crop-yield response to chemical fertilizers; farmer and trader perceptions of, and reactions to, market uncertainties; fiscal constraints to investment in production and marketing; etc., all of which are critical in assessing the potential effects of reforms in factor and product markets on the availability of, and access to, food. In addition, the propensity to collect too much detailed data prior to the processing and analysis stage has severely limited timely feedback of research findings to on-going policy processes.

Third, many of the problems encountered in previous research efforts to inform food policies result from a too narrow conception of the nature of the food security problems. Marketing studies have tended to focus on tests for static market equilibrium under perfect competition assumptions, just as investigations in farm management and production economics have emphasized constraints to optimal farm organization and production. Yet,

very few studies have paid enough attention to how market opportunities affect farmers' production decisions and how aggregate output relates to changes in prices in a poor technological and institutional context (Staatz 1984, 10-12). While production and marketing are adjacent productive activities in the food system, they have generally been treated as separate activities in farm management research and agricultural marketing research (Riley and Staatz 1981). As will be discussed later, the separation of food availability (production) problems from food access (entitlement) problems is one of the root causes of most difficulties faced by past attempts to use micro-level data to inform food security policies.

...erial cotton autarky in the face of the threat they saw to traditional sources of supply--the United States--with the growth of the

1.3. Problem within the Context of Mali As a result, "the French cotton

1.3.1. Agricultural and food policy in historical perspective in Mali

The evolution of food policy in Mali cannot be thoroughly understood from an institutional standpoint without a brief reference to the 1928-1959 colonial agricultural policy legacy in French Sudan, which clearly determined the policy options inherited and followed by the governments of Mali after independence (1960). Briefly, after the conquest (1878-1898) of what became French Sudan and the construction of the Dakar-Koulikoro railroad in the 1890s and 1900s, the French colonial administrators started using the railway to import cloth, salt, construction material, drinks and machines while looking "for exports that would fill the empty [returning] railway cars and which French industry could buy" (Jones 1976, 20-23). Only gum Arabic, vine rubber and ivory were moving compared with CFAF 85,000 per long-tonne tonnage in 1959, most of the

out of this West African region, which showed no prospects for rich gold mining or exotic plantation development of coffee or cocoa production.

The French therefore turned their attention to the great agricultural potential that could be realized through the irrigation of the central delta of the Niger river. This dream was translated into the first major French agricultural project in French Sudan, the Office du Niger project, which was intended for the ambitious objective of 1.2 million irrigated hectares (deWilde 1967; Jones 1976). The first interest of the French in local crops was clearly cotton. As Jones reports, "the Association Cotonnière Coloniale [was] clearly interested in any possibilities for French imperial cotton autarky in the face of the threat they saw to traditional sources of supply--the United States--with the growth of the American textile industry" (Ibid., 24). As a result, "the French cotton lobby vigorously supported the Office du Niger", which was intended to become not only the "bread basket" of French colonial West Africa, but also and primarily the main source of supply of raw cotton to be linked to France via a Trans-Saharan railroad that was never constructed (Ibid., 25). Estimations by Amin show that, from 1928 to 1959, total public investments in French Sudan in 1959 constant terms amounted to CFAF 42.2 billion (about US\$ 172 million at the 1959 exchange rate of US\$ 1 = CFAF 246), of which 57% was allocated to agriculture and devoted exclusively to irrigation, the Office du Niger alone accounting for 48% (approximately US\$ 83 million) of all public investment (Amin 1965, 37-40; Amin 1971, 153-54; Jones 1976, 25-26). The Office du Niger became a prestigious scheme, with irrigation costs amounting at CFAF 500,000 per hectare as compared with CFAF 85,000 per irrigated hectare in other areas of the

central delta of the Niger river (Amin 1965, 39). In spite of the priority given to irrigation, and because of the high costs of the irrigation scheme and bureaucratic rigidities and socio-cultural problems encountered during the implementation of the settlement phase, results remained far from expectations. Fewer than 20,000 hectares in the Office du Niger were irrigated and cultivated in single annual cropping by fewer than 10,000 farmers in 1959 (Jones 1976, 26). *contives of Sudanese farmers and*

Faced with major difficulties in developing the Office du Niger, the colonial administration considered the possibility of developing cotton production in rainfed areas of French Sudan. Efforts in this direction resulted in the interventions of the Compagnie Française de Développement du Textile (CFDT) in 1949 (deWilde 1967). The Compagnie Malienne de Développement des Textiles (CMDT) replaced CFDT in 1974. However, as Amin (1965) notes, development assistance in favor of traditional rainfed agriculture remained extremely modest throughout the colonial era. Research efforts in the few research stations (M'Pessoba-N'Tarla, Kogoni and Sotuba) were focussed on irrigated or rainfed cotton and irrigated rice to a limited extent, while research stations in Senegal carried out the bulk of research on peanuts, a crop that the colonial authorities spread more successfully, mainly because of its similarity to the Bambara groundnuts grown for centuries by Sudanese farmers (Jones 1976, 24). Technical assistance to farmers in rainfed areas centered around the colonial settlement formula developed in the 1940s at the farm-school of M'Pessoba, with an intensive and very directive extension policy. This policy aimed at inducing farmers to stop bush fires and the practice of shifting bush-fallow cultivation. Instead, farmers were to grow more cash

grow more cash crops through a system of rotation, which included cotton with manure, followed by sorghum then peanuts and fallow plowed in the rainy season. They were encouraged to use animal traction for an improved tillage of extended area and the production of manure to be transported to the fields by ox carts (Ibid., 268-78).

As far as marketable surplus was concerned, the French had an extremely low opinion of the energy and the incentives of Sudanese farmers and therefore preferred coercion to market incentives as a means to induce farmers to adopt the crops the French aimed at developing. As Jones notes, "most administrators considered their administratees so indolent that they could be induced to produce crops for market only by imposition of head taxes and establishment of quotas of cash crops to be grown by villages at the direction of chiefs who cooperated with the new regime" (Jones 1976, 24). Virtually all important marketing activities were entrusted to French commercial companies and Lebanon traders, who were given monopoly rights. Consequently, the Sudanese traders, who were once vital actors in the pre-colonial trans-Saharan trade were faced with the alternative of either collaborating with these foreign traders by playing subsidiary roles in domestic markets or fleeing the area altogether. This short history is useful in understanding (1) the anti-market, anti-merchant bias, (2) the perceptions of the agricultural incentive system, and (3) the propensity for direct state interventionism and monopolies that prevailed in Sudanese political circles by 1959, i.e., at the eve of Mali's independence.

Shortly after its accession to independence and the failure of the Mali-Senegal Federation, the new Republic of Mali opted for a radical

socialist development path aimed at achieving economic independence through a rapid development of agriculture, the diversification of the economy through the development of agricultural input manufacturing and product processing industries, the systematic search for oil and mineral resources, and the implementation of mass-oriented social policies in education, health, administration, etc. (Amin 1965, Bingen 1985). Based on the colonial legacy of French planning since 1946, central planning was adopted as the best way to achieve Malian development goals. As Jones notes, however, "Mali and Upper Volta were quite poorly equipped with statistics, national accounts and trained people for planning," and "after independence, French planning advisors dominated all their former colonies" (Jones 1976, 137, 140). Prior to independence, no Malian trained in France "had had the benefit of a formal course in economics," while the few who received any economics training at all (including Mali's first planning minister) got their informal "training in economics by attending communist-run, non-credit night courses while working on a degree in [other fields such as] philosophy" (Ibid., 106). Upon Mali's request for French assistance in designing its first five development plan, professor Jean Bernard was sent as leader of a team of experts including Samir Amin (Amin 1965, 99-100). The first National accounts of independent Mali were prepared by this team from sparse records of the colonial administration. On the basis of these accounts, the draft of Mali's first four-year plan (later converted after strong political influences and amendments into a five-year plan) was prepared in the record time of three months (Jones 1976, 117).

The basic economic structures that are currently being reformed in the Malian economy were put in place under the first five-year development plan (1961-1966). The most controversial among these were a plethora of state enterprises created to take over or control virtually all major economic activities in the country (Humphreys 1986; Dioné and Staatz 1987; Staatz, Dioné and Dembélé 1988). Of a total of 33 such enterprises created between 1960 and 1968 (under the Modibo Kéita regime), 29 were founded and 27 began activities under the first development plan (Jones 1976, 232-54). State enterprises that were most directly related to the agriculture and livestock sectors included the Office du Niger (ON) for irrigated rice production, processing and marketing, the Société Malienne d'Importation et d'Exportation (SOMIEX) for imports and exports of all major commodities, the Société pour l'Exploitation des Produits Oléagineux du Mali (SEPOM) for the processing and marketing of oilseed products, the Société Nationale pour l'Exploitation des Abattoirs (SONEA, later split into OMBEVI, SEPAM and SOMBEPEC) for livestock product processing and marketing, the Société Nationale des Tabacs et Allumettes du Mali (SONATAM) for the manufacturing and marketing of tobacco products, the Société de Crédit Agricole et d'Équipement Rural (SCAER) for agricultural credit and input distribution, and the Office des Produits Agricoles du Mali (OPAM) for domestic agricultural product marketing. All these public-sector enterprises were granted legal monopoly rights in their respective spheres of intervention on the basis of the fundamental assumption (inherited from perceptions nurtured during the colonial era) that the private sector lacked the capacity and/or the willingness to

consumer cooperatives at the cost of... (text is faint and partially obscured)

perform critical production and marketing functions in the best interest of the majority of the population (farmers and urban consumers). Throughout the 1960-68 period, food policy was dominated by efforts toward the collectivization of production and compulsory marketing through OPAM, which was nothing but the second reshaping of a tradition established by the creation of the Office des Céréales du Soudan (OCS) in 1959, later converted into the Office des Céréales, des Fruits et Légumes du Mali (OCFLM) (Sall 1987a, 2). Farmers in each village were forced by administrative authorities to create local party committees and Grouperments Ruraux de Production et de Secours Mutuels (GRPSM), which "were responsible for buying goods of first necessity from SOMIEX and selling agricultural crops to it or to OPAM" (Jones 1976, 286-99). The agricultural sector received only 20% of the total amount of investments under the first development plan, and nearly 68% of this share went to Office du Niger and other irrigated rice production perimeters (Ministère de l'Agriculture 1987, 234). In the absence of basic investment in agricultural research and rural infrastructure, official consumer and producer prices for all major agricultural commodities were fixed by the state with the three conflicting objectives of (1) increasing rural incomes, (2) providing cheap food (cereals) to urban consumers, and (3) extracting a surplus from agriculture to finance state investment in other sectors (Dioné and Staatz 1988, 144). This conflict was solved by giving priority to the last two objectives through depressed producer prices, forced quota-deliveries of cereals by farmers to OPAM, and subsidized consumer prices through urban consumer cooperatives at the cost of accumulating OPAM deficits. Hence,

direct control over the prices of major wage goods allowed a relative freezing of the government's wage bill through a tight regulation of the cost of living of urban-dwellers, a significant proportion of whom were not only politically powerful, but also government or state-enterprise employees. Not surprisingly, except for the spread of animal traction and the subsequent growth in cotton production (which was also encouraged by higher head-tax liabilities), farmers responded with little enthusiasm to public-sector interventions in agriculture, tending to view the new public policies very much as a continuation of previous colonial rules.¹ Farmers allocated the most marginal lands and the lowest activity-priority to collective village fields and showed no interest in increasing the production of foodgrains for the official OPAM market. As a result of the relative stagnation of food production in the face of a population growing by 2.3% per year, Mali shifted from a position where its net annual cereals exports ranged from 9,000 to 37,000 metric tons between 1958/59 and 1963/64 to a situation where it became a net importer of continuously increasing quantities of cereals thereafter, ranging from 6,000 to 15,000 metric tons per year between 1964/65 and 1966/67 (Jones 1976, 368).

(3) supply surpluses of raw or processed commodities for exports required to achieve an equilibrium in foreign trade (Nétière de l'Agriculture 1987, 236-41). In contrast with these high expectations, investments in the agricultural sector amounted to only 18.4% of the total investments in the plan. Moreover, the bulk of the investments made in agriculture

1. The number of plows increased from 34,980 in 1960/61 to 90,300 in 1967/68 (Jones, 1976, p.304). Between 1960 and 1968, cotton production rose from 9,000 to 48,000 metric tons, while peanut production declined from 122,000 tons to 95,000 tons and coarse grain and rice production fluctuated around their 1960-levels (Lecaillon and Morrisson, 1986, Annex 31).

1.3.2. Economic Recovery Plan and Cereals Market Restructuring Program

In November 1968, a military coup terminated the first political regime of independent Mali and induced the political evolution of the country toward its present state. The new leaders of Mali abandoned some of the more radical socialist initiatives of the first regime and even attempted to abolish OPAM's legal monopoly in agricultural product marketing (Dioné and Staatz 1988, 144-45). However, this early experiment of market liberalization did not last more than one year, "as OPAM accused the private traders with whom it had contracted for grain of failing to honor their agreements," while most of the latter claimed that these contracts went in fact to non-traders (Ibid., 145).

The change in political regime in no way altered the propensity for development planning in Mali. On the contrary, less than two years after the military coup, a new four-year development plan called the Programme de Redressement Economique et Financier (Economic and Financial Recovery Plan) was underway for the 1970-1973 period. This plan called for a reliance on agricultural growth in order to (1) meet the food requirements of Mali, (2) ensure an adequate supply of raw materials for the full employment of the existing and projected industrial capacity, and (3) supply surpluses of raw or processed commodities for exports required to achieve an equilibrium in foreign trade (Ministère de l'Agriculture 1987, 236-41). In contrast with these high expectations, investments in the agricultural sector amounted to only 19.4% of the total investments under the plan. Moreover, the bulk of the investments made in agriculture were allocated to three commodities: cotton (27%), groundnuts (13%) and irrigated rice (39%). Coarse grains, tobacco, fruits and vegetables

shared only 21% of total agricultural investments or 4% of total investments under the recovery plan (Ibid.). The 1970-73 Recovery Plan failed to induce any significant increase in food production, particularly in the context of the severe drought that lasted over the whole period. A second five-year (1974-78) plan followed and fell very much in the same lines as its predecessors with respect to investment priorities and agricultural development interventions and activities implemented. (In 1980) Inspired by the relative success of CMDT in stimulating growth in rainfed agricultural (especially cotton) production and the strong control of the Office du Niger over irrigated rice farmers, the government of Mali set up, generally with strong donor support, a plethora of public-sector integrated rural development organizations called the Opérations de Développement Rural (ODRs) throughout the 1970s. By 1981, 26 such ODRs were created and used over 11,000 permanent employees to manage virtually all major agricultural development activities, including extension, credit and input distribution, output marketing, etc. (SATEC 1982, 7, 18). These parastatal organizations have been severely criticized for combining too many (private sector and administrative) activities that often conflict with their production roles, the low level of formal and practical training of their technical agents, the poor management and coordination of their programs and projects, and their heavy reliance on foreign financing (Ibid., 6-36). Based on the fact that 75% of the financing of all ODRs (excluding CMDT and Office du Niger) came from foreign sources in 1981, and that the ODRs accounted for one-sixth of all public debt expenditures in 1982, the SATEC study concluded that "everything happens as if a good many [agricultural] projects were directly managed by the

foreign sources of financing, government's role being limited to registering the [different official] conventions" (Ibid., 10). This statement clearly suggests that in spite of official statements about the alleged priority given to agricultural and food production through the different development plans, Mali had yet to define a clear agricultural growth strategy of its own, the actual strategy that still prevailed being in sum the result of a simple addition of different projects designed (in most cases), approved and funded by foreign donors.

Throughout the 1970s, the responsibility for agricultural development was shared by OPAM for output marketing, the Direction Nationale de l'Action Coopérative (DNACOOP) for the promotion of cooperative organization among farmers, SCAER for credit and input distribution, and ODRs for all other aspects related to agricultural production. The increasing food production gap reached a peak during the severe drought of early 1970s and continued unaltered thereafter. Donor pressure for strong institutional and policy reforms built up around concerns about the enormous budgetary deficits and public subsidies caused by the mismanagement of OPAM and the ODRs as well as the implicit consumer subsidization scheme imbedded in the official price schedules. As a result, SCAER was eliminated in 1980 and a critical evaluation of the ODRs in 1982 set the ground for major ongoing reforms of these organizations. They were henceforth to limit their activities to providing useful technical (extension) services to farmers in their respective zones, except for CMDT, which would continue to also provide marketing services for cotton.

Among all the recommended and implemented reforms, the Cereals Market Restructuring Program (PRMC by its French acronym) has received so much

2. These donors were the World Food Program (which acted as secretariat of the program), Austria, Belgium, Canada, The European Community, France, Great Britain, the Netherlands, the United States, and West Germany.

Gagnon 1986; Humphreys 1986; Gagnon 1987; Dioné and Dembélé 1987; Dioné and Staatz 1987; Haykin, Roth and Wilcock 1987; Sall 1987; Sivini 1987; Gagnon 1988; Staatz, Dioné and Dembélé 1988). These studies have clearly established that the cereals trade was gradually liberalized (in 1981/82 for coarse grains and 1986/87 for rice) and many new private merchants entered cereals trade since 1981, that OPAM's budget deficits were reduced thanks to a strong structural reform program and a strong financial assistance, and that official producer prices were progressively raised (although they did not achieve the initial targets). However, in the absence of empirical information on the structure of domestic cereals production and marketing, the PRMC was designed and most of its subsequent assessments were made on the basis of several implicit assumptions (Dioné and Staatz 1988; Staatz, Dioné and Dembélé 1988).³ These assumptions are spelled out in Chapter II.

Although all these assumptions (whether correct or incorrect) have important implications for food security in Mali, the previous studies on PRMC have only rarely addressed them in a systematic way, primarily because of the lack of policy-relevant micro-level data. Hence, these studies did not ask "What did or could the PRMC achieve with respect to food availability and food accessibility in Mali?" This dissertation is intended as an initial contribution to the debate on these central issues.

3. For instance, prior to 1985, no time series existed on producer prices or quantities transacted on the private market, which operated more or less clandestinely because of OPAM's legal monopoly. Nevertheless, the private market generally accounted for more than 80% of the total estimated marketed surplus of cereals before 1981. Bamako retail prices constituted the only time series available on private market consumer prices of cereals before the PRMC.

1.4. Definition and Dimensions of Food Security ²⁾ access to food through

The concept of food security emerged during the 1974 World Food Conference in Rome from fears of chronic food shortages and potential mass starvation following the rise of international grain prices and lagging food production in many low-income countries of Asia and Africa in the early 1970s (Siamwalla and Valdés 1984; Eicher and Staatz 1985, 1). Since then, food security concerns have evolved from a heavy concentration on aggregate supply issues (increasing domestic food production and constitution of international grain reserves) to include demand-side issues of purchasing power (Reutlinger and Selowski 1976) or entitlement (Sen 1981). There is presently a widespread consensus among scholars to define food security to include for both supply and demand considerations. Such definitions consider food security as "the ability of food-deficit countries, or regions or households within these countries, to meet target levels of consumption on a yearly basis" (Siamwalla and Valdés 1984, 190), or the "access by all people at all times to enough food for an active and healthy life" (World Bank 1986, 1). Consistent with an integrated view of supply-side and demand-side concerns, research carried out by Michigan State University on food security in Africa has evolved around the definition of food security 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 1987, 216).

This last definition clearly points to a double structural dimension of what Rukuni and Eicher (1987) call the "food security equation." Food security requires "(1) food availability through domestic production,

storage and/or trade [on the supply side] and, (2) access to food through home production, the market or food transfers [on the demand side]" (Rukuni and Eicher 1987, 8). In addition to supply (availability) and demand (entitlement) considerations, food security has also transitory and chronic dimensions (Eicher and Staatz 1985, 2-3). Transitory food insecurity results from short-run falls in food consumption, which may be caused by shortfalls in production in years of drought, flood, etc. or by temporary fluctuations in effective demand due to changes in income and/or prices. Chronic food insecurity--persistent lack of real income to assure an adequate diet--is at the core of economic development for most African countries with significant food production gaps, since food availability and food entitlement are closely inter-related for the majority of the population whose livelihood is predominantly determined by agricultural production. For these countries, the long-run solution resides in "creating food production and distribution systems that assure adequate access of the poor to food through income generation and an efficient supply system for food, either domestically produced or imported" (Ibid., 3).

3). Gaps between macro-level policies and micro-level issues (Eicher 1988)

Understood in this broad way, food security clearly has technological, institutional and policy dimensions. In a country such as Mali, where over two-thirds of the population lives primarily from low-productivity and near-subsistence agriculture, appropriate technical change to increase productivity in agricultural and food production is a strong precondition for long-term food security. Such technical progress requires, in turn, substantial and long-term investments in human capital formation, research, extension, and institution-building. "The ability

of farmers to move to new production frontiers through input-intensive production systems [further] depends critically on viable input and output markets" and credit distribution systems (Weber and Jayne 1988, 4). Finally, domestic as well as foreign macroeconomic policies have considerable effects on food security. For instance, foreign trade regulations (tariffs, subsidies, quotas, etc.) may affect significantly aggregate food availability and the income of the rural poor. Exchange rate distortions (overvaluation of domestic currency) may undercut domestic farmers' capacity to compete in the world market. Implicit and explicit taxation via official pricing and direct head taxes may reduce both farmers' willingness and capacity to invest in surplus food production. Subsidized interest rates, in the context of a liquidity shortage, lead to excess demand for credit and subsequent rationing of investment loans, often in favor of the richest segments of the farmer and trader population. Although this study focusses more on micro-level questions, it is fully acknowledged that, at the limit, a comprehensive food security debate may not proceed without a thorough examination of the linkages between macro-level policies and micro-level issues (Eicher 1988a, 27).

1.5. Dissertation Outline

The remainder of this dissertation is divided into six chapters. Chapter II summarizes the methods used to generate, organize, analyze and disseminate information from primary data collected at the level of rural markets, wholesale centers and a panel of farm households and private coarse grain wholesalers from 1985 to 1987. Chapter III presents the

overall conceptual framework that inspired the different analyses included in the study. Chapter IV analyzes farm households' coarse grain production and transactions, and the policy implications of these patterns of household behavior. Chapter V discusses major constraints to farmers' investment in improved production technologies, with an emphasis on the analysis of the process of farm households' investment and disinvestment in the single most important technical package presently available, i.e., animal traction. Chapter VI examines some of the main institutional constraints to increasing coarse grain surplus production and marketing, especially in relation to rural development agencies' interventions, credit and input distribution systems, output markets and the form and extent of farmer organization and participation in agricultural development management. Finally, Chapter VII summarizes the main findings of the study and their policy implications, and suggests areas of focus and methods for future research activities on food security in Mali.

Malian Commission Nationale de Suivi et d'Evaluation de la Strategie Alimentaire (CESA), the United States Agency for International Development (USAID), and Michigan State University (MSU). Within these institutions, the principal actors were the Technical Secretary of CESA, the manager of the Food Security in Africa Cooperative Agreement in the Africa Bureau and the Bureau of Science and Technology at USAID/Washington, the chief and the agricultural economist of the Developmental Development Office of the USAID mission in Bamako, and three village leaders of the Department

of Agricultural Economics of MSU (Dr. Michael T. Weber, Director of the Food Security Project; Dr. James D. Shaffer; and Dr. John Staatz, major back-stopping person for the Mali study).

CHAPTER II

METHODOLOGY

2.1. Background on the Organization of the Study

Within the general framework of the MSU/USAID Food Security in Africa Cooperative Agreement (USAID 1984a), the idea of the research project for Mali originated from and evolved around two central themes: the Malian Food Strategy and the Cereal Market Restructuring Program initiated in 1981.

2.1.1. Institutional links

The CESA-MSU Food Security Research Project was financially, administratively and technically linked to three main institutions: The Malian Commission Nationale de Suivi et d'Evaluation de la Stratégie Alimentaire (CESA), the United States Agency for International Development (USAID), and Michigan State University (MSU). Within these institutions, the principal actors were the Technical Secretary of CESA, the managers of the Food Security in Africa Cooperative Agreement in the Africa Bureau and the Bureau of Science and Technology of USAID/Washington, the chief and the agricultural economist of the Agricultural Development Office of the USAID mission in Bamako, and three faculty members of the Department

of Agricultural Economics of MSU (Dr. Michael T. Weber, Director of the Food Security Project; Dr. James D. Shaffer; and Dr. John Staatz, major back-stopping person for the Mali study).

A research proposal was drafted under the guidance of the MSU faculty members. Then refinement and approval of the main research objectives and terms of reference was reached through intensive interactions between the actors of the three institutions over the period of January through May 1985. The discussions during this preliminary phase were concentrated on trade-offs between a comprehensive, coarse grain subsector analysis and a more focussed study of some aspects of this subsector. The final consensus of the three parties called for a study of the interactive effects of macro-level policies, institutions and technology on farmers' and traders' capacity and willingness to invest in coarse grain production and marketing.

The research project was intended to help Mali develop its institutional capacity to monitor on-going policies related to food security. Consequently, the project was linked to the Technical Secretariat of the CESA (National Monitoring and Evaluation Commission of the Food Strategy of Mali), which has the mandate to coordinate all research activities related to the Food Strategy of Mali. To assume its coordination role, the Technical Secretariat of CESA acts through seven working groups focussing on (1) ecological zoning, (2) agricultural statistics, (3) research and development, (4) food processing, (5) marketing, (6) logistics, transportation and storage and (7) consumption, health and nutrition. Given the multi-dimensional nature of the CESA-MSU food security research agenda, the project could not be linked to a

single working group; it was therefore tied directly to the Planning and Evaluation Division of the Institute of Rural Economy (DPE/IER), which plays the role of Technical Secretariat of the CESA (ST/CESA) and was therefore designated to provide the overall administrative and legal sponsorship of the project. The ST/CESA represented the transmission link between the project and the Government of Mali, on behalf of which it approved research terms of reference, signed all official documents, participated directly in the implementation of the project by providing two full-time persons (an agronomist and an agricultural economist) to the field team, discussed all research outputs (working papers) and monitored project progress.

Throughout the design and implementation phases of the research, USAID was fully involved, not only in assuming the financial burden of all the activities, but also in providing feedback on the usefulness and the relevance of on-going analyses and findings in relation to the main issues examined. The liaison with the USAID mission in Bamako was achieved through the USAID/ADO agricultural economist, who played an active and interactive role in ensuring that research outputs dealt specifically with the issues and became available in a timely fashion not only to the USAID mission, but also to all donors participating in the cereals market reform effort.

The field project was administratively and technically linked to the Department of Agricultural Economics of MSU. The three faculty members involved took an active role in shaping the initial design of the project, negotiating both field activity funding with USAID and the Memorandum of Agreement between the three parties, and planning the implementation of

field activities. Following this initial design and planning phase, quarterly field visits of Dr. Staatz ensured the proper technical backstopping through periodic monitoring and reshaping of all survey and analysis work underway. In addition, MSU faculty members participated directly in the production of finished or semi-finished research outputs by providing guidance for useful working papers, by reviewing these papers or by co-authoring them.

2.1.2. Project staffing

The field research team of 14 persons was made up entirely of Malians. In addition to the principal investigator (author of this dissertation), a Malian applied economics M.A. candidate at the University of Michigan (Ann Arbor) worked in the design and analysis unit during the first year of field data collection. The supervisory body of the project also included two full-time research associates of ST/CESA as well as a full-time junior agricultural economist in charge of the day-to-day supervision of all field data collection in the CMDT zone. The support personnel comprised a bilingual secretary trained in word processing and data entry by the project, and a professional car driver.

Field data collection was achieved by a total of seven enumerators. Each rural market and the sample producers of its surrounding villages were covered by one person. A full-time enumerator conducted the wholesaler interviews in Koutiala, Sikasso and Mopti, while two part-time enumerators shared the trader sample in Bamako. The field activity supervisor for the CMDT zone, the project support personnel and the

enumerators were all selected jointly by the ST/CESA and the principal investigator, and hired and paid by the ST/CESA.

2.2. Hypotheses Underlying Proposed Policy Changes

Perceived as the centerpiece of the Malian Food Strategy by many members of the food aid community and implicitly accepted as such by several officials of the Government of Mali, the Cereals Market Restructuring Program (PRMC) ultimately sought an increase in domestic foodgrain production as a response to producer price incentives and a freer market. This view was based on the over-riding conclusion of most of the past studies on cereal marketing in Mali (CRED, 1976; de Meel, 1978) that depressed official prices to protect urban consumers were the primary reason for the stagnation or the decline of agricultural production in Mali during the late 1960s and the 1970s. The PRMC was therefore launched on the basis of several implicit assumptions made by both the donors and the Government of Mali about how the cereals subsector functioned, with very little information on the structure of production and marketing. Six major assumptions constituted the pillars of the policy reforms implemented between 1981 and 1987 (Dioné and Staatz, 1988).

2.2.1. Official prices matter

The main ingredient to raise farm-level incentives to produce more cereals was perceived to be an increase in producer prices. This goal was to be achieved through a gradual increase in official producer prices, assuming that (a) actual prices received by farmers were highly correlated

with official prices and (b) farmers' production decisions were primarily based on commercial considerations.

2.2.2. Farmers are net sellers

Therefore, higher official prices would contribute to uniformly increase farmers' incomes and correct the negative aspects of the previous price policy which, it was believed, taxed farmers to the benefit of urban consumers.

2.2.3. Farmers have a high marginal propensity to invest in cereals production

Hence, by virtue of the previous two assumptions, an increase in official producer prices would automatically induce higher investment in foodgrain production.

2.2.4. Private traders are ready to seize the opportunities opened up by market liberalization

The only major constraint preventing private traders to play an active role in grain marketing was perceived to be the anti-merchant policies previously implemented by the state. The PRMC designers therefore believed that the suppression of OPAM's monopoly and liberalization of cereal trade would suffice to bring the private sector to perform efficiently the marketing functions abandoned by the state.

2.2.5. OPAM (the cereals marketing parastatal) should continue to exist

Although PRMC designers were unanimously concerned with the removal of OPAM's monopolistic marketing roles, none of them questioned the

existence of the parastatal per se. This reflected donors' need to have a Malian institution through which they could channel food aid and recognition of the political necessity of protecting OPAM's privileged clientele from higher grain prices.¹

2.2.6. Mali would continue to experience cereal deficits

This assumption was the cornerstone of both official price and food aid components of the policy reform package, because it implies that (a) official prices, if not raised, would always lie below market prices and therefore, inhibit production incentives and (b) food aid would continue to be an appropriate mechanism to fund the reforms.

2.3. Subhypotheses Regarding Factors Affecting Farmers and Traders' Ability to Respond to the Policy Reforms

It is of utmost importance, when predicting the outcome of a given policy, to understand the main determinants of the strategic behavior of the target population. This behavior results from the interactive forces of environmental conditions, institutional factors, technological conditions and existing policy variables within which individual decisions are made. The rationality of any behavior simply cannot be understood outside of these factors, which affect both individual resource endowments and uses. Hence, even in the absence of data prior to a given policy change, it is still possible to infer its likely outcomes from a behavioral analysis which helps to pinpoint why people do what they

1. Policy changes in January 1988 have resulted in OPAM abandoning much of its previous clientele, who are now forced to face market prices.

presently do and what they will likely do if any current factor should change in a given direction.

To carry out such an analysis, this research started with the basic assumptions undergirding the proposed policy reforms being examined and derived researchable subhypotheses related to a set of environmental, institutional, technological and policy factors that were considered most likely to affect the ability of farmers and traders to respond to the policy reforms.

2.3.1. Subhypotheses on factors affecting farmers' ability to respond

In contrast to a model of uniform farmer behavior, this research was designed on the basic assumption that farmers' ability to respond to the marketing and price policy reforms launched under the PRMC was significantly affected by:

(a) The environmental constraints (particularly rainfall) of the areas (zones) in which they live. In a highly uncertain world such as the Sahel, it would be logical to believe that farmers have learned from their experience of past droughts to develop and adopt risk-management strategies for their own family food security. These strategies will depend, to a large extent, on the magnitude of the risk perceived by farmers in different rainfall subzones. We hypothesized that farmers in the least vulnerable rainfall subzones had higher per capita production levels in a less uncertain environment, a more commercial orientation regarding coarse grains, and were therefore more price-responsive than those in subzones with lower and more irregular rainfall. At the limit, the first group would perceive the cereal market as an income-generating

device while the latter, in contrast, would consider it as a source of supply and expenditure. In other words, on the average, farmers in high rainfall subzones are likely to be on the supply side of the foodgrain market while those in low rainfall areas will be on the demand side of the foodgrain market.

(b) Their access to production resources including land, labor and particularly capital. In order to respond to any cereal price incentives or market access improvement policy, farmers need to be in a situation where they can invest more in grain production either by bringing idle resources into use or by shifting some resources from their current uses to cereal production. In a country such as Mali where land is believed to be a relatively abundant factor (Club du Sahel, 1983), the main constraining resources, given current crop varieties, are capital and labor available during the cropping (rainy) season. Moreover, capital in the form of animal traction equipment and draft animals (the major capital inputs in dryland cereal production in Mali) can substitute for labor to a large extent and therefore contribute to shifting out the production possibility frontier. In the absence of a major land constraint, we hypothesized that a relatively small proportion of farmers with the best capital endowment (draft equipment and animals) produce the bulk of the marketed surplus of coarse grains and currently had the capacity to respond to potential cereals price incentives.

(c) The institutional context of their production. Institutions play an important role in affecting farmers' access to both input and product markets as well as services such as credit and information. Two broad categories of institutions must be taken into account. First, public or

parastatal agencies administering rural development programs are involved, to a large extent, in determining production techniques through their extension networks, in setting the rules for access to input markets and formal credit, and, to a lesser extent, in performing direct product marketing functions. Hence, their conduct affects both farmers' investment possibilities and perceptions of market opportunities. Second, farmers' own organizations at the village level (cooperative associations) alter farmers' access to input, credit and product markets, and subsequently their behavior and strategies in response to price and marketing policy reforms. We therefore hypothesized that farmers in zones with good institutional support services (such as CMDT) were more market-oriented and significantly more capable of responding to price incentives than those in poor institutional environments (e.g., OHV).²

(d) Their access to alternative income sources. Cereals production is only one income-generating activity that Malian farmers may undertake. In addition to foodgrain production, farmers face a wide range of other income opportunities including (depending on the zone), cash crop production (cotton, peanuts, tobacco), livestock production, cottage industry, small trade, and off-farm employment. All these activities, along with cereal production, have among themselves complementarity and substitutability relationships which shape farmers' market and investment strategies. It may therefore be that investments in cereals production are made with income generated mainly by other activities or, conversely,

2. OHV stands for Opération Haute Vallée. The acronym is used to indicate the public-sector agency in charge of rural development management in the upper valley of the Niger River or the agricultural zone covered by this agency.

that cereal income be reinvested in more profitable activities than cereal production. Most important, farmers' strategies in an uncertain environment will likely use a combination of all these activities in order to achieve the highest level of family food security while meeting other basic income needs such as tax payments, health care, social liabilities, etc. These arguments underlie the hypothesis that farmers capacity and willingness to respond to cereals market incentives increases with the extent of their involvement in cash-crop production and major non-farm activities.

(e) Constraints imposed by policies other than those related to marketing and prices: Policies applying to one aspect or the other of the foodgrain subsector do not stand by themselves. They interact to determine the resulting behavioral patterns of the subsector participants. For instance, expectations from market liberalization and price support policies may be jeopardized by adverse effects of fiscal (tax) and credit policies. Hence, analyzing market-related policies in isolation will not enable one to predict farmers' responses when some of the major policy-related constraints to which their objective function is subject are ignored. It is therefore hypothesized that farmers' response to cereals market-related policies is significantly constrained by fiscal and credit policies.

2.3.2. Subhypotheses on factors affecting traders' ability to respond

Cereals market and price policy reforms of the early 1980s were initially designed on the assumption that the removal of the anti-merchant policies of the state would be sufficient to induce rapid investment by

traders in expanding their operations.³ In contrast, this research was based on the assumption that traders' capacity and willingness to respond to the proposed policy changes are affected by several other factors including:

(a) Traders' perceptions on the permanence of the proposed policies. Malian traders have learned from experience that policies regulating their activities are by no means immutable. The focus of these policies has often shifted from a heavy control by foreigners during the colonial era to attempts at liberalization and outright state monopoly over major trading operations since the country's independence in 1960. We therefore hypothesized that merchants would be very cautious and reluctant to undertake significant investment in relatively fixed grain marketing assets (such as warehouses) in the short run, in spite of the official liberalization of cereals trading.

(b) Traders' perceptions of, and attitudes toward, the risks involved in grain trade. Private grain trade in Mali is by no means risk-free. Traders always face risks linked to uncertainties about both the supply and demand. For instance, the level of rainfall during a given year may induce drastic price changes within a period of a few months or even a few weeks and food aid or grain from public sources may be dumped on the market without any prior notice and bring about sharp drops in price levels from one day to the next. Above all, the thinness of the domestic grain market causes wide price fluctuations in short periods of time, mainly due to a lack of effective demand and the wide swings in

3. The PRMC later recognized that there were other barriers to traders' responding to the liberalization, and created, during the final year of its initial phase (1987), a credit program for cereal wholesalers.

marketed surplus, which is only a small proportion (15-20%) of total production. In such an uncertain environment, it is very likely that traders will adopt investment and operational strategies to cope with the magnitude of risk they perceive.

As an illustration, a major feature of almost all private trading businesses in Mali is the variety of commodities handled in any given year. The great flexibility of traders to shift from one commodity to another almost on a daily basis is even one of the reasons why the state has always perceived merchants simply as opportunistic and selfish agents seeking only their profit at the expense of both producers and consumers. But such a mode of operations is a risk-management strategy, which enables most traders to make cross-compensations of their losses and gains in seeking at least a break-even position through time.

Contrary to the view that traders (just as farmers) may be treated as a uniform group of economic operators, one would expect the existence of a learning process that differentiate merchants' behavior in the cereal trade. It therefore seems safe to assume that traders who operated clandestinely before the market policy reforms are more risk-takers than those who entered in the business only when private trading became legal. This difference in attitudes towards the risks involved in foodgrain trading may in turn affect traders' investment and operating strategies under the new policies.

On the basis of the above assumptions, we hypothesized that, despite cereals market liberalization, private traders would not rush to undertake investments required for a full specialization in coarse grain trading,

mainly because of uncertainties about policies and both domestic supply and demand.

(c) Traders' access to resources, particularly to formal financial sources. In a developing country such as Mali, the severe shortage of capital is one of the main constraints to investment. The lack of adequate access to formal financing through the banking system increases the impact of this constraint by raising the demand for informal credit and thus placing a very high opportunity cost on any activity involving capital immobilization. Under these circumstances, one would expect traders to avoid an investment strategy calling for a slow turnover of their capital such as holding significant stocks of traded commodities over relatively long periods of time, unless returns were extremely high. Moreover, the combination of the high opportunity cost of capital and the high risk linked to price uncertainties resulting from unforeseen fluctuations of the supply of foodgrains might make it unprofitable to invest significantly in long-term cereal storage. Because of financial market imperfections (poor access to financing and high opportunity cost of capital), we hypothesized that private traders had neither the capacity nor the willingness to undertake large-scale coarse grain marketing functions such as storage over relatively long periods of time.

2.4. Using Natural Experiments to Test the Subhypotheses.

Quasi-experimental designs are often used by social scientists to investigate the effects of a defined set of factors on people's behavior and strategies. Unlike pure experiment designs where factors and their levels are controlled for the different experimental units, the social

scientist may identify natural experimental units according to a set of defined factors and factor levels to which they are subjected in real life and which are assumed to bring about variable responses of the observed units (Campbell and Stanley, 1963). Hence, the major difference between such a natural design and pure experiments is that the investigator has no control over the factors and treatments, nor can he reallocate the experimental units from how they are naturally distributed in the population. This also constitutes one of the main limits of the application of quasi-experimental design to investigate human behavior, since the lack of control over experimental units, factors and treatments may limit the researcher's ability to reach strong conclusions about the pure response of the subjects to a given level of any single factor. Nevertheless, the method may enable one to establish the direction of experimental subjects' responses to major factors, even though the observed magnitude of these responses may incorporate the effects of other secondary factors not accounted for in a small sample which offers a limited number of degrees of freedom.

2.4.1. Selection of commodities

From the start, the research focus was limited to coarse grains (millet, sorghum and maize) for two main reasons (Dioné, 1985). First, coarse grains have an overwhelming importance in the agricultural and food economy of Mali. During the seven years (1978 to 1984) preceding this study, coarse grains accounted, on average, for 92% of the total area cultivated in cereals, 91% of the total domestic cereal production and 82% of the total food grain availability. Moreover, during the same period,

the domestic production of coarse grains represented 78% of the total cereal availability, including all commercial imports and food aid (OSCE, 1986). Second, the proposed price and market policy reforms were implemented only for coarse grains in 1984. Their potential impacts could not be examined for rice which, despite the lower magnitude of its production as compared with coarse grains, is perceived to bear a very high strategic value in the Malian food strategy.

2.4.2. Selection of the zones

The sampling design of the research proceeds from the assumption that the probability of learning anything of significant policy value about farmers' and traders' potential responses to market and pricing policy reforms is higher in those regions of Mali with the highest potential for producing marketable surpluses of cereals. As a result, the spatial focus of the study was limited to the southern zones of the country, where annual rainfall ranges from about 600 to 1000 mm in average years (Dioné, 1985).

An examination of regional per capita coarse grain production as an indicator of potential marketable surplus shows that, over the ten-year period of 1975 to 1984, only three of the six administrative regions of Mali had excess production in a good year. The region of Ségou had an average annual per capita production of 287 kg and a maximum of 420 kg in 1975; the region of Sikasso had an average of 189 kg per capita and a maximum of 320 kg in 1983; and the region of Koulikoro produced an average of 147 kg per capita and a maximum of 210 kg in 1977 and 1984. Not surprisingly, these 3 regions also accounted for 72% of the total coarse

grain production and up to 85% of the total maize production over the 10 years considered (OSCE, 1986).

Although it has the highest percentage of domestic coarse grain production (35% from 1975 to 1984) and the highest per capita coarse grain production (287 kg), the region of Ségou was not selected mainly because of the lack of variety in the commodities it produces. Indeed, 98% of the region's coarse grains are millet (mainly) and sorghum; only 2% is maize. Most maize is grown in the regions of Sikasso (64% of the national production) and Koulikoro (15%). Therefore, the region of Ségou appeared not to be an appropriate research zone if differences in farmers' market strategies for different coarse grains were to be taken into account.

Furthermore, the regions of Sikasso and Koulikoro were better suited for investigation of the effects of different institutional environments on farmers' behavior. They both share similar endowments in natural resources (land and rainfall particularly), and they are, to some extent, both well connected to national coarse grain market channels through a network of all-season roads. However, there is a major difference between the two regions because their rural development programs are managed by two different institutions: the Compagnie Malienne de Développement des Textiles (CMDT) for the region of Sikasso, and the Opération Haute Vallée (OHV) for the region of Koulikoro.

Major differences between these two rural development agencies, hypothetically, may underlie the gap between the agricultural performance of the two zones that they cover. As a rural development institution, CMDT, which operated as the Compagnie Française de Développement des Fibres Textiles (CFDT) prior to Mali's independence (1960), is much older

and is therefore more experienced in managing agricultural projects than is OHV, which was created in 1964. In 1982, CMDT was actively involved in 36 rural development activities against 27 activities for OHV (SATEC, 1982).

Besides this difference in the number of activities of their rural development program, CMDT's performance in implementing its program is, in many respects, far better than OHV's. First, by transferring some of its marketing functions (assembly and primary transport) to village communities, CMDT was able to induce a higher participation of farmers in more of its rural development activities than would otherwise follow the top-down implementation pattern followed commonly in Mali. Second, the extension efforts of CMDT to promote crop production are generally accompanied by parallel efforts to guarantee outlets for the products (e.g., the maize development project). Third, through its links with the French CFDT, CMDT is tied into an international research program for its major cash crop (cotton) as well as international marketing channels for it. OHV lacks such links. Fourth, thanks to the same linkages with CFDT, CMDT enjoys a stronger financial credibility, which results in better access to the banking system to fund its activities. After the dismantling of the agricultural credit and rural equipment parastatal (SCAER) in 1980, CMDT became the only rural development agency capable of supplying all other rainfed zone rural development operations with purchased farm inputs and implements. Finally, through its equipment maintenance and credit policy, CMDT is also the only rural development institution able to maintain an acceptable rate of replacement of farmers'

equipment (10 to 15% per year) as compared with virtually no replacement in the OHV zone (SATEC, 1982, 39).

As a result, an estimated 75% of the CMDT farms have animal traction equipment against only 43% in OHV. In spite of very similar population densities of the two regions (about 15 inhabitants per square kilometer), the estimated area cultivated by an active worker is 56% higher in CMDT (1.0 hectare) than OHV (0.6 hectare) (SATEC, 1982). Furthermore, average yields for the combined coarse grains (millet, sorghum and maize) for the period 1978 to 1984 were 15% higher in the region of Sikasso (CMDT) than Koulikoro (OHV) according to the data of the National Direction of Statistics. Although mineral fertilizers are not often applied directly to cereals in Mali (except maize), differences in coarse grain yields between similar agroclimatic zones can be partly attributed to the residual effect of cotton fertilizers on coarse grains grown in rotation with cotton. Therefore, the superiority of yields in CMDT is related to this zone having the highest share of the total fertilizer use in dryland agriculture. With 37% of the total cultivated area (DNSI, 1984), CMDT accounted for 87% of the total quantity of fertilizer used in dryland cropping from 1979 to 1983 (O.S.C.E, 1986), while OHV, with 7% of the total surface used only 6% of the total amount of dryland fertilizers. In other words, the average rate of fertilizer use in CMDT is about 2.9 times that in OHV.

Because of its success, CMDT has become the model for rural development operations (ODRs) in Mali. Therefore, the examination of the reasons for CMDT's success relative to another rural development institution such as OHV, helps address the question of whether it is

possible to replicate the CMDT model elsewhere in the country. Hence, CMDT and OHV were selected to reflect the impact of the institutional environment on farmer behavior and strategies towards coarse grain production and transactions.⁴

2.4.3. Selection of subzones and rural markets

Farmers of a given rural development zone may be viewed as a homogenous population as far as institutional factors are concerned. Yet their strategies will likely vary depending on differences in rainfall which, to a large extent, constitutes the dominant determinant of yields and of total and per capita foodgrain production in rainfed agricultural zones. Both the CMDT and the OHV zones share average annual rainfalls ranging from about 1450 millimeters in the south to some 600 millimeters in the north. Secondary data showed that per capita production of coarse grain can be as much as 75% higher in the south than the north of CMDT (SATEC, 1982; Club du Sahel, 1983). Likewise, average per capita coarse grain production for the 1981-1984 period was about 70% higher in the south than the north of OHV (OHV, 1985).

In addition to their greater levels of foodgrain production, farmers of the southern subzones have access to land and rainfall suitable for cotton, the main cash crop of Mali. In 1983 for instance, 74% of all cotton produced in the country was grown in the south of CMDT, 25% in north CMDT and 1% in the south of OHV (DNSI, 1984).

4. See Appendix I for more detail on agro-ecological conditions in CMDT and OHV.

To take into account the impact of rainfall on farmers' foodgrain production and transactions, two subzones, one in the north and one in the south, were selected in each of the two zones. Because of its large size, the CMDT zone is administratively subdivided into regions. Each of these administrative regions and the entire area of OHV are in turn subdivided into administrative subunits called rural expansion zones (ZERs). A ZER comprises a number of "base sectors" (SBs), each containing several villages. In the OHV zone as well as the Koutiala region of CMDT, two sectors were purposively selected on the basis of both rainfall and the importance of coarse grains in the crop mix grown. This selection ensured not only a certain degree of control for rainfall variations, but also that only sub-areas with significant coarse grain production were retained. In this respect, the most southern sectors of the two zones were discarded because of the relative importance of root crops and tubers in their production structure, thanks to higher rainfall levels (1100 to 1400 mm per year).

Based on information obtained from the Land Resource Inventory Project (PIRT), the purposive selection of the study subzones also ensured that not only rainfall, but also soil types were controlled across zones. As a result, the southern subzones were located in the 1000 millimeter rainfall areas, and the northern ones in the 700 millimeter rainfall band of each zone. More specifically, these were the sectors of Koutiala in the south and Bla in the north of CMDT, and the sectors of Ouélessébougou in the south and Koulikoro in the north of OHV.

The ultimate selection of the precise survey points (ZERs) was based on the location of a major coarse grain rural market, around which

villages could be chosen, to some extent, for their market access. The four major markets and their related ZERs selected were Zangasso (market and ZER) in south CMDT, Dougouolo (market and ZER) in north CMDT, Ouélessébougou (and ZERs of Ouélessébougou and Sougoula) in south OHV, and Sirakorola (ZERs of Sirakorola and Tougouni) in north OHV (see Figure 2.1). An examination of rainfall data for the 13 out of 22 years (1961 to 1982) for which complete data existed for all four subzones shows average annual rainfalls of 967 millimeters and a coefficient of variation of 17.7% for Zangasso as compared with 1013 millimeters and a coefficient of variation of 15.6% for Ouélessébougou in the south, and 701 millimeters and a coefficient of variation of 15.8% for Bla, compared with 692 millimeters and a coefficient of variation of 18% for Banamaba (in the vicinity of Sirakorola) in the north.

2.4.4. Selection of villages

Village selection proved to be the most difficult part of the sampling design, since one would logically want to take into account the degree of access to both input and output markets in dealing with farmers' production and transaction behavior or strategies. But market access depends on a complex set of factors including, among others, distance, the existence and the state of roads, the presence of assemblers visiting or based in the village, the degree of linkage to extension networks, and the existence and the dynamism of village-level farmers' organizations. Accounting for each of these factors separately would have led to the selection of a number of villages and a farmer sample size too large for the survey resources available. Therefore, a pragmatic trade-off was

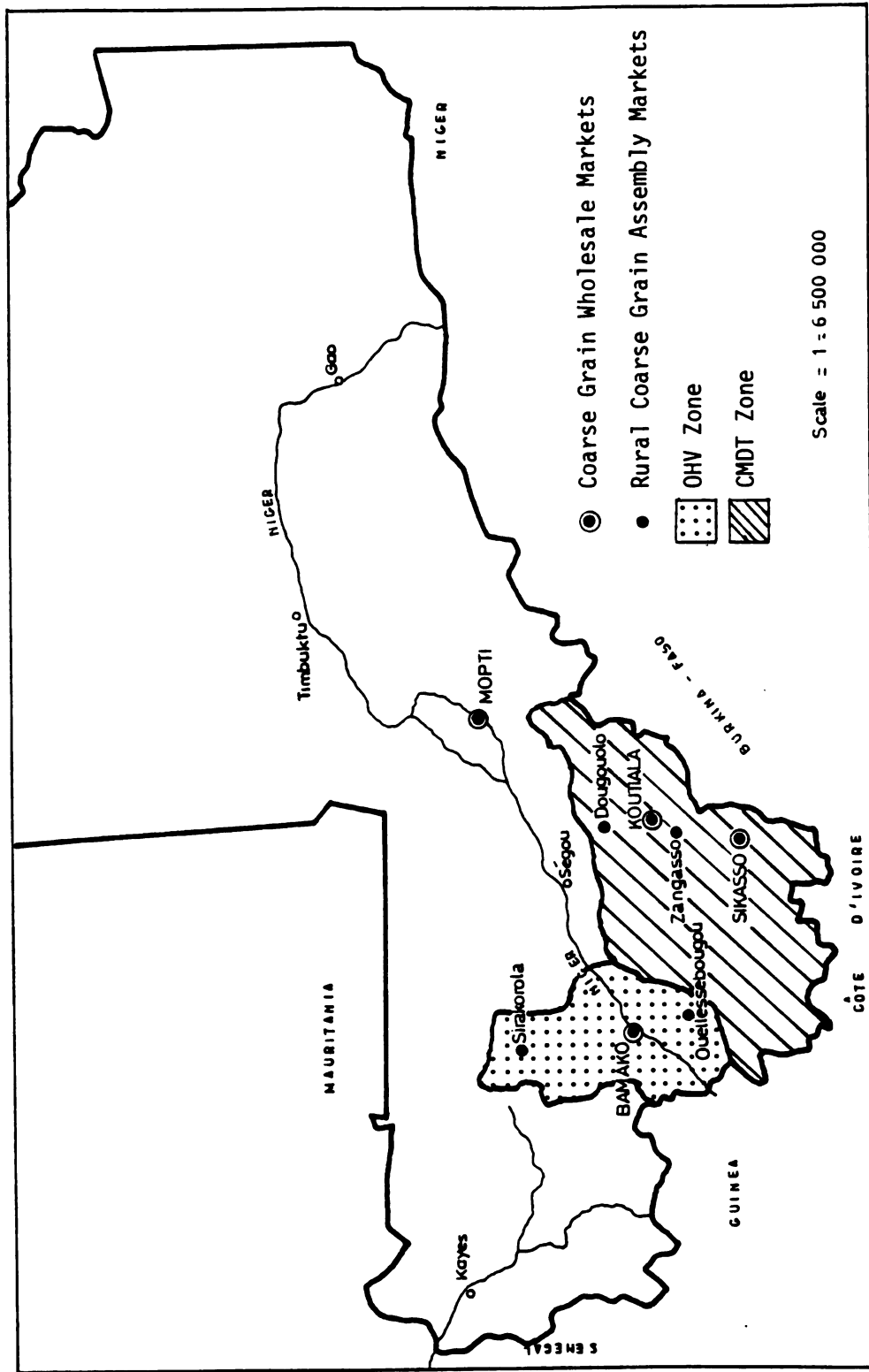


Figure 2-1. Republic of Mali: CESA-MSU Survey Sites

made by which a limited set of combinations of three of the most important factors (distance, extension services and village-level associations) were considered.

As a result, four villages were selected in each subzone. The first was the market village itself, which was assumed to have the best access to the market because of a zero-distance, permanent presence of a ZER extension office, and the existence of a village association officially approved for agricultural input and credit distribution as well as product assembly. The village association criterion could not be respected in OHV, where very few villages had officially approved associations in 1985, and none of the villages with approved associations were the main coarse grain markets of the subzones covered.

The second and third villages of each subzone were chosen close (within a radius of 12 kilometers) to the market village. They differed, however, in that the second had a permanently based extension agent (and an approved village association in CMDT), while the third did not. Finally, the fourth village was the most remote from the market (at least 15 kilometers) and the residence of an extension agent. Therefore, no pure case of worst market access (long distance, no extension agent and no farmer association) was included, partly because of survey resource limitations. In addition, it was assumed (based on preliminary reconnaissance surveys) that variations in distances not exceeding 20 kilometers would have a lower effect than the presence or absence of an extension agent and a village association on farmers' behavior towards production and marketing. This was felt to be particularly true in CMDT and OHV, where all villages are relatively well connected to the major

markets via secondary markets, frequent visits of mobile merchants, and the best rural road networks of the country.

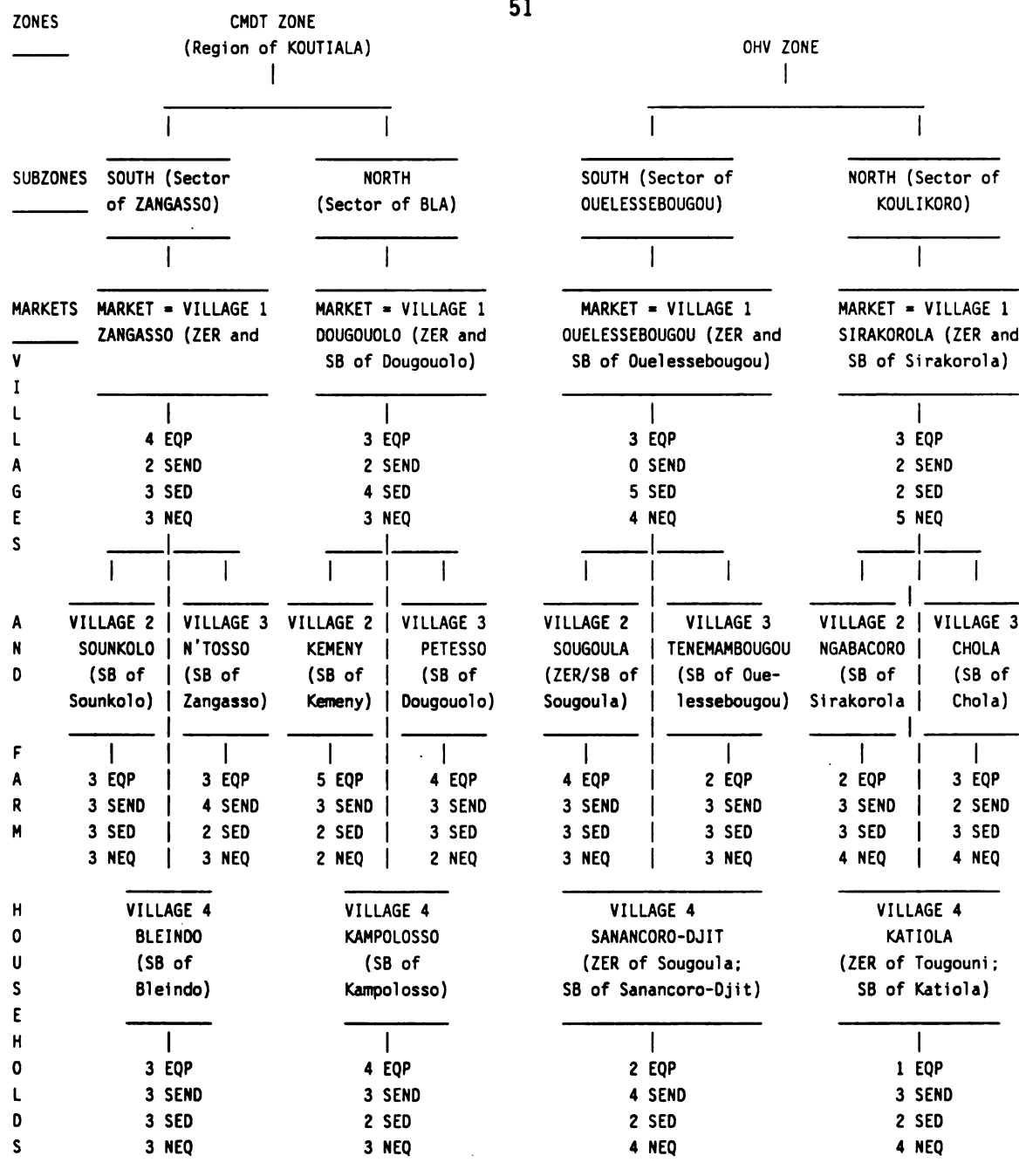
2.4.5. Selection of sample farmers

The selection of the 16 villages (4 in each of the subzones) was followed by a census of all their farm households in order to identify and use stratification variables relevant to farmers' foodgrain strategies. Details on this census are presented in part 2.5. The result of this procedure was the drawing of approximately equal sized sub-samples of farms with different levels of animal traction equipment (fully-equipped, semi-equipped and non-equipped) from each of the selected villages.

In summary, a total of 190 farm units were sampled according to their level of animal traction equipment (technological factors) from 16 villages distributed around four major rural markets (market access factors), one in each of the southern and northern subzones (natural environment factors) of two agricultural development zones (institutional factors), as depicted in figure 2.2.

2.4.6. Selection of wholesale centers and wholesalers

In order to understand farmers' behavior towards the local coarse grain assembly markets better, the major urban wholesale centers to which the selected rural markets are ultimately connected were included in the study. Based on a preliminary analysis of national cereal market channels and integration (Dioné and Dembélé 1986a), four cereal trading cities were selected: Sikasso and Koutiala (both in south CMDT), which constituted the main exit points of coarse grain surplus production of the CMDT zone;



Note: ZER = Rural (development) Expansion Zone; SB = Rural development Base Sector; EQP = Equipped farm household (owning plowing, weeding and transportation equipment and animals); SEND = Non-food-deficit semi-equipped households (lacking part of the draft equipment or animals); SED = Food-deficit semi-equipped households (lacking part of the draft equipment and/or animals); NEQ = Non-equipped farm households (owning no draft equipment)

Figure 2-2. Diagram of the Farm Household Sample Structure

Bamako, the national capital, which drains marketed surpluses of both the CMDT and the OHV zones; and Mopti, for its strategic position as both the most important client of coarse grains from CMDT and the dispatching point of cereals marketed in the most northern and chronically deficit regions of the country (Gao and Tombouctou).

As with the farm-unit sampling, a census of all coarse grain wholesalers was conducted in the four cities. Except for Bamako, where a sample of 30 out of a total of 43 was retained, the total population of coarse grain wholesalers of each city was covered. Details on the characteristics of the trader sample are presented in part 2.5 on the presentation and analysis of the preliminary census data.

2.5. Identification of Farmer and Trader Stratification Variables through the Generation and Analysis of Census Data.

Because of the lack of detailed and reliable data on the basic characteristics (size, production techniques, resource endowments, output levels, etc.) of the individual farms and traders of the selected villages and cities, no appropriate stratification could be applied beforehand. To cope with this problem and the lack of a sampling frame that could be used to draw an appropriate sample, a census of all farm units and wholesalers was carried out, using a set of questionnaires (Producer No. I and Trader No. I, Appendix III).

2.5.1. Farm census

The farm-level census conducted in October and November 1985, covered a total of 990 farm households in the 16 villages retained for the study. The farm household was defined as a group of persons related by kinship,

residing in the same community (village) and owning or entitled to use a set of agricultural resources (land, labor and capital) managed according to the decisions of one person known as the head of household (chef d'exploitation). The household may include more than one nuclear family (couple and dependent relatives). Although the collective use of resources is characteristic of the farm household, individual uses of part of the resources (e.g., individual fields) are often allowed. Household decision making is a very complex process, because different resources are often controlled by different family members for different realms of activity. Although we tried to capture some of the complexity, part of it obviously escaped us. In general, the head of household stands as the chief person responsible for the social and economic welfare of the household before the community. All household members are generally registered in a family book established by the local administration and held by the head of household for virtually all official purposes (population census, head tax collection, public education, health services, etc.). The main objective of the farm-level census was to collect information on a set of farm characteristics which would be indicative of the farm household's position vis a vis coarse grain production and marketing. Nine broad categories of such characteristics were covered:

- a) Social features, including the type of family (nuclear or extended), field ownership (collective and/or individual), the age and sex of the head of the household and the ethnic group of the family;

- b) Farm size according to village ranking (small, medium or large), number of active agricultural workers and total household population during the 1985 cropping season;
- c) Off-farm activities practiced, and migration;
- d) Equipment and draft animal renting and possession, particularly with respect to animal traction;
- e) Farm access to formal credit over the past recent five years;
- f) The mix of crops grown in 1984;
- g) A rough estimate of the proportion (zero, less than half, half, more than half) of agricultural production sold in 1984/85;
- h) Access to land, as indicated by the extension of cultivated land over the past five years, the possession of fallow land and farmers' perceived possibilities for further extensification; and
- i) Farm household food status as perceived by the agricultural extension agent covering the village.

The field-level extension personnel of the rural development agencies (CMDT and OHV) were contracted to conduct the census because of their personal knowledge of the farm households with whom all of them have lived in close relation for more than five years. Therefore, although the field extension agent's perception of farm household's food status might seem subjective, it was given an important weight in the identification of stratification variables, because within the Malian context, five years of close contact should suffice to enable one to rank objectively village

families with respect to their habitual food status (excess producer, self-sufficient and food deficit).⁵

The analysis of the census data focussed on the relationships between the major structural characteristics of the farm households and their position vis a vis food self-sufficiency and agricultural commodity markets, as well as the correlations among the structural variables themselves. The most relevant of these correlations are summarized in Table 2-1. Some potential stratification variables such as the practice of off-farm activities and the availability of land for extensification were dropped because of the low level of their correlation with factors other than the zone and the subzone, which were already taken into account during the first stage of the survey design.

In general, all the estimated correlation coefficients are low; beside the correlations between household type, size and demographic characteristics, all the coefficients (except for cash crop sales and access to formal credit) are less than 0.50. This is not surprising given the rough nature of the proxies (most of which are categorical, not continuous variables) considered during the reconnaissance census. However, both the correct signs and the statistical significance of the correlation coefficients provide an indication of some of the household's characteristics most likely to be related to its food status and position with regard to agricultural output markets.

The possession of farming equipment turned out to be strongly correlated with farm coarse-grain and cash crop sales and farm

5. The farm household's food status was not based solely on own-farm production; it included purchases as well.

Table 2-1. Coefficients of Correlation between Farm Census Variables.

	FTYPE	FSIZE	WORK	POPUL	RENTEQ	POSEQ	CRED	SLCER	SLCASH	FSTAT
FTYPE	1.00									
FSIZE	0.68	1.00								
WORK	0.47	0.51	1.00							
POPUL	0.58	0.68	0.69	1.00						
RENTEQ	-0.22	-0.24	--	--	1.00					
POSEQ	0.37	0.37	0.27	0.30	-0.37	1.00				
CRED	--	--	--	--	--	0.30	1.00			
SLCER	--	--	--	--	--	--	0.33	1.00		
SLCASH	--	--	--	--	--	0.33	0.72	0.33	1.00	
FSTAT	0.22	0.29	--	0.20	-0.28	0.38	0.33	0.27	0.36	1.00

Note: Only correlation coefficients of 0.2 or greater are reported. All coefficients shown are significantly different from 0 at the 1% level with a minimum number of 942 pairwise observations.

The following codes were used for:

FTYPE (Family type): 0 = nuclear; 1 = extended.

FSIZE (Farm size): 1 = small; 2 = medium; 3 = large.

WORK = Number of family workers in farming in 1985.

POPUL = Number of persons living in the farm household in 1985.

RENTEQ (Animal traction equipment renting): 0 = no; 1 = yes.

POSEQ (Animal traction equipment possession): 0 = no; 1 = yes.

CRED (Access to formal credit in past 5 years): 0 = no; 1 = yes.

SLCER (Cereal Sales in 1984/85): 0 = no; 1 = yes.

SLCASH (Cash Crop Sales in 1984/85): 0 = no; 1 = yes.

FSTAT (Food Status): 0 = deficient; 1 = non-deficient.

household's food status. Sales were also related to access to credit (coefficients of 0.33 for cereals and 0.72 for cash crops). However, credit access was not taken as a stratification variable for two reasons. First, credit is simply an instrumental variable that improves access to farm equipment and other inputs, which are the direct cause of higher production. Second, possession of animal traction is an easily observable indicator which, for food security purposes, could be used by others in subsequent studies, because it is easier to measure than access to credit. To a large extent, formal credit for all farm inputs is extended on the basis of cash crop (particularly cotton) production, which has always been promoted through highly purposive and targeted agricultural development projects and extension networks. One may even suspect that the correlation between farm equipment and access to formal credit (0.36) is under-estimated when measured with the simple binary variables used in the census. In fact, the relation between the actual amount of credit obtained and the mix of equipment owned by the farm is probably very high.

Finally, the fact that equipment possession was the single variable most related to almost all other farm characteristics (family type, farm size, number of workers, population, renting of equipment, sales and food status) was a key determinant in selecting animal traction equipment owned as a major stratification factor. Given that the mix of draft equipment and animals and its subsequent effects on agricultural productivity may vary from one farm to the next, a second step was undertaken to define farm household strata not only on the basis of the mere possession of equipment, but in terms of meaningful combinations of equipment owned, i.e., according to specific levels of equipment.

To do so, in addition to the draft animals, three broad categories of equipment were considered because of their significant effects on the labor constraints associated with different farming activities: land preparation (plowing), weeding and transportation. Harvesting was not explicitly taken into account although it constitutes one of the most labor-intensive activities in Malian agriculture, because no mechanized techniques for harvesting coarse grains exist in the study zones. In addition, it is assumed that access to labor for harvesting will be, to a certain extent, significantly related to the equipment mix, which is positively linked to the number of family workers and also to the level of cash crop production and sales, which generate most of the income used to hire external labor. Likewise, seeders and sprayers were not explicitly accounted for, because the ownership of both types of equipment is strongly correlated with that of plowing equipment.

Plowing equipment used by the CMDT and OHV farmers includes simple plows (charrue) and multi-purpose tool bars (multiculteur), on which different types of blades can be attached for plowing or weeding. In addition to the charrue and the multiculteur, single-purpose hoes (houe attelée) may be used for mechanical tillage operations. However, these hoes had a negligible effect on the ultimate definition of equipment levels, since they were owned by only 18 (1.8%) of the total 990 farm households covered by the census, and 10 of these 18 farm units also owned multiculteurs. Transportation equipment includes donkey and oxen carts. The draft animals are donkeys, commonly used only for transportation, and oxen, which can be used for all animal traction activities including plowing, planting, weeding and transportation.

Table 2-2 presents the correlation coefficients among the three categories of equipment and between them and the most relevant characteristics of the farm households. The examination of these coefficients shows that all the selected farm characteristics are more or less equally related to the three categories of equipment and the possession of draft animals. The highest correlation (0.44) between the farm household's food status and the different pieces of equipment pertains to the multi-purpose plow. Both the multi-purpose and the simple plows are to some extent more related to farm sales than are the transportation equipment and animals.

As assumed above, carts and donkeys show the closest relationship (correlation coefficient of 0.87) among the various types of equipment and animals considered. In addition, the correlation coefficients in Table 2-2 indicate strong relationships between the multi-purpose plow on the one hand and the possession of the cart and oxen on the other hand, and also between simple plow and oxen possession. As a result, one would expect most farmers who own multi-purpose toolbars to also possess transportation equipment and draft animals, and most of the other farm units to lack part of the equipment or the draft animals. Indeed, of the 526 farm households owning a multiculteur, 67.3% also possessed a cart and oxen. In contrast, only 21.9% of the 187 farm units that owned equipment not including a multiculteur had both a cart and oxen.

Based on the above findings, three broad equipment strata were defined. The first stratum (EQUIPPED) contained only farm units that owned plowing, weeding and transportation equipment and oxen; the second (SEMI-EQUIPPED) comprised farm households possessing an incomplete set of

Table 2-2. Coefficients of Correlation between Draft Equipment and Animal Possession and Other Farm Characteristics

VARIABLES	POSSESSION (0 = no; 1 = yes) OF:					
	Single-Purpose Plow (MULTIC)	Multi-Purpose Plow (CHARRUE)	Cart (CART)	Oxen (OXEN)	Donkeys (DONKEY)	Equipment Level (LEVEQ)
Family Type	0.26	0.29	0.36	0.33	0.36	0.40
Farm Size	0.39	0.33	0.41	0.36	0.39	0.44
Agric. Workers	0.30	0.22	0.32	0.22	0.31	0.31
Farm Population	0.32	0.24	0.37	0.37	0.36	0.36
Cereal Sales	0.14	0.17	0.10	--	--	0.12
Cash Crop Sales	0.33	0.39	0.27	0.37	0.29	0.39
Food Status	0.44	0.41	0.41	0.42	0.41	0.49
Access to Credit	0.37	0.37	0.25	0.31	0.26	0.37
Equipment Rental	-0.32	-0.31	-0.34	-0.42	-0.34	-0.40
Multic	1.00					0.81
Charrue	0.47	1.00				0.71
Cart	0.64	0.49	1.00			0.79
Oxen	0.58	0.64	0.52	1.00	0.80	
Donkey	0.63	0.49	0.87	0.52	1.00	0.76
Seeder	0.40	0.33	0.44	0.25	0.41	0.41
Sprayer	0.41	0.38	0.47	0.28	0.44	0.44

Note: All coefficients are significantly different from 0 at the 1% level with a minimum of 958 pairwise observations.
 The following codes are used for equipment level (LEVEQ):
 0 = non equipped; 1 = semi-equipped; 2 = fully equipped
 (see text for how these levels were defined).

the above equipment and animals; and the third stratum (NON-EQUIPPED) included all the farms lacking both plowing and weeding equipment. These three levels of equipment show higher coefficients of correlation than any single type of draft equipment or animals with both farm size (0.44) and farm household's food status (0.49). In other words, the most equipped farms are among the largest which tend to enjoy the best food status (self-sufficient or excess availability).

Table 2-3 summarizes the main characteristics of the three strata for the 990 farm units covered by the census. From an examination of these characteristics, it follows that the stratification of farm households according to the three levels of equipment allows one to take implicitly into account variables such as family type, farm size, access to credit, sales of agricultural commodities and overall food status. Farms are thus ranked along a technological ladder, with the equipped ones at the top and the non equipped at the bottom.

The breakdown by stratum shows that, in all subzones, equipped farm households are larger, have a better access to formal credit and a higher propensity to expand their cultivated area, are more active in output markets, and display lower frequencies of food shortage than do the semi-equipped households, which in turn rank higher than the non-equipped households. In spite of the very similar frequencies of food-deficit households in the southern and northern parts of each zone, the subzone division is strongly correlated with alternative production and transaction strategies followed by farmers in coping with their family food security. For instance, the proportion of households involved in non-farm activities varies from 21.7% in the north of CMDT, to about 50%

Table 2-3. Distribution and Characteristics of Census Farms by Zone/Subzone and Level of Equipment

ZONES/SUBZONES AND EQUIPMENT LEVELS	FARM HOUSEHOLDS		FARM POPULATION		PERCENTAGE OF FARM HOUSEHOLDS WITH:					
	NUMBER	PERCENT	ACTIVE	TOTAL	FORMAL CREDIT	LAND EX- TENSION	NONFARM ACTIVITIES	CASH CROP SALES	CEREALS SALES	FOOD DEFICIT
SOUTH CMOT										
Equipped farms	131	40.3	4.8	13.3	00.0	80.9	38.9	95.4	60.3	16.2
Semi-Equipped	107	32.9	3.7	9.7	100.0	72.6	32.7	91.6	57.9	37.4
Non-Equipped	87	26.8	2.2	6.1	97.6	51.8	16.1	73.6	46.0	67.4
Total	325	100.0	3.7	10.2	99.4	70.5	30.8	88.3	55.7	36.8
NORTH CMOT										
Equipped farms	172	51.8	5.7	14.4	92.4	36.8	29.1	87.8	16.9	19.0
Semi-Equipped	105	31.6	4.2	9.4	86.5	33.3	15.2	86.7	20.0	50.5
Non-Equipped	55	16.6	2.6	7.0	58.5	30.9	10.9	60.0	10.9	96.2
Total	332	100.0	4.7	11.6	85.1	34.7	21.7	82.8	16.9	41.7
SOUTH OHV										
Equipped farms	23	14.7	5.2	22.8	81.8	87.0	73.9	78.3	13.0	43.5
Semi-Equipped	64	41.0	3.4	12.8	45.3	65.6	51.6	37.5	3.2	60.3
Non-Equipped	69	44.2	2.2	7.5	23.2	67.2	40.6	18.8	8.7	82.4
Total	156	100.0	3.1	11.9	40.6	69.5	50.0	35.3	7.1	67.5
NORTH OHV										
Equipped farms	31	17.5	10.9	21.7	23.3	45.2	38.7	3.2	0.0	45.2
Semi-Equipped	56	31.6	8.2	16.9	29.1	53.6	53.6	0.0	1.8	53.6
Non-Equipped	90	50.8	4.6	11.5	11.5	32.2	51.1	0.0	1.1	77.8
Total	177	100.0	6.9	15.0	19.2	41.2	49.7	0.6	1.1	64.4
TOTAL SAMPLE										
Equipped farms	357	36.1	5.8	15.2	88.5	56.9	36.4	82.6	31.1	21.1
Semi-Equipped	332	33.5	4.5	11.3	73.2	55.6	34.3	64.2	25.9	48.6
Non-Equipped	301	30.4	3.0	8.2	47.7	45.5	31.2	36.5	17.6	79.1
Total	990	100.0	4.5	11.8	71.0	53.0	34.1	62.4	25.3	47.9

Note: The percentages of farms with formal credit and land extension concern the 5-year period of 1981-1985.
The percentages of farms with cash crop sales and coarse grain sales concern 1984/85 marketing year.

in both the south and the north of OHV. In addition, the percentage of farms which sold cash crops and/or coarse grains in 1984-85 systematically decreases from the subzones of CMDT to those of OHV, and from the south to the north within each zone. Such zone and subzone differences suggest that farmers very likely differ by zone and by subzone according to the mix of alternative sources of income available and their decisions in allocating their resources to the production of cereals for their own consumption and for the market, or to other activities that may generate more cash to buy food.

The most heterogeneous of the three farm strata with respect to household food status is the semi-equipped, where approximately half (51.4%) of the farm units were classified as non-food deficit (Table 2-3). To cope with this diversity, this stratum was further subdivided in food-deficit and non-food deficit units to allow more precision in the analysis of the variety of farms at this critical middle level of the technological path.

Following this initial analysis, a multi-stage stratified random sample of 190 farm households was constituted with sub-samples of approximately three farms randomly drawn from each of the four strata in each of the 16 villages. The distribution of this sample by zone, subzone, village and equipment level is presented in Table 2-4.

This distribution shows a few minor discrepancies from the pattern of equal sample size for each stratum, mainly because the total number of farms falling into some strata for some villages was so low that the principle of equality of sub-sample size could not be applied (e.g., only

food-deficit semi-equipped households existed in Ouélessébougou, and there was only one equipped household in Katiola).

The descriptive statistics (averages and frequencies) reported in the remainder of this dissertation are group averages weighted by the proportions of the different farm strata among the farm population of the 16 villages. The equal-sized strata statistics are used for comparisons between farm strata within each subzone of each zone. Adjustments are made for comparisons at higher levels of aggregation (zone, subzone, and total sample), since the strata were not equally distributed among the 990 farm population of the 16 villages as they were in the smaller 190 farm sample. Table 2-5 shows the weights used for these adjustments. This table shows, for instance, that the total farm population in south CMDT comprised 40.3% equipped households, 32.9% semi-equipped households, and 26.8% non-equipped households.

2.5.2. Wholesaler census

The need for a census of coarse grain wholesalers of the four selected cities derived from the lack of information that could be used for identification and sampling purposes. Wholesalers were defined as traders who buy grains mostly from rural market and village-level assemblers or other small merchants and sell mostly to retailers and other traders (Dembélé, Dioné and Staatz 1986a). By this definition, wholesalers of the surplus production zones (Koutiala and Sikasso) buy from rural assemblers and sell mostly to wholesalers of the major urban consumption centers (e.g., Bamako) and the dispatching points of the deficit zones (e.g., Mopti). In both cases, wholesalers may have their own retail

Table 2-4. Distribution of the Farm Sample by Zone, Sub-zone and Level of Animal Traction Equipment

ZONES and SUB- ZONES	VILLAGES	EQUIPPED FARMS	NON- DEFICIT SEMI- EQUIPPED	DEFICIT SEMI- EQUIPPED	NON EQUIPPED FARMS	TOTAL
SOUTH CMDT	Zangasso	4	2	3	3	12
	Soukolo	3	3	3	3	12
	N'Tosso	3	4	2	3	12
	Bleindo	3	3	3	3	12
	Total	13	12	11	12	48
NORTH CMDT	Dougouolo	3	2	4	3	12
	Kémeny	5	3	2	2	12
	Pétesso	4	3	3	2	12
	Kampolosso	4	3	2	3	12
	Total	16	11	11	10	48
SOUTH OHV	Ouélessébougou	3	0	5	4	12
	Sougoula	4	3	3	3	13
	Ténémambougou	2	3	3	3	11
	Sanancoro-Djit	2	4	2	4	12
	Total	11	10	13	14	48
NORTH OHV	Sirakorola	3	2	2	5	12
	N'Gabacoro	2	3	3	4	12
	Chola	3	2	3	4	10
	Katiola	1	3	2	4	10
	Total	9	19	19	17	46
TOTAL CMDT		29	23	22	22	96
TOTAL OHV		20	20	23	31	94
TOTAL SOUTH		22	22	24	26	96
TOTAL NORTH		25	21	21	27	94
TOTAL SAMPLE		49	43	45	53	190

Table 2-5. Proportions of the Different Farm Strata in the Total Farm Population of the Survey Villages

I. <u>TOTAL BY SUBZONE BY ZONE</u> (Column total = 1.0)				
	<u>SOUTH CMDT</u>	<u>NORTH CMDT</u>	<u>SOUTH OHV</u>	<u>NORTH OHV</u>
Equipped Farms	0.403	0.518	0.147	0.175
Semi-Equipped	0.329	0.316	0.410	0.316
Non-Equipped	0.268	0.166	0.442	0.508
 II. <u>TOTAL BY EQUIPMENT STRATUM BY ZONE</u>				
	<u>CMDT (row total=1)</u>		<u>OHV (row total=1)</u>	
	<u>SOUTH</u>	<u>NORTH</u>	<u>SOUTH</u>	<u>NORTH</u>
Equipped Farms	0.432	0.568	0.426	0.574
Semi-Equipped	0.505	0.495	0.533	0.467
Non-Equipped	0.613	0.387	0.434	0.566
All Farms	0.495	0.505	0.468	0.532
 III. <u>TOTAL BY EQUIPMENT STRATUM BY SUBZONE</u>				
	<u>SOUTH (row total=1)</u>		<u>NORTH (row total=1)</u>	
	<u>CMDT</u>	<u>OHV</u>	<u>CMDT</u>	<u>OHV</u>
Equipped Farms	0.851	0.149	0.847	0.153
Semi-Equipped	0.626	0.374	0.652	0.348
Non-Equipped	0.558	0.442	0.379	0.621
All Farms	0.676	0.324	0.652	0.348
 IV. <u>TOTAL BY EQUIPMENT STRATUM</u> (all sample villages)				
	<u>ZONE (row total=1)</u>		<u>SUBZONE (row total=1)</u>	
	<u>CMDT</u>	<u>OHV</u>	<u>SOUTH</u>	<u>NORTH</u>
Equipped Farms	0.849	0.151	0.431	0.569
Semi-Equipped	0.639	0.361	0.515	0.485
Non-Equipped	0.472	0.528	0.518	0.482
All Farms	0.664	0.336	0.486	0.514

outlets where a minor portion of the total volume of their cereals is traded.⁶

The census aimed at identifying the wholesaler population and some of its major characteristics which might be useful for stratification and sampling purposes such as:

- a) Sex, age and ethnic group;
- b) Number of years of experience in the cereal trade;
- c) Sphere (local, regional or national) and scale (volume) of activity;
- d) Own and rented resources (warehouses, vehicles and employees);
- e) Sources of working capital;
- f) Ranking of activities and traded commodities;
- g) Seasonality of cereal buying and selling operations; and
- h) Relations with suppliers.

Traders are well-known in Mali for being among the most cautious people in releasing information about their business. Therefore, after a first census effort that yielded many missing responses for Koutiala, Sikasso and Mopti, a shorter version of the initial questionnaire was used to cover traders of Bamako. Furthermore, it was foreseen on the basis of informal information that the size of the total wholesaler population of the four cities would not be beyond the capacity of the survey resources and management, given the small number of intensive cost-route data involved.

6. A forthcoming paper by Mona Mehta provides more detailed information on the structure of wholesale grain trade in Mali.

Although this dissertation does not explicitly address issues related to the structure, conduct, and performance of the wholesale trade, the analysis of the wholesaler census data provided some interesting information summarized in Table 2-6.

Most (61%) traders identified were already involved in clandestine grain trading before the implementation of the PRMC (1981). A higher percentage of these experienced risk-takers possessed their own warehouses and transportation means than did recent entrants. The average grain sales of the more established merchants for the month prior to the census almost doubled that of the wholesalers who entered the profession during the PRMC.

Approximately half of the wholesalers were involved in other activities in addition to trade (agriculture, livestock production, transport, etc.). More of those practicing only cereal trading tended to own warehouses, but not vehicles. The level of average sales of coarse grains of the specialized traders was half of that of wholesalers who also engaged in other activities, and their turnover was slower.

The largest difference in sales volume was found between wholesalers who traded only cereals and those who handled a broader range of commodities. The average quantity for the latter was almost five times that of the former.

The breakdown of the wholesaler sample by period of entry and the degree of specialization of their coarse-grain trade shows that those who entered the profession before the PRMC and traded cereals and other commodities seemed to have the largest scale and tended more to own vehicles. Almost 91% of those who were in the profession before the PRMC and who traded only cereals had their own warehouses. None of those who

Table 2-6. Distribution and Characteristics of Coarse Grain Wholesalers

Wholesaler Classification with Respect to:	Wholesalers		Percent Owning		Percent with Buying Agents	Last Month Sales (tons)	Cereal Storage Duration (days)
	Number	Per- cent.	Ware- house	Vehicle			
<u>Period of Entry:</u>							
Before PRMC	72	61.0	85.2	14.5	63.0	75	13
During PRMC	46	39.0	50.0	6.7	70.0	34	14
<u>Range of Activities:</u>							
Trade only	60	50.8	81.8	5.2	72.7	42	17
Trade and other	58	49.2	73.1	17.9	61.5	81	10
<u>Traded Commodities:</u>							
Cereals only	77	65.3	80.0	9.6	58.3	27	13
Cereals and other	41	34.7	57.1	14.6	76.9	130	13
<u>Entry/Traded Commodities:</u>							
Before PRMC/Cereals only	45	38.1	90.9	9.5	56.3	34	12
Before PRMC/Others	27	22.9	60.0	22.2	72.7	159	13
During PRMC/Cereals only	32	27.1	50.0	9.7	62.5	14	15
During PRMC/Others	14	11.9	50.0	0.0	100.0	77	7
Number of observations	118	118.0	37.0	114.0	37.0	87	31

Note: The number of observations used to compute the frequency distributions for warehouse ownership, the use of buying intermediaries and storage duration does not include traders of Bamako who were interviewed using a shorter version of the census questionnaire.

began trading cereals and other commodities during the PRMC owned a vehicle. In any case, the level of sales is significantly higher for wholesalers who trade other commodities in addition to cereals.

The distribution of the wholesaler population (Table 2-7) shows that, except for Bamako, more than 63% of the merchants identified were trading cereals even before the PRMC. This percentage is particularly high in Mopti (72.8%), where most of the supply of the chronically deficit northern regions of the country (Gao and Tombouctou) transits. In Bamako, which is the largest urban consumption center with the highest share of OPAM's former clientele (government officials and employees), more than half of the wholesalers began trading coarse grains only after the PRMC was launched. Finally a higher percentage of wholesalers of the major consumption centers (Bamako) and deficit production zones (Mopti) tended to be specialized in trading cereals only.

Table 2-7. Distribution of Wholesalers by City, Period of Entry, and Degree of Trade Specialization with Respect to Cereals

Period of Entry/Specialization	Koutiala	Sikasso	Bamako	Mopti
Before PRMC/Cereals only	6	6	12	21
Before PRMC/Cereals and other	7	8	9	3
During PRMC/Cereals only	3	6	15	8
During PRMC/Cereals and other	4	2	7	1
TOTAL	20	22	43	33
Percent. entered before PRMC	65.0	63.6	48.8	72.7
Percent. Trading Cereals only	45.0	54.5	62.8	87.0

This sample of wholesalers served as the basis for wholesale price series and most of the trader-related issues discussed in this dissertation.

2.6. Research Planning

Two main instruments were used for the planning and the management of the activities of the research project: a planning matrix and a PERT chart (Appendix II).

2.6.1. Research planning matrix

"The research planning matrix is a method of breaking down a research problem into conceptually related but separate and more manageable tasks, and then systematically thinking through the steps involved in going from broad research questions to the specific primary and/or secondary data one needs to answer the question" (Crawford, et al. 1988, 418). Operationally, the research planning matrix is a spreadsheet which outlines the broad research components of the study (e.g., farmer, trader, market, food system) and, for each component, defines subcomponents, general questions, specific questions and their rationale, precise data needs and secondary and/or primary data sources.

The main purpose of the research planning matrix was to guide data collection systematically. It related each of the general research questions to one of the four following study components: village, farmer, trader and market. The planning matrix further outlined specific variables in connection with each question and identified operational proxies or indicators for these variables to be used in designing

questionnaires for interviews. Finally the matrix included a distribution of the variables by questionnaire and key respondent, the frequency of interview required to gather the data and the list of alternative sources of information when available.

Therefore, from the start, the planning matrix was instrumental in defining the nature, the rationale, the place and the frequency of the precise data to be collected. Its use helped avoid both the omission of information on critical variables and the inclusion of data on aspects that were either irrelevant or of low priority.

2.6.2. PERT chart

A PERT chart was developed to ensure the proper timing of the questionnaire design and interview process. Variables and proxies were distributed among a set of questionnaires targeted at a given group of respondents on the basis of the timing of the event or aspect to be covered. At the outset, the PERT chart outlined the precise timing for the design of each questionnaire and interview as well as preliminary analyses and production of working papers.

2.7. Questionnaire Design and Data Entry/Management Strategy

A total of 22 questionnaires (some in different versions) were used to collect the required data over the two years of field survey. The questionnaires included one at the village level, one for the rural markets, 12 for farmers, three for rural market-level assemblers, four for wholesalers and one for transporters (Appendix II). Each questionnaire was designed in conformity with both the planning matrix

and the PERT chart described above. The questionnaires were pre-tested and revised before the interviews. The most frequently used questionnaires (e.g., those dealing with weekly or monthly transaction data) were often modified to include questions on additional information sought to drop low-priority questions and to ease the data entry/management process.

Data entry and questionnaire design were simultaneously planned. Thanks to the two microcomputers available to the field research team, data entry files were defined in conjunction with the design of each questionnaire. Most variables were pre-coded and those related to open-ended questions were post-coded after an examination of the range of actual responses.

The supervision of the data collection was assured through frequent visits (one to two times per month) to enumerators by the principal investigator (author of this dissertation) and his four close collaborators (analysts), who also handled directly interviews related to the most sensitive information. All project analysts and the project secretary were trained to enter data as soon as questionnaires were filed in from the field. The primary data files, which were all written in the RBase program, were subsequently translated into fully documented SPSS files to allow a broader access for other researchers from MSU and professionals of CESA and USAID.

2.8. Iterative Process of Research Hypotheses and Instruments

The main original feature of this research project was the great flexibility in its methodology and operational approach throughout its

implementation. Based on the theory of markets and exchange, the research started with a set of hypotheses that were continuously checked and reshaped in the light of preliminary analyses of primary data as they became available from the farmer and trader panels. As a consequence, sub-hypotheses could be reformulated more accurately and additional data needs defined more precisely.

It also follows that the research planning and operational instruments such as the planning matrix, the PERT chart and questionnaires were often revised to take into account the various amendments of the subhypotheses and variables. Not only did this iterative process allow a flexible and dynamic search for the most relevant information, but it also gave a clear idea of the issues to be given priority in a second phase research effort, which started in late 1987.

2.9. Feedback to the Policy Process

The iterative research process described above was further enriched through an extension effort made to feed back to the policy process major research findings as they became available. In order to reach the majority of relevant decision-makers, the strategy adopted to disseminate research outputs used a combination of different informal and formal means. First, informal briefings of the technical secretary of the CESA on project progress and findings were made through day-to-day personal contacts of the principal investigator. Such briefings and discussions were also held with the agricultural economist of the Agricultural Development Office of USAID/Bamako. Second, periodic informal discussion

meetings were organized around relevant working papers with the members of the technical committee of the 10 donor countries supporting the PRMC. Third, in a more formal fashion, almost quarterly staff meetings were held at the level of both the inter-ministerial commission of the CESA (30 members) and the USAID/Bamako mission to assess project progress and present and discuss on-going findings generally during the field visits of MSU back-stopping faculty members. Fourth, the monthly coarse grain producer and wholesale prices generated were regularly fed to the information center of the CILSS (Inter-State Drought Committee for the Sahel) in Ouagadougou, Burkina Faso. Finally official contributions of the principal investigator were invited to one national and two international seminars on cereal policy in Mali, the Sahel and Africa.

These informal and formal means of information dissemination and discussion allowed, to a large extent, a timely release of research findings to decision makers while feeding back insights on additional data needs to the research team.

CHAPTER III

CONCEPTUAL FRAMEWORK OF FARM HOUSEHOLD'S FOOD STRATEGIES

Public policy and interventions in the agricultural sector always proceed from some explicit or implicit conceptual views of the organization, the objectives and the decision-making process of the sector participants. Accordingly, policies aiming, for instance, at increasing the production and sales of some agricultural commodities, reducing rural out-migration, transferring agricultural resources to other sectors of the economy, etc., are all based on the perceptions that policy makers have of the social and economic organization, the objectives and the decision process of the farm population, and therefore the expected responses of this population to various constraints or incentives.

Likewise, the economic analysis of farmers' responses to different policies cannot proceed without a frame of reference, which helps conceptualize their behavior. Although a consensus has yet to be reached on the appropriate extent of formalization of farmers decision-making processes into mathematical models, virtually all the work of social scientists rests on their explicit or implicit models of the organization and behavior of micro or macro economic entities (individuals, households, firms, nations, etc.). This chapter presents the conceptual framework used in generating and analyzing our research data. Although a trader component was included in the surveys, the chapter concentrates on the

farm-household component, which constitutes the focal point of this dissertation.

3.1. The Farm Household as a Production/Consumption Unit

In the traditional approach to consumer-demand and producer-supply analysis, farmers' production decisions and consumption decisions are treated separately, under the implicit assumption that production activities and consumption of goods and services are determined independently from each other. This assumption seldom applies to farm households which, unlike producers and consumers of industrial goods, supply a significant proportion of the inputs that they use in farming and retain a substantial part of their output for home consumption. This is particularly true for Mali, where an estimated 80% or more of total labor used in farming is supplied by farm household members (Doumbia, Mariko and Touya, 1986) and only 10% to 20% of farmers' cereal production is marketed (CRED 1976). Under such circumstances, the separation of the farm household decision-making process into independent firm and consumer components inevitably results in misleading conclusions about farmers' behavior and expected responses to alternative stimuli.

Following Chayanov's (1925) pioneering effort to explain Russian peasant households' allocation of time between work and leisure, and the subsequent elaboration of his model by the Japanese economists Tanaka and Nakajima during the 1950s and 1960s, a group of farm household economists has emerged around the common view that, unlike conventional economic households, farm households' production and consumption decisions are interdependent and should be treated as such.

The body of literature on farm household decision models is well documented by Singh, Squire and Strauss (1986), who also give a clear presentation of the basic framework and the general approach used in agricultural household decision models. Although they do not depart from the fundamental basis of neoclassical production and consumption economic theory, these models differ from the traditional ones in that they explicitly establish a bridge between farm household's resource allocation decisions in production and its consumption decisions. All these models start with the assumption of the existence of a household utility function, which is composed of various arguments, including household consumption of different commodities and leisure. The set of commodities consumed by the household comprises own-produced and market-purchased food and nonfood goods.

Farm households are assumed to maximize their utility function, subject to three major constraints. First, a cash-income constraint ensures that the household's total expenditure on market-purchased goods and wage labor does not exceed its total income from marketed surplus of own-produced goods and family labor. Second, a time-budget constraint guarantees that the household may not allocate more time to on-farm production, off-farm employment and leisure than its total available time. Third, a production function translates the input-output relations determined by the production technology used by the household. These three constraints collapse into a single full-income budget constraint, whereby household's total expenditure on market-purchased commodities (including labor), own output and leisure may not exceed its full income measured by the total value of its stock of time, exogenous income (such

as remittances) and farm profits (defined as the difference between the value of output produced and that of the total labor and other purchased inputs used by the household).

The fundamental problem facing the farm household then consists of choosing the levels of consumption for the different commodities and the total labor input to allocate to agricultural production, non-farm activities, and leisure as to maximize utility. Three major conclusions are derived from the comparative statics of the basic model, when markets are assumed for all commodities and for labor, and the household is a non-autarkic price-taker in each market.

First, a household's choices can be modeled as recursive decisions, even though the decisions are made simultaneously in time (Nakajima 1969; Jorgenson and Lau 1969). In other words, the household first maximizes its full-income by equating the marginal value-product of each input in the production function to its marginal cost (input price times the marginal utility of income), and then maximizes utility derived from the maximum full income by equating the marginal utility of each commodity consumed to its marginal cost (commodity price times the marginal utility of income).

Second, production decisions are only determined by farm technology, quantities of fixed inputs and prices of variable inputs and of outputs, and can therefore be made independently of consumption and labor-supply or leisure decisions (Singh, Squire and Strauss, 19; Strauss, 75). Alternatively, a household's consumption preferences, the prices of consumption goods and income do not affect production decisions. This holds true to the extent that capital markets work well, so that access

to additional cash income from external sources does not affect capital-requiring production decisions.

Third, farm household consumption decisions, in contrast, are affected not only by commodity prices, but also by household production decisions, through the linkage between full-income and production activities. Changes in factors influencing farm profits (e.g., changes in farm technology or input and output prices) will change farm household's full-income and consequently its consumption behavior. This extra-income effect, referred to as "the profit effect," is the main peculiarity of farm household models. It helps explain why an increase in the price of a commodity that is both produced and consumed by the household may raise household's own consumption-demand for the commodity and decrease its marketed surplus (Singh, Squire and Strauss, 9, 20; Strauss, 76).

As Strauss (1986) notes, whether the farm household's production and consumption decisions are separable depends essentially on the existence of markets, where the household can sell or buy as much of every commodity (including labor) as it wants. The absence of markets for labor or a commodity, imperfect substitutability between the household's labor (or produced goods) and hired labor (or purchased commodities), as well as the autarkic choice of a household which consumes all of its output, lead to the existence of virtual (shadow) prices that are endogenously determined in the decision model. Under such circumstances, production and consumption decisions can no longer be treated separately as if they were sequential, since the shadow prices, which depend on both the household's preferences and production technology, will be determined so as to equate household's supply and demand for labor or the commodities concerned, so

that consumption decisions in turn affect production decisions (Strauss, 77).

Singh, Squire and Strauss report empirical results from estimations by various authors of agricultural household models with household data from Taiwan, Japan, Thailand, Malaysia, Korea, Nigeria and Sierra Leone, which convey a series of important policy-relevant messages (pp. 22-46). In most cases, these messages diverge from what would be predicted by traditional, standard consumer-demand theory.

First, the inclusion of the profit effect in these models reduces the magnitude or even inverts the sign of own-price elasticities of household consumption demand for commodities produced by the farm. In other words, an increase in the price of a commodity produced and consumed by the farm household leads to a lower reduction or even to an increase in household's own demand for the commodity than would be predicted by traditional models of demand. Whether or not such an increase in home consumption results in a reduction in marketed surplus depends on the magnitude of the price elasticity of output (normally positive) on the supply side, relative to that of the profit effect (also positive) on the demand side of the model. In the empirical studies reviewed by Singh, Squire and Strauss, own-price elasticities of marketed surplus remain strongly positive, indicating that for farm households capable of producing such surpluses, total farm output is responsive enough to producer prices to offset increased household consumption induced by the profit effect.

Second, strongly positive cross-elasticities are found between commodities produced by the farm household and market-purchased goods, while traditional demand models would predict low or negative cross-

elasticities because of negative income effects. This finding, which also results from the profit effect, suggests that the level of farm incomes and the availability of nonfarm goods (e.g., purchased farm inputs and implements as well as consumer goods) are important determinants of farm household responsiveness to agricultural output-price incentives. Third, in standard consumer-demand theory, farm household's labor supply is expected to respond positively to an increase in farm output prices, which would reduce household's consumption of both farm output and leisure. However, when the profit effect of farm output price increase is taken into account, the household's labor supply may respond negatively to changes in agricultural commodity prices, because an increase in agricultural commodity prices raises farm profit and full-income, and therefore induces an increase in household consumption of leisure, and most probably an increase in household's demand for hired labor.

Fourth, because they integrate production and consumption, agricultural household models provide some elasticities, such as elasticities of demand with respect to non-labor input prices and stocks of fixed factors of production (e.g., land and farm technology), that are not dealt with in traditional demand models (Ibid., 28). As a result, farm household models may help assess the effects of changes in purchased non-labor input prices and agricultural technology on both household consumption and investment.

The features summarized above make farm household models very appealing as a conceptual framework for the analysis of the effects of public policies on the performance of the agricultural sector. However, as any major theoretical framework of human economic behavior, these

models have their own drawbacks, which limit to a large extent their applicability.

The first difficulty relates to the usual controversy on the concept of the utility function. A farm household is composed of several individuals, each of whom can be assumed to have his/her own utility function, thereby creating an aggregation problem at the whole household level. Even assuming a household utility function, the specification of the arguments of such a function would remain a highly normative issue, since strong assumptions would have to be made on what contributes positively or negatively, and to what extent, to household utility. Furthermore, there is no universal consensus about the leading goal sought by farm households in making their decisions, although most economists agree that every person pursues some form of utility maximization. In the literature on farm decision-making, the form of the utility sought varies from neoclassical profits in a certain and perfectly competitive environment to a wide range of attributes under risk, including expected profit, expected utility, security or safety. Under risk-decision theory, a few models have developed that deviate from the notion of pure maximization, such as efficiency analysis of a partial ordering of risky prospects (which only exceptionally yields a unique solution), and satisficing principles, whereby the limited cognitive abilities of decision makers and the costs related to maximizing approaches justify the use of rules-of thumb, such as the choice of the first prospect in which all payoffs are in excess of a specified crucial level.

Beside these normative difficulties, another category of major constraints that deter analysts from an extensive use of whole-farm

household models are the type and the amount of data required for the estimation of a completely integrated household model. The estimation of a complete set of output-supply and input-demand functions, as well as commodity-demand equations including leisure or labor supply, requires an extensive set of data on basic household demographic characteristics, consumption expenditures on purchased and own commodities, disaggregated labor supply, farm and non-farm outputs, household-supplied variable inputs and fixed assets, and inputs and output prices (including wages). Such complete sets of data are only exceptionally available for developing countries, where most current household surveys can seldom afford collecting them.

Despite these serious limitations, farm household models, when compared with standard neoclassical consumer-demand and producer-supply models, appear as more advanced conceptual tools in analyzing farmers' production and consumption decisions. The main strength of agricultural household models, as noted earlier, is the systematic integration of the supply side and the demand side of the decision process. The relevance of such approaches for Malian agriculture is established by the fact that, despite a strong orientation toward subsistence, a significant proportion of farm households engage in non-farm activities and market transactions of various agricultural commodities (including cash crops and food staples), and can therefore be qualified as semi-subsistence or semi-commercial farm households. Data limitations prevent a comprehensive application of agricultural household decision theory in the context of this study however. As a consequence, a much simpler conceptual framework inspired from this theory is used here, where no systematic attempt is

made to estimate formal output-supply and variable input-demand functions or commodity-demand equations.

As a starting point, it is assumed that, as far as rainfed foodgrain production is concerned, survival or household food security is a prime goal for virtually all farm households in Mali, given the high level of risk imposed on them by rainfall uncertainty. Although not empirically established, farmers' decisions in such an uncertain environment may reasonably be assumed to follow a safety principle, whereby they implicitly minimize the probability that cereals availability for home consumption falls below a perceived disaster level, or a safety-first concern, whereby they attempt to maximize foodgrain availability for household consumption, subject to an exogenous probability of disaster determined by inter-annual rainfall fluctuations (Anderson 1979).

Yet the natural environment is by no means the sole determinant of farmers' security decisions. As depicted in Figure 3.1, a farm household's production, consumption and transaction decisions are made within macro-level policy and institutional settings, which affect farm access to both production factors (especially capital and extension services) and output markets. Farmers' awareness of farming technologies other than the traditional ones depends on the performance of agricultural research and extension institutions, which generate and disseminate knowledge about new crops and improved technical packages. The profitability of the new crops, techniques and inputs is determined by input-output technical relations in the production process, and prices in input and output markets, the performance of which is itself subject to input and output marketing policies. Farmers' capacity to acquire purchased implements and inputs is a function of the supply and the price of farm inputs as well

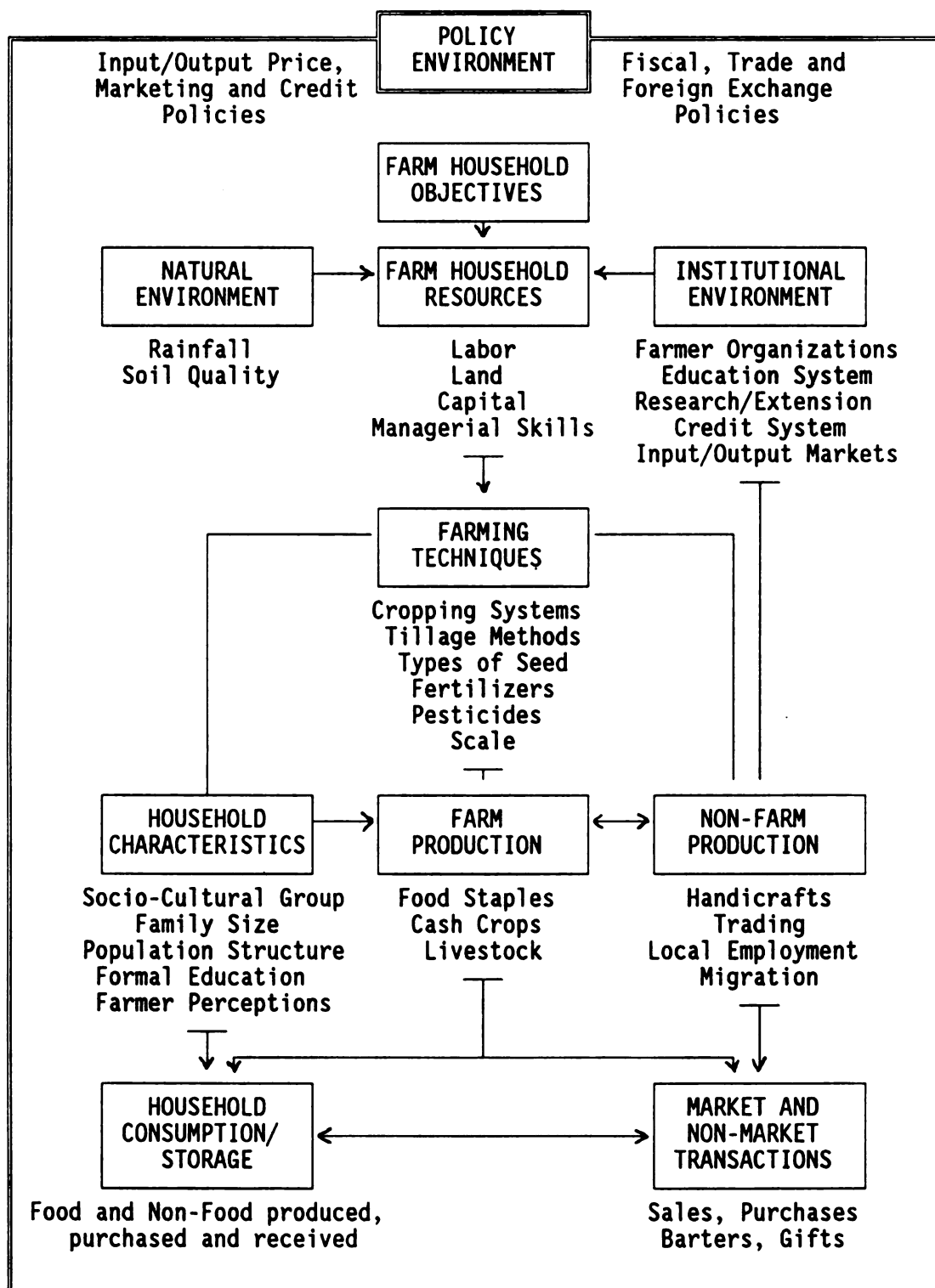


Figure 3-1. Diagram of Factors Influencing Farm Household's Coarse Grain Production, Transaction, and Consumption Decisions

farm household's financial capacity, which is affected by the availability of income-generating opportunities, fiscal policies (taxes and subsidies) and access to formal financing determined by credit institutions and policies.

At the outset, farmers' production technologies result from the interactions between policies, institutions and natural environment. The production process itself, which reflects the choice of enterprises and technical input-output relations, can therefore be considered as a function of the natural conditions, the policy environment and the institutional setting of the farm household. Furthermore, in the semi-subsistence and subsidiary-commercial agriculture of Mali, the bulk of farming inputs (particularly labor) is supplied by the farm household itself, so that total output can be assumed to be closely related to the total stock of resources (labor and equipment) available, if one discards assumptions of high levels of underemployment or disguised unemployment of labor and capital in a relatively land-abundant context. Consequently, from a household food-security standpoint, farm production of major food staples (such as coarse grains) can be modelled as a function of ecological variables, the household's total stock of agricultural labor and equipment, complementary or competing farming and non-farm activities, and institutional factors.

In operational terms, this conceptual framework is translated in the following analyses by regressions of farm household coarse grain production against categorical variables reflecting the rural development institutional zone, the ecological subzone, the level of farm equipment in animal traction, competing household activities (e.g., cotton

production and non-farm activities and employment), and continuous variables such as the household's total stock of farm labor.

Farm household transaction and consumption decisions are subsequently modelled in a recursive manner with respect to production. Although one may argue that farmers' foodgrain production decisions depend on their consumption decisions in the near-subsistence agricultural sector of Mali, the picture may be much more complex in reality. The relations illustrated in Figure 3-1 involve a continuous on-going process, since the outcome of household's consumption/storage decisions and market and non-market transactions in time T affect farm household resources in time $T+1$. Furthermore, even though coarse grains provide the bulk of calories and may be grown primarily for home consumption in the two rural zones covered by this study, it remains true that farmers' cereals may end up in several competing uses once the harvest is on hand.

Figure 3-2 gives a conceptual view of the basic elements of farmers' foodgrain strategies from a household security standpoint. In this global foodgrain balance sheet, a farm household's total foodgrain availability in each year comes from stocks carried over from the previous year(s), current production and total inflows through cash-market transactions (purchases) and non-cash transactions (barter and gifts). This total quantity of available foodgrains is allocated between cash transactions (sales), non-cash transactions (barter and gifts), seed provision for the next cropping season, the household's current consumption and security stock building. The level of carried-over stocks depends on farmers' perception of risk, their previous production, net inflows and consumption. Since net inflows are a function of both the household's production deficit and purchasing power, inter-annual security stock and total annual

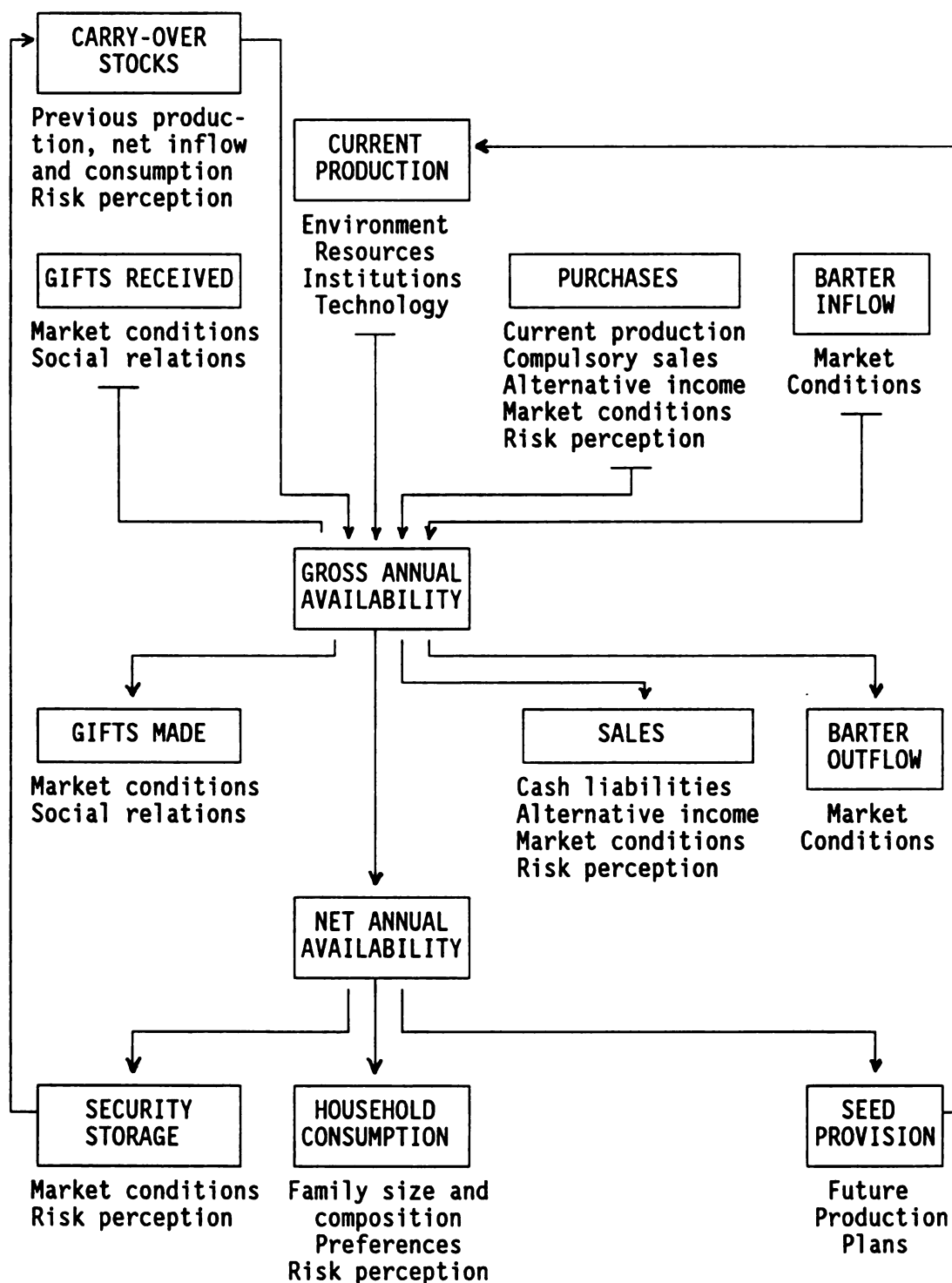


Figure 3-2. Conceptual Elements and Determinants of Farm Household's Foodgrain Transaction, Consumption and Security Strategies

cereals availability are determined by household total income from both farm and non-farm activities.

Current transactions are all related directly or indirectly to current surplus stocks (i.e., all stocks including current production compared with consumption needs), alternative income sources and market conditions, although some nuances need be made. First, non-cash transactions (especially gifts) will respond to farmers' internal valuation (shadow prices) of cereals relative to market prices. It may be argued that the level of these shadow prices is linked to the perceived utility of keeping social or religious ties with gift recipients or the value of the social security (or traditional risk-sharing) achieved through such gifts in the rural community. Second, sales will likely not proceed from the same rationale for all farm households: those who produce a real marketable surplus will act more according to market conditions (prices) and profit maximization principles, while deficit producers will sell, regardless of market-price levels, only under the compulsion of rigid cash liabilities (e.g., loan repayment and taxes) that cannot be met by alternative income sources. Third, a farm household's cereals purchases can also involve a complex strategy, which may result from favorable current market conditions (e.g., low prices cereals at harvest) combined with high risk-aversion even for some surplus producers at one extreme, or the insufficiency of own-production compounded by compulsory sales for deficit producers at the other extreme. The timing of cereals purchases will also depend on the prices of the goods sold to purchase foodgrains, i.e., on the relative price of cereals.

The net stock of cereals that is available to the farm household comprises own-production and all net inflows, and is used primarily for household consumption, seed provision and security-stock building. Current farm household consumption is therefore determined, not by own production as such, but by the net amount of foodgrains available from different sources between two harvests. As a consequence, the farm household may not consume entirely and exclusively its own output of cereals, and its consumption decisions, although they may influence production decisions to some extent, will likely be made after the harvest, i.e., in a recursive way relative to production plans.

Finally, an important component of the above strategic framework (Figure 3-2) that is omitted in most analyses of farm household food strategies is the phenomenon of household-level inter-annual security storage. Farmers' utility for such security stocks and their propensity to build them are likely to increase in a highly uncertain rainfall and market environment such as the Sahel. Here again, withholding surplus foodgrains from the market may be explained by the farm household's shadow pricing of its cereals relative to market prices, given its perceptions of the risk of future food insecurity. This shadow pricing based on farmers' expectations may allow that a price increase that signals an emerging cereals shortage results in farmers retaining their stocks for security reasons (beyond the "profit effect" on their current consumption demand), thereby reducing their sales as a consequence of an even higher increase of the shadow value of foodgrains relative to their market price.

Alternatively, the approach taken here to explain farmers' consumption and marketing decisions under instability is that of the variant of

the permanent-income hypothesis adopted by Bigman (1985), which assumes farmers' consumption to be a function of their long-run expected income rather than their current income. "To bridge the gap between the quantity of consumption afforded by their current income and the quantity desired on the basis of their permanent income, farmers accumulate stocks of food (or income) in years of plentiful production that would supplement their consumption in years of poor harvest" (Bigman, 149). This argument may help shed some light on surplus producers' sales strategies, particularly during the three to four months of the rainy season (July-October) which immediately precede each new harvest, and when farmers may be assumed to form strong expectations about their income for the next year.

3.2. Accumulation Under Risk and Uncertainty

There is a universal consensus that agriculture is typically a risky business which takes place within a highly uncertain environment. Whether risk and uncertainty are truly different in that the former is measurable while the latter is not (Knight 1921, 20) is rather a semantic problem, and, to be pragmatic, one must adopt a workable definition in which the two terms are used synonymously, with the only nuance that risk pertains to the degree of uncertainty in a given situation (Magnusson 1969; Roumasset 1979). In fact, defining risk as the dispersion of possible outcomes of a given action, or the probability that returns to a given decision will fall below some critical "disaster" level, or the probability of loss, all converge to considering risk as a measure of the consequences of a decision made in a situation characterized by uncertainty.

Risk and uncertainty result from the decision makers' lack of perfect knowledge of how the system in which they act works or the conjectural actions of other decision makers who directly or indirectly affect their fortunes (Day, 116-117). Following Magnusson's classification, the agricultural producer faces a wide variety of risk problems, including production risks, product and factor price risks, demand and income uncertainty, factor limitations, conjectural behavior of other actors and institutional uncertainty (e.g., tax structure and depreciation rules). Among these categories of risks, the single most important risk factor pertaining to rainfed agricultural production in Mali is the extremely fluctuating climatological setting of the Sahel. All other risk components of economic or institutional nature (such as price instability, demand uncertainty, fiscal risk, etc.) that farmers face can then be considered as compounding elements--some of which (e.g., price instability) are partially a function of the weather--which contribute in an additive or a multiplicative way to fostering farmers' risk-aversion attitudes.

Many risk-economists have shown how the introduction of uncertainty (stochastic modelling) may lead the producer or the firm to deviate from the type of smooth expansion path of accumulation through maximum profits and optimum investment in improved technologies dictated by deterministic neoclassical models of production economics and technological innovation. As Magnusson notes, the ultimate production function reached under uncertainty includes mutually exclusive categories of controlled variables that can be manipulated by the producer independently of each other (e.g., production factors owned or bought on the market), uncontrolled or uncontrollable variables that have uncertain outcomes (e.g., meteorologi-

cal and geographical variables), and external variables (such as tax rates) that are supposed to have given outcome and be controlled by actors other than the producer. Magnusson shows that if risk aversion exists, the amount employed of the decision (controlled) factors will be less under uncertainty than in the deterministic case, implying a tradeoff between the level and the variability of the expected income. Mirrlees (1974) contends that, "when a long-run view is taken...the precautionary reaction to uncertainty is the predominant one: the more uncertainty there is, the more should be saved," and as a corollary, less will be invested. Arrows (1971) goes even further in arguing that, in the absence of appropriate risk-shifting devices, the predominance of risk aversion over risk preference may result in the total rejection of risky projects (e.g., a good deal of technological innovations) by individual investors, even when society may be better off by the increased production of such projects.

The above examples converge to the preeminent conclusion that risks impose suboptimal decisions on virtually all economic actors in an uncertain environment. This point is supported by empirical findings by Kunreuther and Wright (1979) who show, for farmers of Nigeria, Bangladesh and the nineteenth century US South, how risk aversion may lead even wealthy producers to follow strategies that are suboptimal by giving priority in their land allocation to food self-sufficiency over the production of higher-return crops such as cotton and jute. Similarly, Ortiz (1979) notes about Indian farmers in Colombia that "most producers are cautious suboptimizers in the sense that they insure their subsistence and may, to their best knowledge, avoid choosing a prospect where a loss below the bearable minimum is highly likely. Yet, while they are insuring

themselves, they are also willing to gamble in another one of their activities" (pp. 243-44).

In fact, as Binswanger concludes, it is quite instructive that, despite their seemingly great differences, the two major groups of optimizing models under risk--the utility-based Bernouillian or Bayesian models and the safety-based (lexicographic, safety-first or satisficing) models--"lead to similar predictions, encounter similar problems in eliciting information about the actors' attitudes, and both need to take into account a learning behavior" (pp. 386-87). The choice of a frame of reference then depends primarily on the analyst's perceptions of decision makers' attitudes, behavior and adjustments in a risky and changing environment. For the near-subsistence farmers of Mali, it seems reasonable to adopt Day's "cautious suboptimizing with feedback" framework, using as central ingredients the concepts of safety, danger and experience. Danger may arise, in this case, from the stochastic nature of events as well as from the lack of information and understanding of the environment (Day, 115-30). Based upon the claim that most managers in business or in farming do not behave as maximizers of some complex and nonlinear expected utility functions, Day suggests that a cautious decision maker selects flexibly among alternative choices that are safe enough (in a safety zone) with respect to a danger metric (distance from a specified safety-focus). When no feasible indifference choice lies within this "zone of flexible response," the decision maker must then choose a feasible point closest to it, i.e., the safest feasible point. This procedure leads to suboptimizing because of the circumscription of safety-feasible points relative to an entire set of feasible choices.

For Sahelian farmers, such a conceptual framework can be better justified on intuitive grounds, particularly when one takes into account Ortiz's important nuance that the subsistence or near-subsistence farmer "does not define his [safety] zone in terms of a combination of activities with a corresponding range of returns, but in terms of two noncomparable ventures--each one requiring a specific land allotment: subsistence and market production" (Ortiz, 234). In the highly uncertain climatological context of Mali, it is safe to assume that all farmers, in the light of their evolving experience, adopt adaptive survival strategies aimed at avoiding a possible disaster, i.e., starvation or any perception of destruction of their way of life through the loss of their property or the social shame and dependency of borrowing to feed their household. Consequently, self-sufficiency in major food staples is likely to be a high-priority safety goal at the household level, despite the potentially higher returns of cash crop production. Moreover, the survival strategies of these farmers should also incorporate a minimal level of cash reserves to face fiscal and social liabilities, which are beyond the farmers' control and which they may by no means predict with certainty. It is therefore only beyond these survival (subsistence and liability) requirements that savings and investments can be made for wealth accumulation.

Although the attitudes and behavior depicted above imply a rather slow and erratic expansion path with possible setbacks through occasional disinvestment, they do not preclude prospects of technological progress and growth altogether. As pointed out by Ortiz, poor farmers are simultaneously risk averters and risk takers, since they engage in other

high-return and potentially high-risk activities (e.g., cash-crop and livestock production and various nonfarm activities) after their subsistence is assured, and depending on their income and their ability to ensure adequate operating funds (pp. 234-35). Also research and development efforts to generate and disseminate new information about the technological, political and institutional environment may reduce farmers' perceptions of the possible range of variations of the outcomes of their decisions and induce them to undertake more profitable activities that might otherwise be perceived as too risky. Nevertheless, agricultural producers' behavior may not be equated to that of an individual who gambles in order to become wealthy, as suggested by Friedman and Savage (1948), simply because, in Ortiz's terms, "the peasant's preference for subsistence over starvation cannot be rephrased into a preference for X chance of Y income over X-n chance of Y-m income" (p. 235).

The costs of suboptimality imposed on society by decisions made under uncertainty are at the heart of policy analysts' as well as decision makers' concerns about risk. These concerns are discussed by Binswanger, who relates them to a wide range of growth and equity issues and to various policy alternatives to deal with the undesirable consequences of risk aversion (pp. 383-97). His list of major concerns include the adoption of profitable but risky technology by farmers; the income-distribution implications of differential risk aversion and its implication for crop choice, adoption behavior and credit use; the regional focus of planning and investment strategies for high-potential or low-risk regions; the regional and topical focus of agricultural research strategies; the determination of rural institutions on the basis of

attitudes towards risks; and the changes in utility by price and output stabilization.

Binswanger further suggests that the degree of riskiness of net returns of new farming technologies depends on (a) the investment levels associated with these technologies (the smaller, the less risky) and (b) how the yield distributions shift or change their shapes. He provides for (b) an interesting classification of technologies into "nonprotective inputs" (e.g., new seeds, fertilizers or machinery inputs) that shift the probability distribution of yields without necessarily reducing risk, "protective inputs" (e.g., pesticides and varieties introduced specifically for disease or drought resistance) that reduce risk but do not tend to increase yields under favorable situations, and "inputs with a dual role" (e.g., irrigation) that increase yields while reducing risk. He then argues that unless institutional credit constraints are severe, risk-averse farmers would overinvest in protective inputs and dual-role inputs and underinvest in nonprotective inputs.

Accordingly, Binswanger proposes two subsets of policy alternatives to deal with risk, the first comprising policies that are specific to agricultural risk, and the second encompassing policies which, either by increasing income or reducing risks in areas other than agricultural production, increase farmers' ability to bear production risks and to adopt higher-return but riskier production activities. Although the degree of appropriateness of such policies depends on the institutional and financial capacity required to implement them, most of them should be considered here as possible choices.

Among the policies that are specific to agricultural risk, mention should be made of crop and credit insurance, loan guarantees, relief and famine policies, price stabilization schemes, plant protection and breeding for crop yield stability. Policy alternatives that are not specific to agricultural risk include subsidization of inputs and credit, agricultural price support as income policy, the regional focus of investment and research, reduction in background risk (e.g., irrigation investment, improved market facilities and information, improved access to technological information, development of nonfarm activities, improved medical and welfare policies), legislation, regulation and institutional reform in areas such as credit and land tenure, land reforms and other income/wealth distribution measures. Policies of this last category are crucial in dealing with the issue of entitlement, which significantly underlies farmers' capacity to cope with risk and uncertainty and achieve an acceptable rate of economic growth in response to different stimuli of their social, political, institutional and macroeconomic environment.

3.3. Entitlements, Investment/Disinvestment Strategies and Food Security

It is widely admitted that all producers, including farmers, are responsive to economic opportunities that contribute significantly to their goals in general, and more specifically to their profits in a neoclassical framework. Hence, investment strategies are often explained mainly by the profitability of the expansion of existing production techniques or the adoption of improved technologies. Similarly, in modern neoclassical production economics, investment and disinvestment decisions are explained on the basis of a marginal analysis centered on the concept

of profits. A good example of such contributions to production economics is the application by Johnson and Quance (1972) of a new definition of durable asset fixity to agricultural supply response. As refined by Baquet (1978), this definition stipulates that:

The firm is optimally organized with respect to investments in durable assets when the net present value of the last unit of durable asset invested in exceeds its acquisition price while the net present value of the next unit of durable, if it were acquired, would not cover its acquisition cost. The net present value of the durable is derived from the services generated in each production period over the economic life of the durable plus the final salvage value. The firm is optimally organized with respect to disinvestments in currently held durables when the net present value of the last unit of durable disposed of is less than its salvage value, while the net present value of the next unit to be disposed of exceeds its salvage value" (p. 80).

The above definitions clearly state the conditions of optimality in investment/disinvestment decisions, and therefore address the question of farmers' willingness to invest. However, in any society, a full explanation of the investment process should take into account two complementary aspects, i.e., producers' (a) willingness and (b) capacity to invest. As Griliches (1957) has shown, the rate of diffusion of a new technology is influenced by both the profitability of the innovation and the asset position of firms.

The second ingredient of the investment recipe, namely the capacity to invest, is particularly crucial in analyses of growth or technological progress of the agricultural sector of poor countries such as Mali. Although the technological lag of agriculture in these countries may be partly attributed to the paucity of profitable technologies on the shelf or the deficiencies of extension services, it is reasonable to assume that even most of the proven profitable innovation may suffer low rates of adoption simply because most of the target recipients lack adequate means

to acquire the necessary inputs. This assumption may hold true particularly where farmers have a very weak self-financing capacity while capital markets (under liquidity shortages in the informal sector and heavy regulation in the formal sector) function poorly. In addition, in low-income countries, certain constraints (non-deferable cash liabilities, for instance) may result in the liquidation of durable assets (e.g., farm equipment and/or draft animals) even when their net present value exceeds their salvage value, unless an extremely high discount rate is adopted to reflect the immediate urge for cash.

The "capacity dimension" of investment emphasizes farmers' access to improved technologies in a very broad sense. This argument can be usefully elaborated in the framework of the entitlement approach developed by Sen (1981). Sen uses this approach to explain starvation not on the basis of low food availability, but primarily as a consequence of failures in individuals' food entitlement or command over food through the legal means available in the society. An entitlement relation applied to ownership is defined as one that "connects [in a recursive and repetitive manner] one set of ownerships to another through certain rules of legitimacy" (Sen, 1). The accepted (legitimate) entitlement relations in a private ownership market economy can be based on own-production, own-labor, trade, inheritance and transfer. Central to such economies, a person's exchange entitlement is defined as "the set of all alternative bundles of commodities that he can acquire in exchange for what he owns". Sen argues that the entitlement set of a person "can be characterized as depending on two characteristics, viz. the endowment of the person (the ownership bundle) and the exchange entitlement mapping (the function that

specifies the set of alternative commodity bundles that the person can command respectively for each endowment bundle)" (p. 45).

Sen argues that "in understanding general poverty, ...it is necessary to look at both ownership patterns (modes of production) and exchange entitlements, and at the forces that lie behind them" (Sen 1981, 6). He further supports that "the importance of expanding food production in Africa, among the strategies to combat hunger on that continent, cannot be denied" (Sen 1988, 69). This helps understand that in Africa the "endowment bundle" and the "exchange entitlement mapping" which determine a person's entitlement set and hence his productive capacity are interdependent. It also helps avoid radical criticisms of the type formulated by Samir Amin (1974b) regarding some neoclassical theories or models (tautologies in Amin's terms), "which proceed from the radically mistaken idea that the unequal distribution of factors is given a priori and not the result of a development strategy," it would be useful to extend Sen's entitlement approach by stressing the recursive and repetitive nature of the entitlement relations.

In fact, Sen asserts that "a person's ability...to command any commodity he wishes to acquire or retain depends on the entitlement relations that govern possession and use in [his] society. It depends on what he owns, what exchange possibilities are offered to him, what is given to him free, and what is taken away from him" (Ibid., 154). The above argument can readily be broadened by including all the assets composing a person's "endowment bundle" among the "commodities he wishes to acquire and retain." Thus, a full recursive and repetitive set of entitlement relations would establish that the endowment situation of a

person at a given point in time is nothing but the result of a specific entitlement set, which in an "economic chain," subsequently influences his exchange entitlement mapping and ownership bundle, and so on... This argument gives credence to the contention that the market is a "political arena," a "locus of competition and conflict" and an "instrument of political control" (Bates 1981). In other words, the argument rests on the institutionalist view that "markets always reflect political preferences and prior distributional decisions," or, equivalently, "demand is determined by the distribution of wealth, and institutions establish the rules of the market" (Shaffer et al., 7). Making endowment endogenous to the entitlement relations allows us to link the entitlement approach to the concept of "a poverty-trap" in which "those caught...do not produce enough beyond immediate subsistence needs to invest in the knowledge, technical inputs, and organizations needed to increase their productivity," and may therefore remain poor because of their poverty in an "efficient but poor" market equilibrium (Ibid., 3-4).

Clearly, in a country such as Mali, where the bulk of the population still depends on agricultural (and especially food) production for its survival, food production (availability) and entitlement (access) can hardly be treated separately. Although trade-based entitlement may be important, it is reasonable to assume here that any major failure in production-based (direct) entitlement will be accompanied by a drastic cut in exchange capabilities because of a significant reduction in real income, which may result in severe food insecurity for many rural households. This is more likely so because the same endowment entitlement set which determines production-based entitlement also underlies

opportunities for exchange entitlement (e.g., cash-crop production, nonfarm production and off-farm employment), so that direct entitlement failures and trade entitlement failures tend to be highly correlated. Finally, at a more macro-level, the strong linkage of all the components of national income to the performance of the agricultural sector in Mali implies that any major failure in farmers' direct entitlement may induce general entitlement failures for other population categories (e.g., incapacity to generate public and private employment, failure to meet public payroll, slow-down in trading and other private activities, etc.).

This broader entitlement framework will be used in the context of this dissertation to analyze not only farmers' own food security strategies through their production and transactions, but also the process of agricultural growth via investment/disinvestment strategies conceptualized not only from the vantage point of pure economic profitability, but more significantly from an institutional standpoint. In so doing, it is fully accepted that the neoclassical marginalist conditions of profitability are necessary to justify Malian farmers' investment/disinvestment intentions, but they are insufficient in providing a full explanation of actual investment and disinvestment decisions, which must also take into account important institutional and policy factors. Entrepreneurial spirit and dynamism are doubtlessly important ingredients for investment and growth; however, in any society, not all individuals with such virtues enjoy the same entitlement set to succeed. And broadening the analysis to focus on inherited and/or granted privileges may yield a higher payoff

than concentrating on inherited virtues alone in the field of development strategy.

Given the same set of potential profitable opportunities, an unequal distribution of what we may call "development entitlements" most likely results, in several instances, in imbalances in growth and poverty within and between regions of the same country. First, the regional focus of agricultural (or other rural) development projects is in itself a strategic choice of distribution of entitlements, which affects relative endowments and productive and exchange capacity. Second, the determination of research and extension priorities with respect to commodities and/or ecological or administrative zones is also conducive to changes in resource and knowledge endowments and production-based entitlements. Third, commodity-based or household characteristic-based criteria of access to inputs and/or credit (with or without subsidy) lead to other entitlement differentials in a given region. Finally, uniform taxation combined with discriminatory access to strategic development inputs and services may very well explain relative success and failure of farm households to expand their capacity to produce.

Hence, individual relative success or failure can be attributed to a large extent to policy choices and institutional arrangements. Consequently, farmers' entitlements, their survival and growth strategies via the process of investment and disinvestment, as well as their overall food security should be considered in a more comprehensive framework, which integrates the effects of ecological, technological, institutional and policy factors in a coherent way. Such a broad framework is useful in analyzing the effects of policy reforms such as the cereals market

liberalization in Mali, because it allows an assessment of both the scope and the limits of market incentives in stimulating farm production, and the identification of other major constraints to increasing food production.

CHAPTER IV

EFFECTS OF ENVIRONMENTAL, TECHNOLOGICAL, AND INSTITUTIONAL FACTORS ON FARMERS' CEREALS PRODUCTION AND TRANSACTIONS

One of the fundamental assumptions underlying the cereals market reforms implemented in Mali between 1981 and 1987 was that most farmers were net sellers of foodgrains. Therefore, official price increases and freer trade would induce more investment in cereals production and increase farm income and national cereal production.

This chapter discusses the above assumption through an analysis of the major constraints that farmers face in responding to price incentives. This discussion is organized around an examination of the interactive effects of natural environment, production technologies, the institutional framework, and public sector policies on farmers' coarse grain production, transactions and food security strategies.

The analysis in this chapter proceeds from the basic hypothesis that in addition to product price considerations, foodgrain production and transactions in Mali are significantly determined by the natural environment (rainfall and soil conditions), which influences yields; available technology; the institutional context, which affects farmers' access to inputs and extension services; and policies that are not directly related to output markets and prices. This formulation is consistent with production theory, which views farm production as a function of land, labor and capital. The only nuance introduced here is

accounting not only for capital per se, but also for the institutional and policy dimensions of capital entitlements.

4.1. The Database

The data used in this chapter were collected in the best two rainfed agricultural zones of Mali (CMDT and OHV) by the CESA-MSU Food Security field research team from October 1985 to October 1987. The data cover the best two agricultural seasons (1985/86 and 1986/87) over the 1970-1987 period. During these two years, average yields and total production of coarse grains reached record levels. Over the two cropping seasons of 1985 and 1986, average yields rose by 31% for millet and sorghum and 88% for maize, and total coarse grain production increased by 77% as compared with the average for the fifteen-year period of 1970-1984 (Ministère de l'Agriculture 1987). This particularly good rainfall strengthens the conclusions and implications derived from the following analyses, since it allows us to draw the "best-case picture" of how different categories of farmers are likely to respond to the coarse grain market in a situation of surplus production.

Data on production and monthly transactions (sales, purchases, barter, and gifts) were obtained through structured interviews, using pre-tested and continuously revised questionnaires. The estimation of the total production by commodity was based on information provided by the sample farmers using their own units of measurement (carts, baskets, bags, calabashes, buckets, etc.), the total number of units harvested, and the weighing of a sample of units for conversion into kilograms. This rough, but cost-effective, method of estimation was used not only because data

collection on production began about one month after the harvest period, but also and mainly based on the fact that over 90% of the 990 farmers interviewed in the preliminary reconnaissance survey had reported information about their own method of measuring their coarse grain harvest. Moreover, it was believed that through repetition, such direct investigation methods induce farmers to memorize and report accurately quantitative information, and therefore allow substantial savings in time and money required to gather critical data on agriculture in the future.

Except for the south of OHV, all cash transactions (sales and purchases) were directly reported in kilograms, the use of scales being a standard procedure adopted by cereal assemblers throughout the country. For all non-cash transactions (barter and gifts) as well as all transaction in south OHV, conversion rates of traditional units were used, based on actual weighings by the enumerators. Information collected about these transactions included the quantities involved, the location (village or market), the client or the supplier, the prices (in kind or cash), and the reasons for the transactions.

A preliminary analysis of the data for the first year was done by the author (Dioné 1987a) and by D'Agostino (1988). The following analyses build on this previous work and include all observations for the two-year period covered.

4.2. Coarse Grain Production

4.2.1. Descriptive examination

The descriptive statistics used in this part are mainly group average production data weighted by the proportions of the different farm categories of the 16 villages in each group. These averages are compared in a general discussion of the influences of the natural, technological and institutional factors on coarse grain production. The separate effects of these factors on production will be further analyzed using econometric techniques.

The average per capita production of coarse grains was adequate to cover farm households' consumption requirements in both 1985/86 and 1986/87. Compared with an annual per capita cereals consumption requirement of 188kg¹, per capita production of coarse grains for the whole sample exceeded farmers' consumption requirements by 19.7% in 1985/86 and 62.2% in 1986/87 (Table 4-1). However, this rather good average picture conceals considerable variations of coarse grain production between farms as illustrated in Figures 4-1 and 4-2. Of the sample farm households, only 51.1% in 1985/86 and 66.5% in 1986/87 produced a surplus of coarse grains above the required 188 kg per capita. Hence, although the average production figures indicate the existence of a marketable surplus in both years, about half of the sample farm households in 1985/86 and one third of them in 1986/87 produced less grain than required for their home consumption.

1. As of 1987/88, USAID has adopted a national grain consumption figure of 188 kg per capita instead of the official 167 kg per capita, which falls below levels derived from nutritional surveys and actual per capita consumption over the 1982/83-1986/87 period (Sundberg, 1988).

A first major factor associated with the variability of coarse grain production is the institutional environment of agricultural development. Data in Table 4-1 show that, relative to OHV, coarse grain production in CMDT was 145% higher per farm, 87% higher per worker and 147% higher per capita in 1985². During the same year, the estimated value of cereals and cotton produced per worker was 149% higher in CMDT than OHV, implying that labor productivity in CMDT (the main cotton production zone) more than doubled that in OHV in both food-crop and cash-crop production. The gap in coarse grain production between the two zones increased in 1986, with foodgrain production in CMDT exceeding that in OHV by 210% per farm, 125% per worker and 195% per capita. On average, the production of sample farmers in OHV covered only 61% of their foodgrain needs in 1985/86 and 71% of these needs in 1986/87. In contrast, coarse grain production of CMDT farmers exceeded their annual consumption requirements by 50% in 1985/86 and 109% in 1986/87. The considerable gap in coarse grain production per worker between CMDT and OHV results in a significant imbalance in the extent of marketable surplus production between the two zones. The proportion of farm households with surplus grain production (more than 188 kg per capita) decreases from 64.9% in CMDT to 23.9% in OHV in 1985/86, and from 86.7% in CMDT to 26.8% in OHV in 1986/87. The strong variation in coarse grain production between CMDT and OHV reflects mainly differences in the institutional environment of agricultural production between the two zones, which, as discussed in Chapter II and Appendix I,

2. The crop year runs from November through October; hence, both the terms 1985 and 1985/86 refer to crops harvested in 1985.

Table 4-1. Coarse Grain Production by Zone, Subzone and Level of Farm Equipment, CMDT and OHV (1985 and 1986)

ZONES SUBZONES LEVELS OF EQUIPMENT	COARSE GRAIN PRODUCTION			PERCENTAGE OF FARMS WITH MORE THAN 188kg PER CAPITA	VALUE OF CEREALS AND COTTON PER WORKER (CFAF)
	PER FARM (kg)	PER WORKER (kg)	PER CAPITA (kg)		
1985					
CMDT (1)	3647	640	282	64.9	51,635
OHV (2)	1489	343	114	23.9	20,781
Variation (1)/(2)	144.9%	86.6%	147.4%	--	148.5%
SOUTH (3)	3474	650	282	59.0	55,964
NORTH (4)	2398	435	171	43.7	31,636
Variation (3)/(4)	44.9%	49.4%	64.9%	--	76.9%
EQUIPPED FARMS (5)	4799	648	278	68.6	48,156
SEMI-EQUIPPED (6)	2523	515	221	49.8	41,941
NON-EQUIPPED (7)	1134	440	166	31.9	28,723
Variation (6)/(7)	122.5%	17.0%	33.1%	--	46.0%
Variation (5)/(7)	323.2%	47.3%	67.5%	--	67.7%
TOTAL SAMPLE	2921	540	225	51.1	41,268
1986					
CMDT (1)	5193	912	392	86.7	--
OHV (2)	1677	406	133	26.8	--
Variation (1)/(2)	209.7%	124.6%	194.7%	--	--
SOUTH (3)	3980	771	329	69.4	--
NORTH (4)	4039	714	282	63.9	--
Variation (3)/(4)	-1.5%	8.0%	16.7%	--	--
EQUIPPED FARMS (5)	6967	941	395	84.2	--
SEMI-EQUIPPED (6)	3029	632	270	64.1	--
NON-EQUIPPED (7)	1590	627	237	48.4	--
Variation (6)/(7)	90.5%	0.8%	13.9%	--	--
Variation (5)/(7)	338.2%	50.1%	66.7%	--	--
TOTAL SAMPLE	4010	742	305	66.5	--

Source: CESA-MSU Food Security Project farm household surveys, 1985-87.

Note: The value of 1985 cereals and cotton production per worker is computed using the weighted average prices of coarse grains for the November 1985 - October 1986 period: 45.5 CFAF/kg for south CMDT, 46.2 CFAF/kg for north CMDT, 49.9 CFAF/kg for south OHV, and 52.8 CFAF/kg for north OHV. Cotton is valued at the official producer price of 85 CFAF/kg.

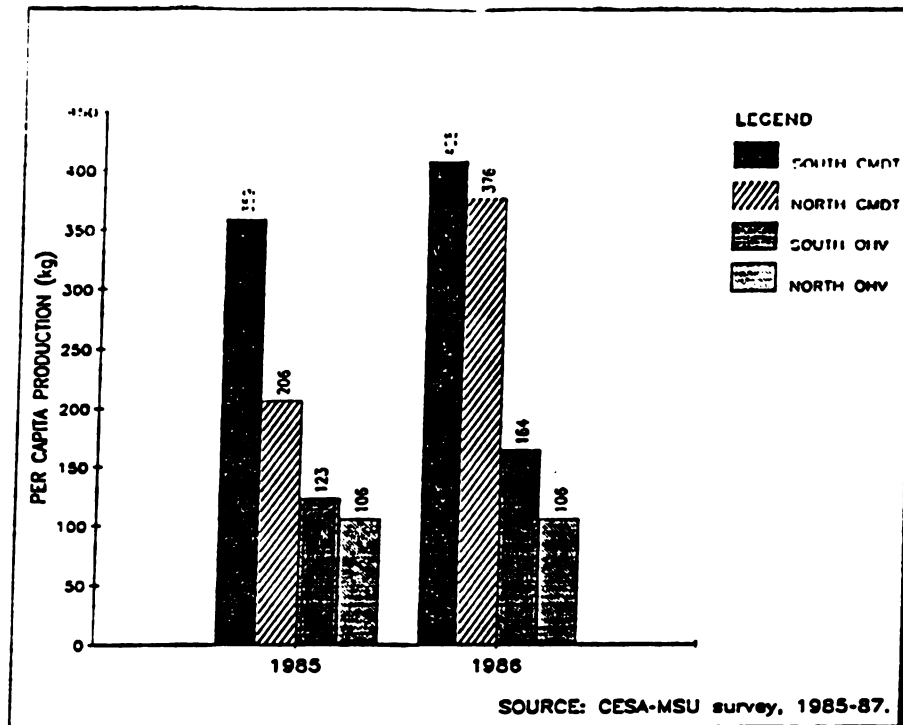


Figure 4-1. Per Capita Coarse Grain Production by Zone and Subzone, CMDT and OHV

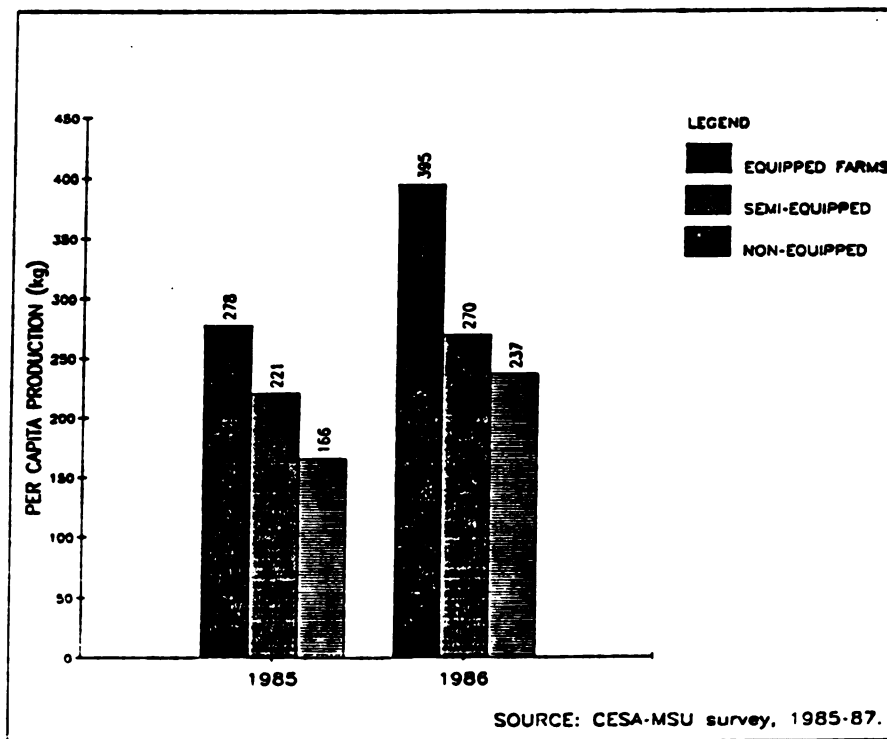


Figure 4-2. Per Capita Coarse Grain Production by Level of Farm Equipment, CMDT and OHV

are not significantly different with respect to natural factors such as rainfall and soils.

As expected, coarse grain production variability is also associated with differences in the natural environment of agricultural production. In 1985/86, coarse grain production of the sample farm households of the southern subzones of CMDT and OHV exceeded that of households in the northern subzones by 44.9% per farm, 49.4% per worker and 64.9% per capita. The gap between the south and the north increases when measured in terms of the value of average cereals and cotton production per worker, which reflects total labor productivity in agriculture better than foodgrain production alone. In 1985/86, this value was CFAF 24,000 (or 76.9%) higher in the south than the north, a difference that amounted to nearly half of the price of a multiculteur or, alternatively, to the value of the annual coarse grain requirements of 2.5 persons on the basis of 188 kg per capita.

The variability in coarse grain production between the south and the north was much lower in 1986/87. Detailed cross-tabulation of the survey data shows this is mainly because coarse grain production per farm increased by 86% in 1986/87 relative to 1985/86 in north CMDT, as compared with only 12% in south CMDT, 28.5% in south OHV and a decrease of 4.5% in north OHV. This disproportionate increase in coarse grain production in north CMDT possibly results not only from a disproportionate increase in rainfall, but also from a major shift from cotton to cereals production by most farmers of this subzone. A survey carried out in May 1986 found that most farmers in the subzone were planning to reduce their cotton fields that year in favor of coarse grains as a response to CMDT's efforts

to limit cotton output in 1986/87 because of low world market prices. Notwithstanding this possible shift, average coarse grain production in the northern subzones of CMDT and OHV remained below that of the southern subzones by 8% per worker and 16.7% per capita in 1986/87. The variation in foodgrain production and the value of cereals and cotton produced per worker between these subzones may be attributed to differences in rainfall and soil conditions, which are better in the south than the north of the survey zones. Average annual rainfall drops from about 1,000 millimeters in the southern subzones to around 700 millimeters in the northern ones, and the soils in the south (loamy clays) are more fertile than those in the north (light sandy loams and loamy sands).

A third major factor associated with coarse grain production variability is the level of farm equipment with respect to animal traction. The cross-tabulation of farm household coarse grain production data according to the three levels of animal traction equipment defined in Chapter II shows that in both 1985 and 1986, coarse grain production of equipped farm households exceeded that of non-equipped households by about one half per worker and two-thirds per capita (Table 4-1). Likewise, the value of cereals and cotton produced per worker was 67.7% higher for equipped households relative to non-equipped ones in 1985. The percentage difference between the semi-equipped and non-equipped households, although relatively low for production per worker, amounted for per capita production to 33.1% in 1985 and 13.9% in 1986. Moreover, output per family worker, estimated by the value of cereals and cotton production per worker was 46% higher for semi-equipped farms than non-equipped ones in 1985. It may therefore be hypothesized that the

ownership of animal traction equipment significantly affects farmers' capacity to produce a marketable surplus of foodgrains in response to cereals price incentives. In fact, data in Table 4-1 show that despite very good rainfall in 1986, only 48.4% of the non-equipped farm households produced surplus coarse grains above the 188 kg per capita required for home consumption.

The above discussion indicates that the natural environment, the institutional context of agricultural development, the level of farmers' equipment with respect to animal traction, and the extent of the farm household's involvement in cash crop production are four important factors to take into account in analyzing coarse grain production.

4.2.2. Econometric analysis

The purpose of the econometric analysis presented here is not a refined estimation of a production function, where the precise marginal product of all inputs can be singled out. This is impossible since the data collected do not relate explicitly to the actual levels of inputs used, but rather to the ownership of, and access to inputs, which, it is hypothesized, are highly related to input use. Therefore, what the following equations attempt to establish is the extent to which the CMDT and OHV farmers' cereals production depends on their natural environment, their access to farming equipment and the institutional environment, which affects their access to markets and agricultural services.

On the basis of the theory reviewed in Chapter III and the above descriptive analysis, total coarse grain production per farm in 1985 and 1986 is modelled as follows:

QTP = $Q(\text{WS, CPW, SZ, Z, SEQ, EQP, ACOT, NCA})$, where:

QTP = total production of coarse grains (millet, sorghum and maize);

WS = household labor stock (number of adult-equivalent farm workers);

CPW = dependency ratio (number of household members by farm worker);

SZ = natural environment (agroclimatic subzone);

Z = institutional environment (rural development zone);

SEQ = indicator of farming capital stock for households with an incomplete set of draft equipment and animals (semi-equipped households);

EQP = indicator of farming capital stock for households with an full set of draft equipment and animals (equipped households);

ACOT = cultivated area of cotton; and

NCA = activities other than crop production.

Except for the omission of land, this formulation takes into account the basic determinants of production suggested by classical agricultural production theory. The variable land is missing because no estimates of land holdings for all major crops (particularly coarse grains) were available for all sample farm households and survey resources did not permit carrying out precise field measurements. However, categorical data were collected on indicators of land availability and access to land such as the extension of cultivated land during the five years preceding the survey, the availability of fallow and bush land, and the existence of

land transfers for free among farm households. Additional analysis by the author and by D'Agostino (not presented here for simplicity) has shown that none of these indicators of land availability is significantly related to coarse grain production. This outcome was expected on the basis of the general perception that land availability and access to land are not yet severe constraints to the expansion of farm production in southern Mali. Consequently, the following analysis, which deals with stock rather than flow input variables, does not take explicit account of land, although it may be hypothesized that the actual amount and quality of cultivated land is to some extent related to the farm household's stock of labor and capital, which in turn are likely influenced by the duration of settlement and the social status of the household in the village community.

More specifically, the above model of coarse grain production per farm includes the following independent variables:

a) Total household agricultural labor stock (WS). This variable represents the number of adult-equivalent household workers who participate in agricultural production. This number was computed from demographic data collected for each household member (Producer Questionnaire No. V, Appendix II), where, regardless of sex, all workers below 14 years of age were attributed a weight of 0.5 and all workers of 15 years of age or older were given a weight of one. The break-down and weighting by age was based on the conventional equivalence system used by agricultural research institutes (especially IER) in measuring farm labor inputs in Mali. Although the omission of outside hired labor would tend to overstate the marginal contribution of the household's labor stock to coarse grain

production, one may argue that the extent of such over-estimation would be small, since not all available household labor is used exclusively in foodgrain production, and family members supply 85% or more of the total amount of labor used in all coarse grain production tasks (land preparation, planting, weeding, harvesting, threshing and storage) in the CMDT and the OHV zones (Doumbia, Mariko and Touya 1986).

b) Dependency ratio (CPW). This variable is included to take explicitly into account the fact that farmers produce coarse grains primarily for home consumption. In a context of incomplete and imperfect markets, where farmers cannot sell or buy any quantity and quality of cereals whenever they want, it is reasonable to hypothesize that the farm household's consumption decisions will affect its production decisions, as suggested by comprehensive farm household models (Singh, Squire and Strauss 1986). The lack of data on household's consumption expenditures on purchased and own commodities prevents here a simultaneous modelling of farm household's coarse grain production and consumption. As a substitute, the dependency ratio (number of household members per adult-equivalent farm worker) is introduced in the production equations to reflect implicitly the effect of the farm household's consumption needs on its production of coarse grains. For a given number of farm workers, the need to produce more cereals per worker would increase as the number of household members that each worker must feed rises, particularly when the largest share of the foodgrains consumed by the household is supplied by own production. It is therefore hypothesized that household's coarse grain production is positively related to the dependency ratio.

c) The natural environment of production (SZ). Coarse grains are rainfed crops, which are grown with very few purchased inputs in Mali. As a result, the level of coarse grain production is expected to vary significantly with agroclimatic conditions (e.g., the level and distribution of annual rainfall and the type and fertility of soils) of the different subzones of each major rainfed agricultural zone. To account for the combined effects of such natural factors on production, a dummy variable (SZ) is included in the coarse grain production equations. This variable takes the value one for the southern subzones, which have higher annual rainfall and more fertile soils, and zero for the northern subzones, where annual rainfall is lower and soils are poorer. The coefficient of the variable SZ is expected to be positive as a result of the positive effect on coarse grain production of the better agroclimatic conditions of the southern subzones relative to the northern ones.

d) The institutional environment of production (Z). Consistent with the conceptual framework discussed in Chapter III, the above model of coarse grain production per farm takes explicitly into account that farm production is also determined by the institutional environment, which affects farmers' access to technological information, input and output markets, and formal financing. The dummy variable Z is meant to reflect the effect on coarse grain production of the institutional differences between the CMDT zone ($Z = 1$) and the OHV zone ($Z = 0$). Its coefficient is expected to be positive as a consequence of the better agricultural support services (research, extension, input and output marketing, credit, etc.) in CMDT relative to OHV.

e) Household's stock of farming capital (SEQ and EQP). Since no individual property rights apply to agricultural land, which is not sold or bought in Mali, the bulk of a household's farming capital consists of its stock of tillage and transportation equipment (hoes, plows, toolbars, seeders, carts) and draft animals (mainly oxen). Animal traction constitutes almost the only improved mechanical farming technology currently available to farmers. The two dummy variables SEQ and EQP are indicators of farm household's animal traction equipment, and correspond respectively to the semi-equipped and fully-equipped strata defined in Chapter II. SEQ takes the value one for semi-equipped households and zero otherwise, while EQP equals one for the fully-equipped farms and zero otherwise. The coefficients of these variables represent the marginal contribution of the corresponding level of animal traction equipment. Both coefficients are expected to be positive, since ownership and use are very likely correlated for animal traction equipment, which allows an outward shift of the production possibility frontier by reducing labor constraints in some farming tasks (mainly land preparation, weeding and transportation).

f) Cash crop production (ACOT). Although the proposed model of foodgrain production does not concern the simultaneous estimation of multi-commodity production equations, a whole-farm approach is implicitly taken into account. Cash crop production competes with foodgrain production for farm household's land, labor and capital. At the same time, cash-crop production and income likely strengthen farmers' access to improved technologies and services when research on crop mix, access to fertilizers, equipment, formal credit and agricultural extension

services are primarily targeted to export commodities such as cotton, groundnuts and tobacco. One would expect under such circumstances that foodgrain production would benefit indirectly from the spillover effects of improvements achieved through cotton production, i.e., an extension of cultivated land, improved and timely land preparation and weeding for coarse grains, and the residual effect of cotton fertilizer on cereals through crop rotation. To account for the effects of cash crop production on foodgrain production, the actual cultivated area of cotton (ACOT) is included as a determinant of coarse grain production. Because of a strong institutional bias in favor of cotton, it is expected that the positive spillover effects outweigh the negative competitive effects of cotton production on coarse grain production, i.e., the coefficient of ACOT is expected to be positive.

g) Non-crop activities (NCA). Several activities other than crop production (e.g., livestock production and non-farm activities) also compete with coarse grain production for farm household's resources. Moreover, these activities generate income that may be used to acquire inputs for foodgrain production. The dummy variable NCA reflects the involvement of one or more farm household members in non-crop activities. NCA equals one for households with such activities and zero for those without them. In the low-input agriculture and low-income context of Mali, the coefficient of NCA is expected to be positive as an indication that the positive impact of non-crop income on labor and/or land productivity in coarse grain production outweighs the negative effect of the competition of these activities for household's productive resources. Income from cash-crop production and non-crop activities is believed to

be important for farmers' investment in foodgrain production particularly in a context of poorly functioning capital markets, where farmers cannot borrow enough for their capital needs.

Both simple-linear and log-linear functional forms of the above equation were estimated for each year of observation and for the pooled data of the two years (where the dummy variable YEAR = 0 for 1985 and 1 for 1986 was included to account for a general increase in production due to higher rainfall in 1986). The log-linear form was preferred to the simple-linear form on the basis of production theory and of a careful analysis of the sign and the significance of the estimated coefficients, the size of the coefficient of determination adjusted for the degrees of freedom (adjusted R^2), and the residuals. The estimated simple-linear equations are presented in Appendix III.

Table 4-2 presents the main statistics of the estimated equations. The level of the adjusted R^2 indicates that our model explains 54% to 60% of the variability of the 1985 and 1986 coarse grain production among the sample farm households. This relatively low level of explanation is mainly attributable to the categorical nature of most of the independent variables considered. The dummy variables used as proxies for soil and rainfall conditions (SZ), farm household's access to institutional services (Z), farming capital stock (EQP and SEQ), and household participation in non-crop activities (NAC), reflect production variations only between the corresponding strata and not within each stratum (where the true level of these variables also varies to some extent). Nevertheless, the results in Table 4-2 point to significant relations between farm

household coarse grain production and virtually all the explanatory factors considered.

In the following interpretations, the base (control) case represents a non-equipped farm household in north OHV ($Z=0$; $SZ=0$; $SEQ=0$; and $EQP=0$), which does not participate in non-crop activities ($NAC=0$) and grows no cotton ($ACOT=0$). Given the logarithmic form of the estimated equations, the regression coefficients are marginal proportional increments of total household coarse grain production for each of the independent variables. These proportional changes are expressed in percentage terms in the discussion of the results for more clarity.

Holding all other factors constant, total coarse grain production per farm increases by 5.7% in 1985 and 6.3% in 1986 for a 10% increase in the available stock of family farm labor. In other words, coarse grain production increases less than proportionally with family labor availability, and doubling the stock of family labor would raise total coarse grain production by about 60%, *ceteris paribus*. This finding suggests a low marginal productivity of labor in coarse grain production for farm households with a large number of family workers and no animal traction equipment. Hence, without investment in labor-saving technologies (e.g., animal traction), increasing the stock of available family labor would likely have a limited effect on marketable-surplus production, since the quantity needed for consumption per added worker would likely outweigh the change in total quantity produced, especially for households whose production roughly equals consumption.

Table 4-2. Estimates of Equations of Total Coarse Grain Production per Farm Household (Log(QTP)), CMDT and OHV (1985 and 1986)

INDEPENDENT VARIABLES	1985	1986	1985 and 1986
Constant	4.97 ** (0.35)	5.28 ** (0.34)	5.02 ** (0.25)
Family Labor (Log(WS))	0.57 ** (0.12)	0.63 ** (0.12)	0.60 ** (0.09)
Dependency Ratio (Log(CPW))	0.49 ** (0.17)	0.43 ** (0.17)	0.46 ** (0.12)
Zone (Z)	0.38 ** (0.13)	0.49 ** (0.13)	0.43 ** (0.09)
Subzone (SZ)	0.22 * (0.10)	0.03 (0.10)	0.13 * (0.07)
Semi-Equipped (SEQ)	0.29 * (0.12)	0.19 (0.12)	0.24 ** (0.09)
Equipped (EQP)	0.62 ** (0.16)	0.46 ** (0.16)	0.54 ** (0.12)
Cotton Area (Log(ACOT))	0.45 ** (0.14)	0.65 ** (0.14)	0.55 ** (0.10)
Non-Crop Activities (NCA)	0.17 * (0.10)	0.01 (0.10)	0.09 (0.07)
Year (YEAR)	-- --	-- --	0.23 ** (0.06)
Adjusted R ²	0.54	0.60	0.58
Number of Observations	190	186	376

Note: The figures between parentheses are the standard errors of the regression coefficients.
The number of asterisks indicate the level of significance of the regression coefficients according to the following codes:

** = significant at the 1% level.

* = significant at the 10% level.

No asterisk: not significant at the 10% level.

The positive effect of the dependency ratio on farm household's coarse grain production strongly supports the view that foodgrain production decisions are affected by the household's consumption decisions. When the family labor stock and all other factors are held constant, a 10% increase in the number of household members per unit of equivalent adult farm worker is associated with increases in total coarse grain production per household of 4.9% in 1985 and 4.3% in 1986. This finding has demographic implications for marketable-surplus production and total farm household income. The proportion of the household's labor stock allocated to foodgrain production increases as the number of consumers that each household worker must feed rises. This priority to coarse grain production in turn implies a reduction in labor availability for other income-generating activities, while the bulk of the additional coarse grain output is primarily produced for home consumption. It therefore appears difficult for households trapped in such demography-induced poverty (with many unproductive dependents) to generate surplus products for the markets in the absence of improved agricultural technologies, which may increase significantly labor productivity in foodgrain production.

As hypothesized, farm equipment in animal traction has a positive and significant effect on farmers' coarse grain production. The estimated marginal effect of the ownership of an incomplete set of draft equipment/-animals (SEQ) is an increase in coarse grain production per farm by 29% in 1985 and 19% in 1986. The expected coarse grain production rises by 62% in 1985 and 46% in 1986 for the fully-equipped farms (EQP) relative to the non-equipped ones. Although the main benefits of animal traction

are in terms of labor-savings and timeliness of farming tasks, the effects observed here may not be interpreted as a pure marginal product of equipment, since draft-equipment ownership and farm's access to, and use of, other inputs (e.g., fertilizers, improved seeds and extension advice) are strongly correlated, especially in cotton production areas. Hence, the estimated relation between foodgrain production and animal traction equipment ownership likely includes part of the effects of the complementary inputs used by the semi-equipped and the fully-equipped farm households.

Independently of the labor and capital resources and the mix of activities of the farm household, better rainfall and soil conditions have a positive effect on coarse grain production. The coefficients of the variable SZ indicate that being in the southern subzones increased the expected coarse grain production per farm significantly by 22% in 1985 but not significantly in 1986 relative to the northern subzones. As discussed in the descriptive analysis, the very low magnitude and the non-significance of the effect of the subzone on coarse grain production in 1986 is mainly caused by a disproportional increase in production in north CMDT, probably because of a higher residual effect of cotton fertilizer on cereals under higher rainfall conditions and a partial shift of land from cotton to foodgrains. Moreover, the effect of rainfall (translated into a dummy indicator instead of the actual level of rainfall) on coarse grain production is most likely understated in all the above equations. In fact, although farmers may have increased their coarse grain area in 1986 relative to 1985, the 23% increase in production in 1986 (coefficient of

YEAR in the 1985-1986 equation) is attributable in part to higher rainfalls in 1986 throughout the country.

There is a strong relation between the institutional environment (Z) and a farm household's cereals production. The expected level of coarse grain production per farm in CMDT increases by 38% in 1985 and 49% in 1986 relative to OHV, when all other factors are held constant. This difference in coarse grain production reflects the effects of all institutional factors (e.g., farmers' access to improved seasonal inputs, credit, extension and marketing services) other than those taken explicitly into account in our model. Hence, for a given endowment in agroclimatic resources, labor and agricultural equipment, the performance of the institutions in charge of the management of rural development activities significantly affects farm households' capacity to ensure their own food security and generate a surplus of food commodities for the market.

Cotton production is among the most important factors associated with the superior agricultural performance of farmers in CMDT relative to the other rainfed farming zones in Mali. The equations in Table 4-2 indicate that a 10% increase in cultivated cotton area is associated with increases of 4.5% in 1985 and 6.5% in 1986 in coarse grain production per farm. This strong complementarity between cotton and foodgrains may be explained by three major factors. First, as a major cash crop with guaranteed outlets and prices for producers, cotton currently provides the most assured source of farm income in Mali, which gives farm households a privileged access to formal credit and input markets. Second, research on agricultural commodities and farming techniques, as well as extension

services, are heavily biased in favor of cash crops (particularly cotton). Some of these improved technologies and extension efforts have important spillovers onto coarse grain production. Third, cereals benefit from residual cotton fertilizers through crop rotations. As hypothesized above, the combination of the positive effects of these factors on coarse grain production most likely outweighs the negative effects of the competition of cotton production for the stock of farm resources, so that foodgrain production increases with the extent of the farm household's involvement in the production of the cash crop.

The non-crop activities (NAC) do not seem to be significantly related to coarse grain production. This finding may be explained in part by the fact that there is no differentiation of the level of income generated by these activities. Moreover, livestock production and non-farm activities are often initiated as diversification and risk-management activities, which are financed with cash income coming from crop production. This implies that the extent of cash crop (cotton) production may be correlated with farm household's participation in non-crop activities. It may also be possible that the relationship between farm and non-farm activities is not linear (but rather U-shaped), as very poor farmers may engage in low-capital non-farm activities and richer farmers in relatively high-capital non-farm activities, while "middle farmers" specialize more in agricultural production (Matlon 1977; Liedholm and Mead).

In sum, the cross-tabulation and regression results reveal a general picture of coarse grain production, where CMDT ranks above OHV (institutional factor), the southern subzones perform better than the northern ones (agroclimatic factors), the semi-equipped and the fully-equipped

farms stand ahead of the non-equipped, and cash crop (cotton) producers also produce more foodgrains than farmers who do not grow cotton. Taking the effects of these factors together allows one to understand why farmers in CMDT are more productive than their peers in other zones with similar agroclimatic conditions. In our survey areas, 46% of the farm households in CMDT and only 16% of those in OHV were fully equipped in 1985. Moreover, nearly 90% of the farms in CMDT compared with barely 15% in OHV engaged in cotton production. Consistent with the above discussion, 92% of the farm households in CMDT and 29% of those in OHV had access to formal agricultural credit (which relates very much to access to farm input distribution) over the 1981-1985 period. Such factors, which affect coarse grain production to a significant extent, are also expected to influence a farm household's foodgrain transaction and security strategies.

4.3. Cash Transactions of Coarse Grains

In dealing with Malian farmers' cereal transactions, it is important to distinguish between cash transactions (sales and purchases) and non-cash transactions (gifts and barter). In an incompletely monetized economy, a significant proportion of good and service are exchanged in kind. In addition, social ties through kinship, marriage, religion, friendship, etc., command an intricate set of liabilities that farmers often meet by the provision of a certain amount of their family labor or their agricultural products, particularly foodgrains. Omitting this social function of coarse grains from the analysis of grain transactions

may lead to an inaccurate estimate of both farm surplus production and foodgrain availability for farm household consumption.

4.3.1. Gross sales

An estimated 63.3% of the farms of the 16 survey villages sold coarse grains in 1985/86 (Table 4-3). A slight drop of this proportion to 58% in 1986/87 was combined with an increase of the average sales per farm from 228 kg to 319 kg, so that the percentage of total coarse grain production sold remained constant at 7.8% for both years. This percentage is much lower than the 10-15% surplus production that is generally assumed to be marketable, suggesting that farmers consume more and/or store more cereals in years of good harvest. The difference may also suggest that a significant proportion of farmers' surplus cereal transactions takes place outside the cash market.

Sorghum is the most sold of the three crops considered. With only a 40% share in total coarse grain production (Table 4-1), sorghum accounts

Table 4-3. Coarse Grain Sales (1985/86 - 1986/87)

	1985/86	Average 1986/87	1985/87
Percentage of farms with sales	63.3	58.0	--
Sales per farm (kg)	228	319	273
Percentage of production sold	7.8	7.8	7.8
Millet as percentage of sales	27.8	26.8	27.2
Sorghum as percentage of sales	65.0	71.9	69.0
Maize as percentage of sales	7.2	1.2	3.7
Percentage of millet production sold	4.2	5.1	4.7
Percentage of sorghum production sold	14.0	11.6	12.5
Percentage of maize production sold	4.5	0.9	2.5

for 69% of the total sales over the two years covered, leaving only 29% to millet, which represents 49% of total coarse grain production, and less than 4% to maize. Alternatively, the proportion of sorghum production sold (12.5%) more than doubled that of millet (4.7%) and amounted to five times that of maize (2.5%).

Many factors underlie this phenomenon. First, most farmers rank millet first as far as durability and storability is concerned. Some of them reported that millet heads can be stored for up to five years without significant losses of quantity or quality, while substantial losses are likely in sorghum or maize stocks kept for more than two years. Second, maize has a shorter production cycle (2-3 months) than sorghum (4-5 months). Hence, most of the maize production may be consumed as a hunger-breaker by the farm household during the last months of the rainy season, prior to the main harvest period. Third, sorghum sales may provide more cash when both sorghum and millet market prices are very close, especially following good rainfall seasons when the marginal value product of farm household's resources is higher for sorghum than millet production. Finally, farmers show a certain consumption preference for millet, which lends itself to a wider variety of dishes than sorghum and maize. From the combined effects of these factors emerges a strategy whereby most farmers in the high-rainfall subzones consider maize as a hunger-breaker, millet as a superior and/or insurance grain, and sorghum as the major cereal for the market.

Data on the variability of farmers' sales of coarse grains by zone, subzone and equipment level are summarized in Table 4-4. Contrary to the general perception that farmers are foodgrain sellers, fewer than two-

thirds of the households of the 16 survey villages sold coarse grains in 1985/86 or 1986/87. There are no major difference between the percentage of grain sellers in the south and the north. However, in any year, both the average quantity sold per farm and the percentage of total production sold in the south more than doubled the levels in the north. This suggests that foodgrain sales are not merely proportional to the level of

Table 4-4. Coarse Grain Sales by Zone, Subzone and Level of Farm Equipment, CMDT and OHV (1985/86 - 1986/87)

ZONES/SUBZONES EQUIPMENT LEVELS	PERCENTAGE OF FARMS WITH SALES		AVERAGE SALES PER FARM (Kg)			SALES AS % OF PRODUCTION (1985/86- 1986/87)
	1985/86	1986/87	1985/86	1986/87	AVERAGE	
SOUTH CMDT	73.7	67.4	438	665	552	12.0
NORTH CMDT	65.9	71.8	162	213	188	4.4
SOUTH OHV	50.3	19.3	52	46	49	2.5
NORTH OHV	50.9	49.2	119	119	119	9.1
TOTAL CMDT	69.8	69.6	299	437	368	8.3
TOTAL OHV	50.7	35.2	88	85	86	5.3
TOTAL SOUTH	66.1	51.8	313	465	389	10.4
TOTAL NORTH	60.7	63.9	147	181	164	5.1
TOTAL SAMPLE						
Equipped farms	79.9	78.0	423	595	509	8.7
Semi-equipped	60.9	51.7	146	201	173	6.2
Non equipped	46.4	41.5	86	121	103	7.6
All farms	63.3	58.0	228	319	273	7.8

production, but are more likely related to the magnitude of production in excess of a given level of (current and future) home consumption. The capacity to generate such a surplus would then be significantly affected

by the difference in natural conditions (e.g., rainfall and the quality of soils) between the southern and the northern parts of each zone.

However, this general statement must be qualified on a zone-by-zone basis. In CMDT, where both southern and northern farms have to some extent a similar set of cash-earning activities (cotton and nonfarm occupations), average sales per farm and the percentage of production sold in the south almost triple those in the north. In contrast, farmers in north OHV, with a much lower per capita production, sold twice as much as their peers in the south of the same zone. This seeming paradox may be explained by the effect of cotton (not grown in northern OHV) on coarse grain sales. CMDT farmers sold relatively more cereals in the south than the north because the interaction of better natural conditions and a good institutional environment (better access to input and output markets) in the south allow them to achieve a much higher level of food security, and to generate a substantially greater marketable surplus through significantly greater production of both cotton and cereals than in any other part of the country. These farmers tend to consider coarse grains as commercial crops more than the other agricultural producers because of the wider range of income-earning opportunities that are available to them for their household food security.

Farm households in south OHV were the least market-oriented for foodgrains, their gross sales averaging out to only 2.5% of total production. These farm households likely follow a strategy whereby the bulk of their cash needs is met by income from other activities (including cotton production to a lesser extent than the CMDT and non-farm activities), and cereal production is saved to assure home consumption. In

contrast, farm households in north OHV, despite their lower level of production, sold twice as much grain as those in south OHV to meet cash-income constraints not met by income from either cotton (not grown) or non-agricultural activities.

Depending on the year, the average farm in CMDT sold three to five times more cereals than the average farm in OHV. Moreover, only farms in south CMDT sold at least 10% of their total production. On average, for the two zones taken together. There are no major difference between the percentage of production sold by farms at different levels of equipment. This suggests a misleading average picture in which sales are an almost fixed proportion of production for all farms regardless of their production techniques. In fact, animal traction equipment induces a great variability of grain sales among farms due to its significant impact on the level of production itself.

The factors discussed above result in a very unequal distribution of grain sales among farm households, as shown in Table 4-5. The fully equipped farms in south CMDT (only 13.2% of the total number of farms of the 16 survey villages) made almost half (49.4%) of all grain sales during the two good years covered. The south of CMDT alone, with fewer than one third of the farms of the sample villages, accounted for two-thirds of all grain sales. Nearly 90% of the sales were located in CMDT and came primarily (63.5%) from the fully equipped farms of this zone. For the two zones taken together, fully equipped farms (36% of the farms) accounted for 44% of the number of households selling grain and 67.1% of the total quantity of cereals sold in the 16 villages.

Table 4-5. Distribution of Coarse Grain Sellers and Sales by Zone, Subzone and Level of Farm Equipment (1985/86 - 1986/87)

ZONES/SUBZONES EQUIPMENT LEVELS	PERCENTAGE OF SAMPLE FARMS	PERCENTAGE OF GRAIN SELLERS	PERCENTAGE OF GRAIN SALES
<u>South CMDT</u>	32.7	36.4	66.8
Equipped Farms	13.2	18.3	49.4
Semi-equipped	11.2	12.4	13.4
Non Equipped	8.3	5.7	4.0
<u>North CMDT</u>	33.6	36.4	22.7
Equipped Farms	17.4	20.8	14.3
Semi-equipped	10.6	10.3	5.0
Non Equipped	5.6	5.3	3.4
<u>South OHV</u>	15.8	12.7	2.8
Equipped Farms	2.3	2.6	1.2
Semi-equipped	7.0	6.3	1.3
Non Equipped	6.5	3.8	0.3
<u>North OHV</u>	17.9	14.5	7.7
Equipped Farms	3.1	2.4	2.2
Semi-equipped	5.9	5.6	2.2
Non Equipped	8.9	6.5	3.3
Total CMDT	66.3	72.8	89.5
Total OHV	33.7	27.2	10.5
Total SOUTH	48.5	49.1	69.6
Total NORTH	51.5	50.9	30.4
<u>Total SAMPLE</u>	100.0	100.0	100.0
Equipped Farms	36.0	44.1	67.1
Semi-equipped	34.7	34.6	21.9
Non Equipped	29.3	21.3	11.0

Note: The percentages presented here are extrapolations to the entire farm-household population of the 16 survey villages, taking into account the respective weights of the different categories of farms in this population.

Figure 4-5 and Table A.4-1 (Appendix IV) illustrate the skewness of the distribution of coarse grain sales among farm households. In each of the two years, much more than one third of all grain sales were made by about the top 5% of farms. Half of the total sales were made by the top 10% of farms in 1986/86 and the top 6.3% of farms in 1986/87. Three-quarters of all sales were made by fewer than 25% of all farms in 1985/86 and only the top 17% of farms in 1986/87. Finally, 90% of the total quantity of coarse grains sold came from only 36.4% of the farms in 1985/86 and fewer than one-third (32.4%) of the households in 1986/87. These facts point to the conclusion that farm households are very heterogenous in coarse grain marketings, even in terms of their gross sales.

A clear distinction appears between CMDT and OHV in the location of farmers' coarse grain sales. Approximately 90% of all sales in CMDT were made at weekly market places, while the largest portion of sales in OHV (71.7% in the south and 55.1% in the north) were made at the producers' home (Table 4-6). Consequently, virtually all sales in CMDT were made to private traders. The marketing parastatal (OPAM) and farmers were very marginal clients in CMDT, each with less than 3% of total grain sales. Farmers in OHV sold relatively more to the public system (15.1% of the sales in the south and 16.6% in the north) and to their neighbor farmers (28.4% of total sales in the south and 12.6% in the north). The data in Table 4-6 also reinforce the argument that farmers in south OHV seem to be less tied into the market system than farmers in the other survey subzones.

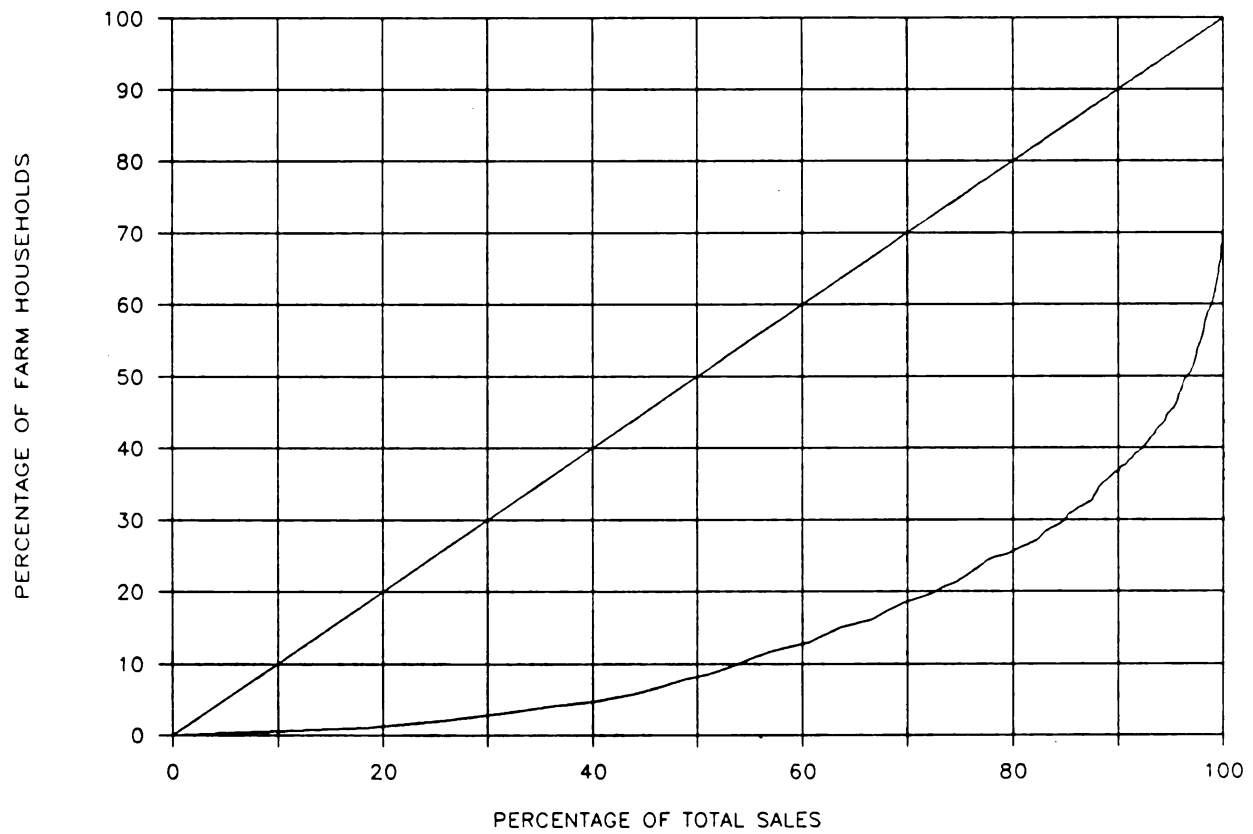


Figure 4-3. Concentration of Sales
CMDT and OHV (1985/86 - 1986/87)

Table 4-6. Distribution of Farmers' Coarse Grain Sales by Location and by Category of Clients, CMDT and OHV (1985/86-1986/87 total)

ZONES/SUBZONES	PERCENTAGE OF SALES BY LOCATION		PERCENTAGE OF SALES BY TYPE OF CLIENT		
	VILLAGE	MARKET	OPAM	TRADER	FARMER
SOUTH CMDT	8.3	91.7	2.2	96.1	1.7
NORTH CMDT	10.6	89.4	0.1	97.1	2.7
SOUTH OHV	71.7	28.3	15.1	56.5	28.4
NORTH OHV	55.1	44.9	16.6	70.8	12.6

It may be hypothesized from these facts that improved market access (the state of the roads and access to transportation) plays a significant role in shaping farmers' commercial behavior. The road and other market infrastructure are relatively much less developed in OHV, where relatively fewer farm households own a cart. Consequently, OHV farmers (most of whom have grain deficits) tend to avoid transaction costs by concentrating their sales more among themselves at the village level and sell relatively more to the public system in an environment with a lower level of private-trader competition. In contrast, the cereals market liberalization may have a positive impact on the income of the surplus producers in CMDT who sell in a more competitive private market.

Farmers' coarse grain sales are significantly determined by the combination of their cash income needs and liabilities on the one hand, and the relative importance of their cash earnings from alternative activities and sources other than grain sales on the other hand. As a

result, the reasons for coarse grain sales vary significantly with the natural and institutional context, which affect both cash liabilities/needs and income-earning opportunities.

Consistent with this view, there is a clear difference between CMDT and OHV farm households' motives for selling foodgrains (Table 4-7). The majority of cereal sellers in CMDT (76.1% in the south and 84.3% in the north) sold surplus grains, primarily in order to purchase nongrain food items (fish, meat, sugar, oil, salt and a variety of spices) in order to improve and diversify their diets. Sales to generate cash for tax or loan payments are, in general, marginal in CMDT and concern mostly the non-equipped households, whose cash-earning capacity from cotton production or nonfarm activities is more limited. Tax payment is a reason for sales for fewer than 15% of the sellers in south CMDT and fewer than 3% in north CMDT.

In the OHV zone, by contrast, tax payment was reported as the first-ranking motive for sales by the majority of cereal sellers (51.3% in the south and 91.6% in the north). When the ranking of sale motives is disregarded, part of the sales of virtually all grain sellers in OHV was motivated by tax payment. Very few of these households (only 30.7% in the south and 3.4% in the north) could afford to sell cereals primarily to improve their diets through the purchase of nongrain food items, although all of them ultimately reported such expenses among their sales motives.

**Table 4-7. Distribution of Coarse Grain Sellers by Sales Motive
CMDT and OHV (1985/86 - 1986/87)**

ZONES/SUBZONES AND EQUIPMENT LEVELS	PERCENTAGE OF SELLERS PER SALES MOTIVE					
	FOOD (CONDI- MENTS)	TAX PAYMENT	LOAN PAYMENT	TOOLS AND EQUIPMENT	HIRED LABOR WAGES	SOCIAL EVENTS
<u>South CMDT</u>						
Equipped Farms	100.0	9.1	9.1	18.2	9.1	9.1
Semi-Equipped	100.0	7.0	9.4	12.5	0.0	0.0
Non Equipped	66.7	33.3	33.3	0.0	0.0	0.0
All Farms:						
No. 1 Motive	76.1	12.0	12.0	0.0	0.0	0.0
Among Motives	91.1	14.9	15.7	11.5	3.7	3.7
<u>North CMDT</u>						
Equipped Farms	85.7	0.0	0.0	14.3	0.0	0.0
Semi-Equipped	100.0	0.0	0.0	0.0	0.0	0.0
Non Equipped	50.0	16.3	50.0	0.0	0.0	25.0
All Farms:						
No. 1 Motive	84.3	0.0	4.1	7.4	0.0	4.1
Among Motives	84.3	2.7	8.3	7.4	0.0	4.1
<u>South OHV</u>						
Equipped Farms	100.0	100.0	87.5	12.5	0.0	0.0
Semi-Equipped	100.0	100.0	100.0	0.0	0.0	0.0
Non Equipped	100.0	100.0	40.0	60.0	0.0	0.0
All Farms:						
No. 1 Motive	30.7	51.3	18.0	0.0	0.0	0.0
Among Motives	100.0	100.0	71.6	28.4	0.0	0.0
<u>North OHV</u>						
Equipped Farms	100.0	100.0	60.0	0.0	0.0	0.0
Semi-Equipped	100.0	84.5	100.0	0.0	0.0	0.0
Non Equipped	100.0	100.0	80.0	0.0	0.0	0.0
All Farms:						
No. 1 Motive	3.4	91.6	5.0	0.0	0.0	0.0
Among Motives	100.0	95.1	82.8	0.0	0.0	0.0

Note: For all farms, "No. 1 Motive" refers to the most important motive stated by the respective grain sellers; the "Among Motives" distribution refers to the percentage of sellers by motive regardless of the ranking of the motives. Break-downs by level of equipment do not take into account motive ranking.

Only a few farmers of the cotton producing subzones (11.5% of the sellers in south CMDT, 7.4% in north CMDT and 28.4% in south OHV) sold cereals explicitly in order to invest in farming tools and equipment. This motive concerns mainly fully and semi-equipped farms and ranks as first only for 14.3% of the fully equipped sellers in north CMDT. In the majority of these cases, the proceeds of the sales were used to maintain and repair rather than to acquire animal traction equipment.

Table 4-7 also shows that the diversity of the sales motives decreases from south CMDT (six reasons) to north CMDT (five reasons) to south OHV (four reasons) and to north OHV (three reasons). This variability in the number of cereals sales motives seems to reflect the increasing poverty as one moves from south CMDT (with relatively high income from cotton) to north OHV (with no important cash crop).

It is only in south CMDT, where cotton production confers to some fully equipped households the status of quasi-commercial farms, that coarse grain sales were occasionally made to pay hired labor wages. Although exchanges of foodgrains for labor are found in almost all parts of the country, these transactions are usually made in the form of barter.

Likewise, only about four percent of the sellers in CMDT and none in OHV listed expenses for social events among the reasons for their coarse grain sales. This outcome is consistent with the common practice of using cereals as gifts in kind rather than converting them into cash during such events.

The timing of sales, it is expected, would vary for the different farm categories depending on the household's sales motives and alternative sources of cash incomes. For this analysis, the 12-month period extending

between two harvests is divided into four quarters. The first quarter (November-January) immediately follows the harvest and normally corresponds to the period of peak supply and lowest levels of coarse grain prices. The second quarter (February-April) completes the 6-month period during which farmers pay their taxes. The last two quarters cover the season of farming activities (from land preparation to next harvest) and coincide with the "hungry season" when foodgrain supply becomes relatively scarce and prices increase gradually up to the one or two months prior to the next harvest.

If all farmers could freely chose the timing of their grain sales, one would expect all of them to postpone the bulk of their sales until the hungry season (May-August), when rural-market prices reach their highest annual levels. This is, however, not the case, as depicted by the data in Table 4-8. Except for the non-equipped households of the north, all other farm categories in CMDT made more than 50% of their sales during the last two quarters (May-October). In contrast, except for the fully-equipped farms of the south, all other farm strata in OHV made more than 88% of their sales during the two quarters (November-April) immediately following harvest. The picture is even worse for the semi-equipped and the non-equipped households of OHV, which made more than 60% of their grain sales during the three months immediately following harvest, and virtually no sales during the last two quarters when prices were higher.

These differences in sales behavior are explained to a large extent by the interactions of the timing of farmers' cash liabilities and their alternative cash income sources. Thus, most of the farmers in CMDT can rely on cotton sales for most of their cash needs during the immediate

**Table 4-8. Quarterly Distribution of Farmers' Coarse Grain Sales
CMDT and OHV (1985/86-1986/87 total)**

ZONES/SUBZONES EQUIPMENT LEVELS	PERCENTAGE OF TOTAL SALES PER QUARTER			
	NOVEMBER- JANUARY	FEBRUARY- APRIL	MAY-JULY	AUGUST- OCTOBER
<u>South CMDT</u>				
Equipped Farms	13.6	10.4	27.9	48.1
Semi-Equipped	30.1	6.1	34.6	29.2
Non Equipped	13.6	10.6	51.3	24.4
All farms	16.6	9.6	30.6	43.2
Price Index	100.0	98.1	130.5	159.0
<u>North CMDT</u>				
Equipped Farms	16.0	20.2	43.6	20.2
Semi-Equipped	18.8	30.1	35.0	16.1
Non Equipped	11.4	45.5	31.7	11.4
All farms	16.0	24.6	40.8	18.5
Price Index	100.0	93.8	141.0	174.4
<u>South OHV</u>				
Equipped Farms	33.6	37.5	25.8	3.1
Semi-Equipped	62.1	26.5	6.1	5.3
Non Equipped	79.4	20.6	0.0	0.0
All farms	52.6	30.3	13.6	3.5
Price Index	100.0	103.2	154.8	185.9
<u>North OHV</u>				
Equipped Farms	47.7	40.9	11.4	0.0
Semi-Equipped	66.9	29.4	3.7	0.0
Non Equipped	66.2	33.8	0.0	0.0
All farms	62.5	34.3	3.2	0.0
Price Index	100.0	97.4	133.3	149.2

Source: CESA-MSU Food Security Project rural market surveys, 1985-87.

Note: Quarterly price indices are computed only for 1986/87 (a more typical year with moderate state intervention), using the November-January quarter as base.

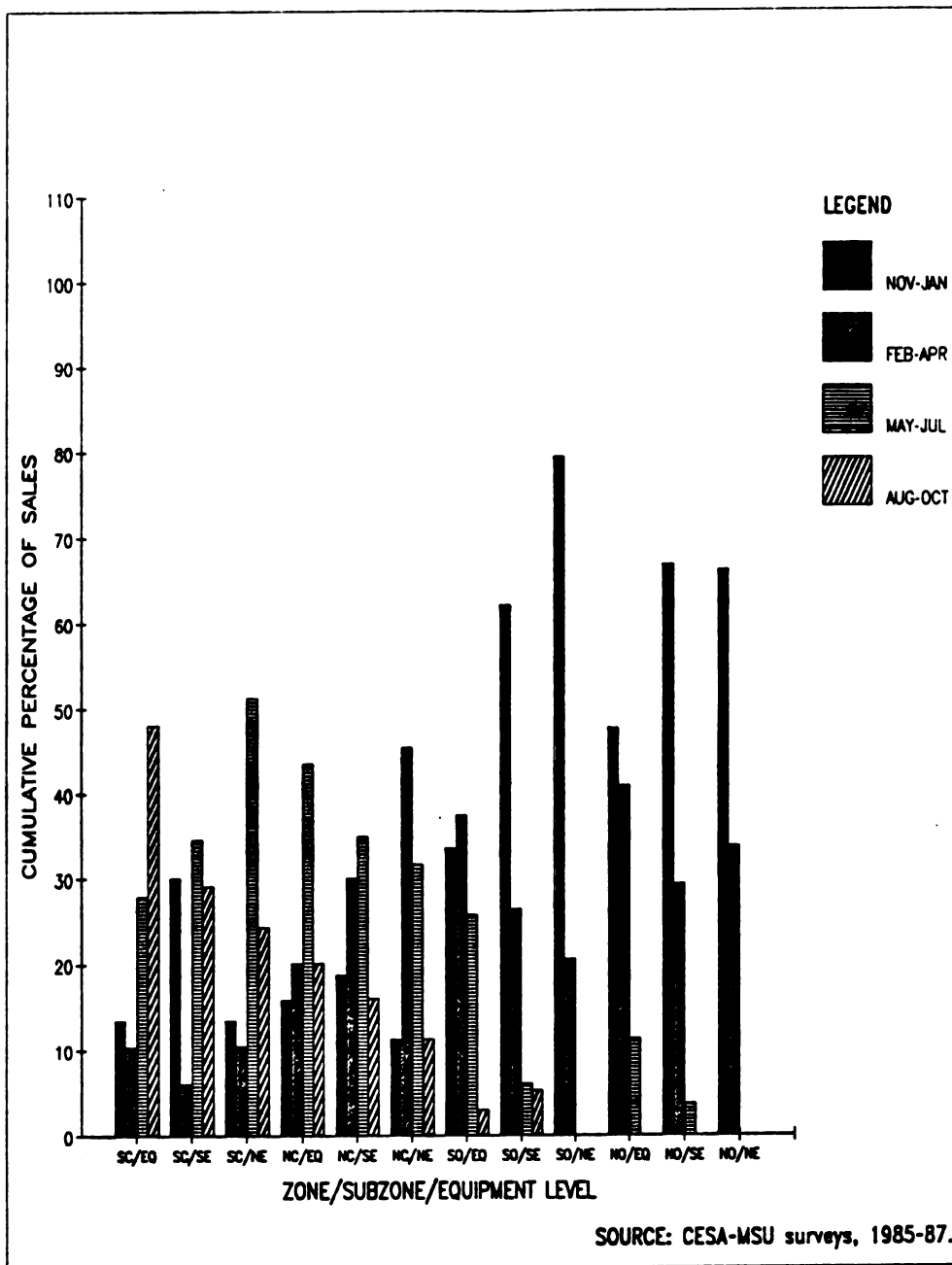


Figure 4-4. Quarterly Distribution of Grain Sales, CMDT and OHV (1985/86 - 1986/87)

post-harvest months. Because the cotton market and prices are guaranteed by the state during the official cotton marketing season (January-April), cotton producers can afford to wait until prices reach seasonal higher levels to sell their cereals. This ability to plan grain sales according to seasonal price variations depends on the level of household cotton production. This is illustrated by the drop in the proportion of sales made over the last two quarters from 73.8% in south CMDT to 49.3% in north CMDT, to 17.1% in south OHV and to 3.2% in north OHV, where no cotton is grown.

Finally, the seasonal pattern of coarse grain sales is related to the level of animal traction equipment, particularly in the areas with less cotton production. In these areas, cash income from sources other than cereals sales is relatively low and most non-equipped farmers do not produce enough cereals for their consumption needs. Most equipped sellers have larger marketable surpluses and may still have some cereals to sell later, beyond their cash needs of the immediate post-harvest period, particularly when they may use their carts to earn non-agricultural income from hauling. In contrast, virtually all the sales of the non-equipped farms of the areas with marginal cotton production are made under the compulsion of cash needs (mainly for tax payment) during the three to six months immediately following harvest. Thus, the percentage of total grain sales made during the first two quarters of the crop year consistently decreases from the fully equipped farms to the semi-equipped and the non-equipped households in north CMDT and the entire OHV. No non-equipped household in OHV sold grain from May to October.

4.3.2. Purchases

Contrary to the common view that farmers only sell and do not buy foodgrains, the data in Table 4-9 show that almost half (46.7%) of the farm households of the 16 villages surveyed bought grain in 1985/86. Even after a second consecutive good harvest in 1986, nearly one-third (32.2%) of the farms reported cereal purchases. For the total sample, the quantity of coarse grains bought per farm (averaging about 220 kg) did not

Table 4-9. Coarse Grain Purchases by Zone, Subzone and Level of Farm Equipment, CMDT and OHV (1985/86 and 1986/87)

ZONES/SUBZONES EQUIPMENT LEVELS	% OF FARMS WITH PURCHASES		AVERAGE PURCHASES PER FARM (KG)			PURCHASE TO SALE RATIO (1985/86- 1986/87)
	1985/86	1986/87	1985/86	1986/87	AVERAGE	
SOUTH CMDT	15.1	13.8	59	40	49	0.09
NORTH CMDT	52.3	17.9	279	116	197	1.05
SOUTH OHV	57.4	34.9	257	45	151	3.10
NORTH OHV	84.7	90.7	354	904	629	5.27
TOTAL CMDT	33.9	15.9	170	78	124	0.34
TOTAL OHV	71.9	64.6	309	502	406	4.70
TOTAL SOUTH	28.8	20.6	123	42	82	0.21
TOTAL NORTH	63.6	43.2	305	390	348	2.12
Total SAMPLE						
Equipped farms	27.9	12.4	181	258	219	0.43
Semi-equipped	53.9	34.5	246	123	185	1.07
Non equipped	61.1	53.3	226	286	256	2.48
All farms	46.7	32.2	216	221	219	0.80

vary much between the two years, implying that the drop in the number of buyers was offset by an increase in the average quantity purchased per buyer in 1986/87. For the two years, farmers made total purchases amounting to 80% of their grain sales. Thus, net sales amounted to only 20% of the gross sales.

Farm household coarse grain purchases varied with the natural environment of production. In each year, the proportion of buyers in the north (63.6% in 1985/86 and 43.2% in 1986/87) more than doubled that of the south. Likewise, the average quantity bought per farm in the north amounted to 9.3 times that of the farms in the south in 1985/86 and 4.2 times that amount in 1986/87. Farmers of the north bought 2.1 times more grain than they sold, while the purchases in the south amounted to only 21% of the gross sales.

Moreover, coarse grain purchases were influenced by the institutional context. Only 34% of the farms in CMDT bought foodgrains in 1985/86, compared with 72% in OHV. Despite a general drop in the percentage of buyers in 1986/87, 65% of the farms in OHV purchased grain, as compared with only 16% in CMDT. The average quantity of grain bought per farm in OHV represented 6.4 times (in 1985/86) and 3.3 times (in 1986/87) that in CMDT. Furthermore, farmers in OHV bought 4.7 times more grain than they sold, while the purchases amounted to only 34% of the gross sales in the CMDT.

Finally, draft equipment and animal ownership also was highly correlated with a farm household's foodgrain purchases. For the whole sample, 61% of the non-equipped households, 54% of the semi-equipped and only 28% of the equipped farms purchased cereals in 1985/86. Although all

these percentages fell in 1986/87, still over half of the non-equipped and more than one-third of the semi-equipped, compared with only 12% of the equipped farms, bought grain. An examination of the ratios of purchases to sales shows that only fully-equipped farms as a class sold more than they bought; the semi-equipped farms approximately broke even (their purchases exceeded sales by only 7%), while the non-equipped had purchases amounting to nearly 2.5 times their gross sales.

It may be argued that 1986/87 represented the best situation to face Malian farmers for several years, since it was one of the rare second successive good rainfall years during the last two decades. Because CMDT and OHV are two of the best endowed zones in agricultural resources (land, soil, rain, labor and capital inputs), one can conclude that at least one-third of the farm households of the country had to buy foodgrains from the market. The proportion of these buyers can vary from as low as 14% in good institutional and natural environments such as south CMDT to as much as 90% in poor institutional and drier subzones like north OHV.

Of the four subzones considered in this research, only the south of the CMDT showed all farm categories with purchases far below gross sales, and except for the fully equipped households in north CMDT and south OHV, all farm strata of the other three subzones displayed purchases larger than their sales. From this standpoint, south CMDT had a net positive export of coarse grains to the market, north CMDT was nearly self-sufficient (only 5% more purchases than sales), while both subzones in OHV were net importers.

There are clear differences between the subzones as far as the location and the types of supplier of the cereals bought by farm

households are concerned (Table 4-10). In the south of CMDT, where the road network is much more developed and the existence of a substantial marketable surplus of grain induce some farmers to act as cereals assemblers, the bulk of the purchases were made in the farmers' own villages (72%) from traders (73%). In contrast, nearly 92% of the sales in south CMDT were made in the marketplace (Table 4-6). One possible explanation of the divergence between the locations of sales and purchases in this subzone is that the large volume of sales (about 550 kg per household per year, Table 4-4) makes it worth the opportunity cost of time to go to the market to carry out the transactions, while for the small amount of grain purchased (40 kg to 60 kg per household per year, Table 4-9), the convenience of carrying out the transactions in the village outweighs the potential savings of going to the market.

Table 4-10. Distribution of Farmers' Coarse Grain Purchases by Location and Category of Supplier, CMDT and OHV (1985/86 - 1986/87)

ZONES/SUBZONES EQUIPMENT LEVELS	% OF PURCHASES BY LOCATION		% OF PURCHASES BY CATEGORY OF SUPPLIER	
	VILLAGE	MARKET	TRADER	FARMER
SOUTH CMDT	71.7	28.3	73.1	26.9
NORTH CMDT	24.8	75.2	55.1	44.9
SOUTH OHV	23.6	76.4	34.6	65.4
NORTH OHV	67.8	32.2	53.5	46.5

In north CMDT and south OHV, where supply may be short at the individual village level, about 75% of the purchases were made in the marketplace, mostly from traders in north CMDT and from other farmers in south OHV, where the market remains dominated by small sellers using traditional measurement units (panys). Another difference between these two subzones is that in north CMDT the relatively large volume of both sales and purchases (about 200 kg per household per year) may justify carrying out most transactions in the marketplace, while in south OHV, only the relatively large amount of purchases (about 150 kg per household per year compared with 50 kg for sales) seems to be worth the opportunity cost in time to go to the market.

In the north of OHV, the global grain deficit of most villages likely makes it worthwhile for traders to supply farmers with cereals directly in their villages, and for a few wealthy farmers to engage in coarse grain trading.

It appears that the private market is very dynamic, both in taking farmers' surplus production and supplying deficit rural households with the foodgrains they need for home consumption. Therefore, measures that improve market access (road networks, transportation means, diversification of cash income-generating activities, etc.) will likely enhance the capacity of deficit grain-producing households to take advantage of such market dynamism to raise their food status.

Most farmers buy coarse grains for family food needs. Immediate home consumption constituted the first-ranking motive for the purchases of virtually all cereal buyers in OHV, where farm production generally falls short of family food needs and cash liabilities often force deficit

producers to sell some of their stocks immediately after harvest. In contrast, only 57.5% of the buyers in south CMDT and 42.2% of those in north CMDT purchased grain to meet current food shortages (Table 4-11). The motive to purchase cereals for immediate consumption was general for all farm categories in OHV, while it tended to be strong only for the less-equipped farms in CMDT.

Outside of south CMDT, security stock building for future consumption is the second most important reason for farm households' coarse grain purchases. This motive even ranks first before immediate consumption for 58% of grain buyers in north CMDT, thanks to their cotton cash income, which enables them to adopt such a risk-avoiding strategy.

More than 80% of the grain buyers (or approximately 75% of the sample farms) in north OHV bought coarse grains for seeds. Although this motive ranked second or third after immediate consumption or stock building for future consumption, it reinforces the idea that farmers of this relatively poor natural and institutional environment are often forced to adopt very short-term crisis-management strategies whereby they usually consume or sell (for non-deferable cash liabilities) all their cereal harvest several months before the next production season. In the interim, they go hungry and have to buy back expensive grain not only for immediate family food needs, but also for seeds¹.

1. No hybrid seeds of coarse grains are used. Traditionally, farmers retain their own seed for planting.

Table 4-11. Distribution of Coarse Grain Buyers by Purchase Motive

ZONES/SUBZONES EQUIPMENT LEVELS	PERCENTAGE OF BUYERS PER PURCHASE MOTIVE				
	IMMEDIATE CONSUMPTION	STOCK BUILDING	PROCESSING FOR SALES	COMMERCIAL SALES	SEED
<u>South CMT</u>					
Equipped Farms	50.0	0.0	0.0	50.0	0.0
Semi-Equipped	0.0	0.0	100.0	0.0	0.0
Non Equipped	100.0	0.0	0.0	0.0	0.0
All Farms:					
No.1 Motive	57.5	0.0	17.0	25.5	0.0
Among Motives	57.5	0.0	17.0	25.5	0.0
<u>North CMT</u>					
Equipped Farms	0.0	100.0	0.0	0.0	0.0
Semi-Equipped	82.0	18.0	0.0	0.0	0.0
Non Equipped	100.0	0.0	0.0	0.0	0.0
All Farms:					
No.1 Motive	42.2	57.8	0.0	0.0	0.0
Among Motives	42.2	57.8	0.0	0.0	0.0
<u>South OHV</u>					
Equipped Farms	100.0	100.0	0.0	0.0	0.0
Semi-Equipped	100.0	100.0	0.0	0.0	0.0
Non Equipped	100.0	83.3	0.0	0.0	0.0
All Farms:					
No.1 Motive	100.0	0.0	0.0	0.0	0.0
Among Motives	100.0	93.2	0.0	0.0	0.0
<u>North OHV</u>					
Equipped Farms	100.0	50.0	0.0	0.0	100.0
Semi-Equipped	100.0	36.6	0.0	6.7	87.5
Non Equipped	100.0	50.0	0.0	8.3	75.0
All Farms:					
No.1 Motive	89.4	4.2	0.0	6.4	0.0
Among Motives	100.0	45.5	0.0	6.4	83.4

Note: For all farms, "No. 1 Motive" refers to the most important motive stated by the respective grain buyers; the "Among Motives" distribution refers to the percentage of buyers by motive regardless of the ranking of the motives. Break-downs by level of equipment do not take into account motive ranking.

As mentioned earlier, farmers purchased grain for commercial purposes (processing and sales) only in the south of CMDT, where there is a reliable and significant supply of surplus production, and in the north of OHV, where the lack of significant cash income from agriculture forces farmers to diversify as much as possible their non-farm activities. Thus, 50% of the fully-equipped buyers of south CMDT could be classified as grain traders since resales for profit constituted the only motive for their purchases. The same applies to all semi-equipped buyers of this subzone, who processed the cereals bought usually into traditional beer that they sold.

In each of the four subzones, more than 45% of farmers' total grain purchases were made during the six-month period extending from May to October (Table 4-12). This period covers all the rainy season and corresponds roughly to the hungry season which, for most of the deficit producers of the southern subzones fades out earlier with the first maize available in August-September. During these six months, average grain prices in rural markets were at least 30% above their post-harvest levels, and almost all the purchases made at these higher prices were very likely motivated by immediate family food needs, which presumably increase because of additional energy requirements during the cropping season.

More than two-thirds of the total grain purchases of the equipped buyers in OHV were made during the six months (November-April) following harvest, likely because of the relative importance of income that they obtained from activities other than farming. The availability of such cash income would enable these equipped buyers of the generally deficit

**Table 4-12. Quarterly Distribution of Farmers' Coarse Grain Purchases
CMDT and OHV (1985/86 - 1986/87)**

ZONES/SUBZONES EQUIPMENT LEVELS	PERCENTAGE OF TOTAL PURCHASES PER QUARTER			
	NOVEMBER- JANUARY	FEBRUARY- APRIL	MAY-JULY	AUGUST- OCTOBER
<u>South CMDT</u>				
Equipped Farms	44.8	0.0	20.1	35.1
Semi-Equipped	11.7	0.0	21.2	67.1
Non Equipped	41.4	3.0	23.7	31.9
All farms	38.8	0.5	20.9	39.8
Price Index	100.0	98.1	130.5	159.0
<u>North CMDT</u>				
Equipped Farms	23.7	15.7	49.8	10.8
Semi-Equipped	36.6	11.8	22.3	29.3
Non Equipped	26.6	18.6	29.6	25.2
All farms	28.6	14.7	37.5	19.2
Price Index	100.0	93.8	141.0	174.4
<u>South OHV</u>				
Equipped Farms	69.7	0.0	0.0	30.3
Semi-Equipped	46.0	5.9	18.8	29.3
Non Equipped	39.3	7.6	28.8	24.3
All farms	43.9	6.5	22.9	26.7
Price Index	100.0	103.2	154.8	185.9
<u>North OHV</u>				
Equipped Farms	50.7	17.4	21.9	10.0
Semi-Equipped	21.7	15.5	44.8	18.0
Non Equipped	29.3	22.8	30.8	17.1
All farms	33.1	20.4	30.8	15.7
Price Index	100.0	97.4	133.3	149.2

Source: CESA-MSU Food Security Project rural market surveys, 1985-87.

Note: Quarterly price indices are computed only for 1986/87 (a more typical year with moderate state intervention), using the November-January quarter as base.

OHV zone to start building stocks for future consumption during the low-price season.

Most of the deficit producers who had to sell part of their own production soon after harvest to meet rigid cash liabilities obviously could not take advantage of the harvest-period low prices to buy the additional foodgrains needed for their home consumption. However, the negative effect of buying grain late in the crop year may be offset in part by an increase in the price of the other products (particularly small livestock) that farmers sell to get cash to buy cereals during the hungry season.

To finance their foodgrain purchases, farmers rely on a variety of activities that differ in relative importance from one subzone to another. Among these activities, cotton production ranked first for 34% of the grain buyers in both the south and the north of CMDT, and none in OHV, where it came as a secondary source of income for only 16% of the buyers (all semi-equipped or non equipped) in the south (Table 4-13). Cotton was the first cash-income source for half of the fully-equipped buyers in south CMDT and for 50% of those in the north CMDT.

In the south of CMDT, where income levels are higher than in any of the other subzones, small trade ranked first (even before cotton) for 53% of the coarse grain buyers. In fact, all the equipped and semi-equipped buyers of this subzone listed trade among their income sources. Secondary sources of income included handicrafts for 50% of the equipped and non-equipped buyers, shea nuts (processed into oil) for all the semi-equipped and other agricultural products (mainly calabashes, tubers and vegetables) for 50% of the non-equipped.

Table 4-13. Sources of Income Used to Finance Coarse Grain Purchases, CMDT and OHV (1985/86 - 1986/87)

SUBZONES AND EQUIPMENT LEVELS	PERCENTAGE OF BUYERS BY INCOME SOURCE								
	COTTON	OTHER AGRIC. PRODUCTS	SHEA NUTS	LIVESTOCK	SMALL TRADE	HANDICRAFT	OFF-FARM WAGES	MIGRATION	LOANS
SOUTH CMDT									
Equipped Farms	50.0	0.0	0.0	0.0	100.0	50.0	0.0	0.0	0.0
Semi-Equipped	0.0	0.0	100.0	0.0	100.0	0.0	0.0	0.0	0.0
Non Equipped	50.0	50.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0
ALL FARMS:									
First-ranking Source	33.6	0.0	0.0	0.0	53.0	13.4	0.0	0.0	0.0
Among Sources	33.6	13.4	32.9	0.0	73.2	33.6	0.0	0.0	0.0
NORTH CMDT									
Equipped Farms	50.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0
Semi-Equipped	11.2	5.6	0.0	47.2	0.0	16.8	18.0	0.0	12.4
Non Equipped	25.0	0.0	0.0	25.0	25.0	0.0	0.0	25.0	0.0
ALL FARMS:									
First-ranking Source	33.6	1.8	0.0	19.1	4.2	29.3	3.9	4.2	3.9
Among Sources	33.6	1.8	0.0	19.1	4.2	31.2	5.7	4.2	3.9
SOUTH OHV									
Equipped Farms	0.0	50.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0
Semi-Equipped	19.9	34.4	100.0	91.4	8.6	0.0	8.6	28.5	0.0
Non Equipped	16.7	50.0	83.3	66.7	0.0	0.0	50.0	16.7	16.7
ALL FARMS:									
First-ranking Source	0.0	0.0	10.6	74.8	3.9	0.0	6.8	3.9	0.0
Among Sources	15.5	43.6	92.6	81.7	3.9	0.0	25.6	19.1	7.4
NORTH OHV									
Equipped Farms	0.0	0.0	0.0	100.0	25.0	25.0	0.0	0.0	0.0
Semi-Equipped	0.0	0.0	0.0	62.5	11.6	0.0	19.2	6.7	25.9
Non Equipped	0.0	0.0	0.0	41.7	8.3	8.3	41.7	16.7	25.0
ALL FARMS:									
First-ranking Source	0.0	0.0	0.0	58.5	1.9	4.2	14.3	10.6	10.5
Among Sources	0.0	0.0	0.0	58.5	12.3	8.6	27.3	10.6	20.9

Note: For all farms, "First-ranking source" refers to the most important source stated by the respective grain buyers. The "Among sources" distribution and break-downs by level of farm equipment are related to the number of buyers by source, regardless of the ranking of the sources.

The range of sources of income used to finance grain purchases is wider in the north of the CMDT and both subzones of the OHV which, contrary to south CMDT, lack activities that are individually capable of generating sufficient cash to cope with household needs. In these areas, livestock production (mainly poultry and small ruminants) becomes one of the most important sources of income, which ranked first for 19% of the buyers of the north CMDT, about three-fourths of those in south OHV and 58.5% of those in north OHV.

Another feature of these three subzones is the higher reliance of their cereal buyers on income earned outside of the farm compound, i.e., wages from sales of family labor, remittances from household members on migration and loans contracted from neighboring wealthier farmers and merchants. The phenomenon of loans was far less important than commonly assumed. It concerned exclusively the semi-equipped and non equipped farms, which were also the only ones to sell some family labor and use remittances from migrants to buy foodgrains for their households. This dependency on off-household income systematically increased with the decrease in the relative importance of cash crop (cotton) production from south CMDT to north OHV.

The diversification pattern described above is consistent with findings of Reardon, Matlon and Delgado (1988), who show that in Burkina Faso, farmers in Sahelian zones adopt a much more diversified income strategy to assure their food security than do farmers in the Sudano-Guinean zone.

Caution is required in assuming that farmers' dependency on off-farm income leads inevitably to the exploitation of the needy farm households by their neighbors or wealthier entities of the world outside of the

village. Remittances from migrants tend to indicate that the marginal productivity of this portion of family labor is higher outside than within the farm compound, even under potential imperfections of the outside labor market. Assuming that farmers are acting rationally, then the opportunity cost of the labor sold in the village during the cropping season in terms of own-production forgone by postponing the achievement of some vital farming tasks, such as planting and weeding, must be offset by the higher value of the grain earned during the hungry season. Hence, dependency on off-farm income itself may not lead to exploitation, while the distribution of wealth that forces poor farmers into such dependency is exploitative.

4.3.3. Coarse grain loans

Informal foodgrain loans between wealthier farmers or traders and needy farm households are one of the most controversial issues of farmer exploitation. Between farmers, these loans are generally made and paid back in kind (grain), while traders usually lend cash or sell grain on credit during the hungry season against an oral promise of the borrower to pay the loan as soon as possible, i.e., at the next harvest time. Many observers have claimed (without empirical evidence) that such loans usually bear interest rates as high as 100% to 200% over a period of three to six months. These claims are usually misleading since farmers of our sample unanimously agree that customary beliefs forbid them to charge any interest on food-staple loans among themselves; cereal loans are paid back bag-for-bag.

Other grain or money-lenders such as traders take into account the value (not the quantity) of grains involved at two different points in

time: the time of the lending and the time of reimbursement. The lending is most often made during the months of May through September, when market supply is at its lowest level and prices reach their peak, while the reimbursement immediately follows harvest (November-January), when prices fall to their lowest levels, as illustrated for 1986/87 in Table 4-14. Given the above magnitudes of price variation, even a doubling of the quantity of cereals loaned during the rainy season would imply only a value mark-up of 9.3% (in south OHV) to 56% (in north OHV) above the principal.

Table 4-14. Comparison of Rainy Season and Post-Harvest Coarse Grain Prices (CFAF/kg) in 1986/87

SUBZONES	Rainy Season Lending Time (May-Sept) (1)	Post-Harvest Reimbursement Time (Nov-Jan) (2)	Percentage Variation (1)/(2)
South CMDT	44.5	25.9	71.8
North CMDT	45.1	25.6	76.2
South OHV	51.3	26.9	90.7
North OHV	57.6	40.0	44.0

Except for the north of OHV, where chronic foodgrain shortages keep prices from falling significantly even during the immediate post-harvest season, any quantity of cereals loaned in August 1986 would have to be reimbursed in double in February 1987 for the lender to just recuperate the value of the loan principal. Therefore, when lending transaction costs and the costs of the risk related to reimbursement default are accounted for, it may be the case that most of the informal lenders merely break-even or even subsidize some of their clients.

In fact, indebted farmers are not always bound to pay back their cereal loans in grains, as illustrated by the data in Table 4-15. In none of the four subzones did more than 31% of the farm households with cereal loans contracted during the drought of the early 1980s pay back all their loans only with coarse grains. Moreover, cereals were not used even as partial payment by more than 63% of the indebted farms. Hence, it appears that although deficit farmers may suffer from some dependency hardships, they are usually allowed to choose among a few alternatives in coping with their food insecurity. Therefore, the common claims of exploitation by lenders, although not discarded, may be largely exaggerated.

Table 4-15. Sources of Income Used by Farmers to Reimburse Coarse Grain Loans Contracted during the 1983-1984 Drought

SUBZONES	PERCENTAGE OF FARMS WITH GRAIN LOANS	PERCENTAGE OF INDEBTED FARMS REIMBURSING WITH			
		COARSE GRAINS ONLY	COARSE GRAINS AND OTHER	COTTON INCOME ONLY	INCOME FROM OTHER ACTIVITIES
SOUTH CMDT	29.8	22.2	43.7	48.7	2.2
NORTH CMDT	17.2	23.5	23.5	8.5	68.0
SOUTH OHV	46.3	30.4	45.4	0.0	50.5
NORTH OHV	68.5	25.3	41.3	0.0	34.4
TOTAL	35.1	24.5	36.7	18.6	37.9

4.3.4. Coarse Grain Net Sales

In dealing with the effects of cereal marketing and price policies on farm households, the concept of net sales is much more relevant than those of gross sales or gross purchases considered separately. By

deducting purchases from gross sales, it becomes possible to distinguish net selling households that are on the supply side of the market from net buying farms, which should be considered along with the "conventional consumers" on the demand side of the market. This break-down is useful for policy purposes; policies such as producer price supports will have opposite effects on the two categories of households. Higher prices raise the real income of the net sellers while depressing that of net buyers, particularly when other constraints not related to cereal markets prevent net buyers from taking advantage of such price incentives to invest more in foodgrain production.

Data in Table 4-16 show that there are significant relations between farmers' net position vis-à-vis the cereal market and such factors as the natural environment, the institutional context and draft equipment and animal ownership. Over the two years of observation (1985/86-1986/87), an estimated 52.7% of the farms of the 16 survey-villages had positive net coarse grain sales. On the other hand, 42.9% of the farms were net foodgrain buyers, and 4.4% of the households reported no net cash transactions.

On average, the net sales per farm increased nine-fold, from a low of 11 kg in 1985/86 to almost 100 kg in 1986/87, mainly because of a 38% increase in per capita production between the two good rainfall years. In spite of this increase, the average net sales remained at a level of

Table 4-16. Net Coarse Grain Sales by Zone, Subzone and Level of Farm Equipment, CMDT and OHV (1985/86 - 1986/87)

ZONES/SUBZONES EQUIPMENT LEVELS	PERCENTAGE OF		AVERAGE NET SALES PER FARM (KG)			NET SALES AS % OF PRODUCTION (1985/86- 1986/87)
	NET SELLERS	NET BUYERS	1985/86	1986/87	AVERAGE	
SOUTH CMDT	75.1	18.2	379	625	502	10.9
NORTH CMDT	58.6	38.2	-116	97	-9	-0.2
SOUTH OHV	35.9	58.9	-205	0	-103	-5.2
NORTH OHV	15.2	82.7	-235	-785	-510	-38.8
TOTAL CMDT	66.7	28.3	129	359	244	5.5
TOTAL OHV	24.9	71.6	-221	-418	-319	-19.7
TOTAL SOUTH	62.4	31.4	190	423	306	8.2
TOTAL NORTH	43.5	53.7	-157	-210	-184	-5.7
Total SAMPLE						
Equipped farms	77.0	19.1	242	337	290	4.9
Semi-equipped	45.2	51.7	-100	78	-11	-0.4
Non equipped	32.0	61.5	-140	-165	-153	-11.2
All farms	52.7	42.9	11	98	54	1.6

Note: The percentage of production sold for the total sample does not reflect a national picture, since no adjustment was made for the actual size of the total farm population in CMDT and OHV, nor were all the subzones of these zones represented in the sample.

only 1.6% of the estimated coarse grain production². This implies that an equivalent of about 80% of the 7.8% of total grain production sold by farmers in 1985/86 and 1986/87 was absorbed by deficit farm households in the survey areas. It further suggests that, because of their perception of risk of food insecurity linked to uncertainties about both their own production and market supply reliability in years of bad rainfalls, surplus producers have a relatively low commercial propensity with respect to foodgrains.

Farmers' net grain sales show a strong relation with the agroclimatic environment. In both years, the farm households in southern subzones had positive net sales (306 kg per farm on average for the two years) whereas those in the north had net purchases (184 kg per farm on average for the two years, about the annual cereal requirement for one person). In addition, 62.4% of the southern households were net sellers, while more than half of those of the north were net buyers. Even at an average of 306 kg per farm, the net sales in the south remained below 10% of total production.

The institutional environment of production and marketing also influences farmers' position with respect to the foodgrain market. Two-thirds of the households in CMDT were net sellers compared with only 25% of the farms in OHV, where about 72% of the households were net buyers. The impact of the rural development setting on net cereal sales may be divided into a direct effect on per capita foodgrain production and an indirect effect of cash-crop (cotton) income and market access on cereal

2. This percentage does not apply to the total net sales of the entire CMDT and OHV zones, since no adjustment was made to reflect the actual sizes of the total farm population of the two zones.

sales. Cotton production likely increases net sales of coarse grains through its effect on cereal production, by improving farmers' access to formal credit, purchased inputs and extension services, and also through the additional security that cotton income provides in meeting cash liabilities and covering other basic household needs. Thus, in CMDT, where almost all farms grow some cotton, average annual net foodgrain sales over the two years amounted to 244 kg per farm (or 5.5% of total production), while OHV was characterized by net purchases of 319 kg per farm equivalent to nearly 20% of the average production per household.

Draft equipment and animal ownership also affects farm net sales, primarily by its effect of increasing per capita production, as seen before. For the whole sample, only the equipped farm stratum (which accounted for more than 75% of net sellers) had positive net sales in each of the two years. The semi-equipped households, with a second year of good rainfall, shifted from a position of net buyers of 100 kg per household in 1985/86 to one of net sellers of 78 kg per farm in 1986/87. The non-equipped farms were consistently net buyers, with net purchases of 140 kg per household in 1985/86 and 165 kg per household in 1986/87. The equipped households had, on average over the two years, net sales amounting to about 5% of their production; the semi-equipped almost broke even, while the non-equipped farms bought in net terms an equivalent of more than 10% of their own coarse grain production.

The global picture of the combined effects of the factors considered above on net coarse grains sales shows that even during the two good rainfall years covered, only in the south of CMDT did all equipment strata have average positive net sales. In the north of this zone farmers were roughly self-sufficient in coarse grains on a net basis. In contrast,

except for the fully equipped, all farm strata in OHV bought more grain than they sold. In fact, outside the south of CMDT, only fully-equipped farms in north CMDT and south OHV were net sellers over the two years. Moreover, 50% or more of the units of all other household-strata were net foodgrain buyers. In general, the percentage of net sellers decreased from 92.3% for the fully-equipped farms of south CMDT to just slightly above 10% for the non-equipped of the north of OHV. Likewise, net sales expressed as a percentage of own production continuously dropped from about 14% for the fully-equipped farms in south CMDT to a negative 52.4% (net purchases) for the non-equipped farms in north OHV. This broad picture shows that even in the best agricultural regions of Mali and under some of the best rainfall circumstances, farmers remain presently divided between the two sides of the coarse grain market, with about half of them on the supply side and more than 40% of them on the demand side. Furthermore, the bulk of the net supply for the market comes from only a small proportion of farm households.

Virtually all net grain sales of the 16 study villages were made by farmers of CMDT. Accounting for about two-thirds of the farms of the sample villages, the households in CMDT constituted 84% of the net sellers and made 94% of all net sales during the two years (Table 4-17)³. The south of CMDT alone, with less than one-third of all the farms of the sample villages, accounted for nearly half of the net sellers and 75% of the net sales. Together the fully-equipped farms of the eight villages

3. All the total sample percentages cited in this section are extrapolations to the 990 farm households of the 16 survey villages, taking into account the respective weights in this population of the different farm strata in each subzone.

the net sales. Together the fully-equipped farms of the eight villages in CMDT (30.6% of all the farms) provided 48% of the net sellers and made 68.6% of the net foodgrain sales.

At the other extreme, 63.3% of the net purchases were made by farm households of OHV, where 56% of all the net buyers were located. North OHV (the poorest of the four subzones, with only 17.9% of the farms of the sample villages) accounted for 34.7% of the net buyers and 50.8% of all net purchases.

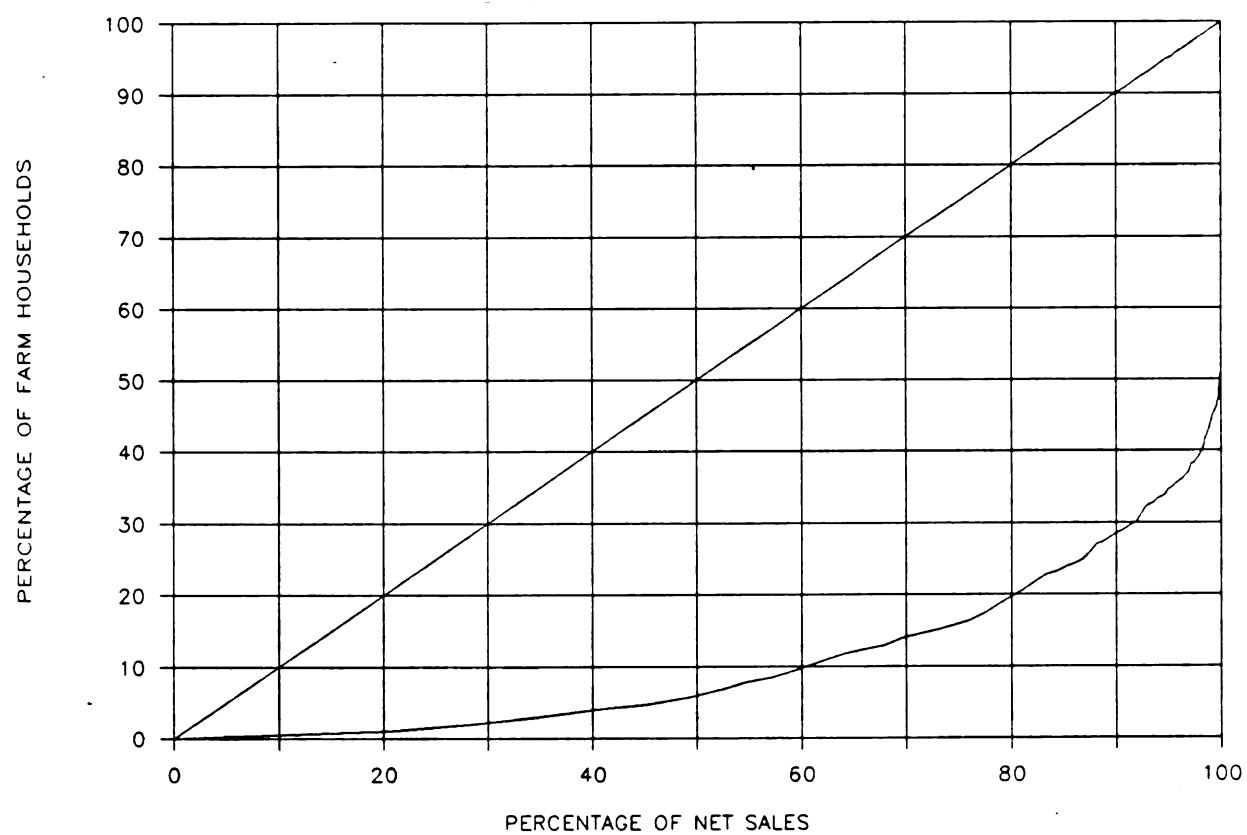
Clearly, farmers' position in the coarse grain market is determined by natural factors such as rainfall and soil types. But it is also determined to a significant extent by much more policy-sensitive variables controlled by rural development institutions that affect production techniques and output levels. In this sense, it is not surprising that fully-equipped farms, which represent only 36% of the farm sample made 71.2% of all net sales, while 84% of the net cereal buyers were either semi-equipped or non-equipped households.

The skewness of the distribution of net coarse grain sales among farmers is depicted by Figure 4-5 (see data in Table A.4-2, Appendix IV). In each of the two years, more than 25% of all net sales were made by only 2% of the farms. Ten percent of the farms made more than 55% of the net sales, 75% of which came from fewer than 20% of all the households. Although an estimated 53% of the farms of the 16 survey-villages showed a positive net balance of cash grain transactions over the two years, 90% of the net sales were attributable to fewer than 30% of all households.

Table 4-17. Distribution of Coarse Grain Net Sellers, Net Buyers, Net Sales and Net Purchases by Zone, Subzone, and Level of Farm Equipment (1985/86-1986/87 total)

ZONES/SUBZONES EQUIPMENT LEVELS	PERCENTAGE OF FARMS OF SAMPLE VILLAGES	PERCENTAGE OF		PERCENTAGE OF	
		NET SELLERS	NET SALES	NET BUYERS	NET PURCHASES
<u>Total CMDT</u>					
Equipped Farms	30.6	48.0	68.6	10.1	16.6
Semi-equipped	21.8	23.1	17.9	20.7	12.7
Non Equipped	13.9	13.0	7.6	13.0	7.4
All Farms	66.3	84.1	94.1	43.8	36.7
<u>Total OHV</u>					
Equipped Farms	5.4	4.8	2.6	6.1	18.6
Semi-equipped	12.9	6.5	1.9	20.8	15.2
Non Equipped	15.4	4.6	1.4	29.3	29.5
All Farms	33.7	15.9	5.9	56.2	63.3
Total SOUTH	48.5	57.9	76.7	35.4	20.0
Total NORTH	51.5	42.1	23.3	64.6	80.0
<u>Total SAMPLE</u>					
Equipped Farms	36.0	52.8	71.2	16.2	35.2
Semi-equipped	34.7	29.6	19.8	41.5	27.9
Non Equipped	29.3	17.6	9.0	42.3	36.9
All Farms	100.0	100.0	100.0	100.0	100.0

Note: The percentages presented here are extrapolations to the entire farm-household population of the 16 survey villages, taking into account the respective weights of the different categories of farms in this population.



**Figure 4-5. Concentration of Net Sales
CMDT and OHV (1985/86 - 1986/87)**

Sales and purchases give only a partial idea of farmers' foodgrain transactions in Mali, however. Given the existence of an intricate set of social and religious liabilities in the rural communities, a non-negligible proportion of farm households' cereal exchanges are without cash compensation.

4.4. Non-Cash Transactions

4.4.1. Barter transactions

Coarse grains barter transactions are, in general, negligible. They concerned fewer than one-third of the farms and only 0.4% of the total cereal production of the 16 villages over the two years of observation (Table 4-18).

These transactions were more frequent in the CMDT zone, where nearly half of the farm households reported them in 1986/87. Nevertheless, barter outflows remained below one percent of total production even in south CMDT, where they reached a maximum level of 30 kg per farm.

No coarse grain barter transactions were reported in south OHV. It may be that, given their low cereal production level, southern OHV farmers prefer to barter other goods or resources, particularly livestock and family labor, which were listed among the sources of income used to purchase foodgrains.

The low magnitude of barter transactions observed may, in many cases, relate to a potential confusion between the concepts of barter and gift. Many gifts may hide barter transactions in compensation of some goods or services acquired in the past or expected in the future. In this sense, most barter transactions without contemporaneous compensation would be reported as gifts by farmers.

Table 4-18. Farmers' Coarse Grain Barter, CMDT and OHV (1985/86-1986/87)

ZONES AND SUBZONES	PERCENTAGE OF FARMS WITH BARTER		AVERAGE 1985/86-1986/87 BARTER PER FARM (Kg)			BARTER OUTFLOW AS % OF PRODUCTION
	1985/86	1986/87	OUTFLOW	INFLOW	NET-OUT	
SOUTH CMDT	30.9	49.0	30	17	13	0.7
NORTH CMDT	34.4	46.2	10	6	4	0.2
SOUTH OHV	0.0	0.0	0	0	0	0.0
NORTH OHV	16.2	6.9	5	5	0	0.4
TOTAL CMDT	32.7	47.6	20	12	8	0.5
TOTAL OHV	8.6	3.6	3	3	0	0.2
TOTAL SOUTH	20.9	33.1	20	12	8	0.5
TOTAL NORTH	28.1	32.5	8	6	2	0.3
TOTAL SAMPLE	24.6	32.8	14	9	5	0.4

Barter of coarse grains for other food was the most common practice in all subzones. This type of transaction accounted for 28% of the total cereal barter outflows in south CMDT, 61% in north CMDT and 100% in north OHV (Table 4-19). In south CMDT and north OHV, more than 90% of the barter of coarse grains for food were in fact barter of one type of coarse grain for another, while in north CMDT, 59% of these exchanges were between coarse grains and rice. In any case, the small quantities involved suggest that such transactions are occasional efforts to diversify the family diet, probably during visits of relatives or friends not residing in the village.

Only farmers in CMDT reported cases of barter of coarse grains for farming inputs. In the south of the zone, 71% of the total grain barter outflows were paid back in labor. This finding is consistent with the

outflows were paid back in labor. This finding is consistent with the fact that this subzone is the only one where farmers listed hired labor wages among their grain sale motives (Table 4-7). The general use of animal traction combined with the relatively labor-intensive cotton production may induce some fully-equipped farms in south CMDT to barter part of their grain surplus for labor supplied by foodgrain-deficit households. In north CMDT, grain barterers related to farming activities concerned only the maintenance of animal traction equipment and the acquisition of manual tools (e.g., hoes and pickaxes).

Table 4-19. Distribution of Coarse Grain Barter-Outflows by Type of Product Received in Exchange (1985/86-1986/87 total)

TYPES OF PRODUCTS RECEIVED IN EXCHANGE OF COARSE GRAINS	PERCENTAGE OF BARTER OUTFLOW		
	SOUTH CMDT	NORTH CMDT	NORTH OHV
Millet, Sorghum or Maize	25.5	20.7	93.0
Rice	2.5	36.2	0.0
Other Food Products	0.1	4.5	7.0
Farming Tool and/or Equipment Maintenance	0.7	33.8	0.0
Hired Labor	71.0	0.0	0.0
Household Tools/Services	0.3	4.7	0.0

Note: Other food products include fonio, peas, tubers and milk. Household tools and services include calabashes, pots, buckets, and the construction and/or repair of granaries or houses.

4.4.2. Coarse Grain Gifts

Coarse grains have traditionally played a central role in economic and social exchanges in Mali. Although their relative market power has decreased with the development of a cash economy driven by the promotion of export crops (e.g., cotton and peanuts), they remain a centerpiece in most social relations in rural areas. Farmers seldom extend cash assistance to each other. In contrast, giving foodgrains to a relative, an in-law, a friend, a religious leader, or a poor person remains a common practice. It may even be argued that, for farmers, the value of the social prestige and/or security produced by such gifts often outweighs the marginal utility of the cash income they could obtain from selling their foodgrains in the market.

Consistent with this hypothesis, Table 4-20 shows that 89% of the farms of the 16 survey-villages made coarse grain gifts compared with 73.2% for sales over the two years of observation. The practice of cereal gifts is particularly strong in CMDT, where fewer than 5% of the farms (compared with nearly 25% in OHV) did not report such transactions. The practice of coarse grain gifts also tends to depend on the relative wealth of the farm household, as indicated by the declining proportion of farms which made gifts from 98% for the fully-equipped to 91% for the semi-equipped and about 77% for the non-equipped.

The total quantity of cereals given represents a relatively constant percentage of coarse grain production, however. This proportion ranged from 4.5 to 6.3% between the four subzones and from 5.2 to 5.7% between farm equipment strata. As a result, it looks as if all farmers were voluntarily committed to a social tax of about 5% of their foodgrain

production. The weight of this social liability is such that total gifts made amounted, on average, to an equivalent of 67.4% of the gross sales or 39.1% of total grain outflows over the two years. In fact, even in the very commercial south CMDT and the grain-deficit north OHV, more than 30% of total cereal outflows were gifts. In south OHV, where cotton is grown (to a smaller extent than the CMDT) and a wider set of products (poultry, small ruminants, shea nuts, etc.) may substitute for cereals for cash purposes, gifts represented more than two-thirds of all coarse grain outflows and 2.5 times coarse grain sales.

Table 4-20. Farmers' Coarse Grain Gifts Made (1985/86-1986/87 averages)

ZONES/SUBZONES EQUIPMENT LEVELS	% OF FARMS HAVING		AVERAGE GIFTS MADE		
	MADE GIFTS	RECEIVED GIFTS	Kg PER FARM	% OF TOTAL OUTFLOWS	AS % OF PRODUCTION
SOUTH CMDT	96.7	49.8	265	31.3	5.7
NORTH CMDT	95.2	27.4	200	50.3	4.7
SOUTH OHV	78.5	34.9	123	71.6	6.3
NORTH OHV	72.8	18.9	59	32.2	4.5
TOTAL CMDT	95.9	38.5	232	37.5	5.3
TOTAL OHV	75.5	26.4	89	50.0	5.5
TOTAL SOUTH	90.8	45.0	219	34.9	5.8
TOTAL NORTH	87.4	24.4	151	46.8	4.7
Total SAMPLE					
Equipped Farms	97.5	31.9	305	36.8	5.2
Semi-Equipped	91.1	39.6	151	44.6	5.4
Non Equipped	76.9	31.7	77	40.3	5.7
All Farms	89.0	34.4	184	39.1	5.3

On average, each farm household of the sample villages gave out enough foodgrain (184 kg) to feed one person during each of the two years. On the other hand, about one-third of the farm households received coarse grain gifts (Table 4-21). This percentage was higher in southern subzones (particularly south CMDT), where a higher proportion of related farmers are likely able to exchange gifts. In any case, the average quantity of grain gifts received per farm was small. With an overall sample average of 28 kg per farm (11% of total grain inflows), the quantities of grain received were also larger in the higher rainfall subzones: they amounted to 44 kg per farm or 40% of cereal inflows in south CMDT and 37 kg per farm or 40% of cereal inflows in south OHV.

Table 4-21. Farmers' Coarse Grain Gifts Received and Net Gifts (1985/86-1986/87 averages)

ZONES/SUBZONES EQUIPMENT LEVELS	GIFTS RECEIVED		NET GIFTS		
	Kg PER FARM	% OF TOTAL INFLOWS	Kg PER FARM	% OF NET OUTFLOWS	AS % OF PRODUCTION
SOUTH CMDT	44	40.0	221	30.0	4.8
NORTH CMDT	15	7.0	185	102.8	4.4
SOUTH OHV	37	19.8	86	-500.8	4.4
NORTH OHV	17	2.6	42	-9.0	3.2
TOTAL CMDT	29	17.8	203	44.6	4.6
TOTAL OHV	26	6.0	63	-24.4	3.9
TOTAL SOUTH	42	30.8	177	36.0	4.7
TOTAL NORTH	16	4.2	135	-297.3	4.2
Total SAMPLE					
Equipped Farms	27	10.7	278	48.2	4.7
Semi-Equipped	28	12.6	123	101.6	4.4
Non Equipped	31	10.3	47	-43.0	3.4
All Farms	28	11.1	156	72.2	4.5

At 156 kg, the average net gift made per farm amounted to 4.5% of total production and 72.2% of the net outflows of coarse grains. That is, an estimate of the sample farmers' foodgrain surplus that only examined their market transactions would have led to an underenumeration of more than 70%. The beneficiaries of this important portion of farmers' grain production include local religious leaders, poorer neighbor-farmers, in-laws, and more importantly, household relatives and friends residing in urban areas (e.g., civil servants and other migrants).

The implication of not accounting for coarse grain gifts becomes even stronger when variations due to natural factors, institutional environment and technological elements are considered. Even in the highest surplus production and most commercial subzone (south CMDT), net gifts represented 30% of all net grain outflows or 42.9% of net market transactions (including barter). On the average, for all the sample farms of the CMDT zone, the southern subzones and the fully-equipped stratum (which had positive net sales), net gifts were equivalent to more than 35% of all net grain outflows and more than 56% of the net market transactions. For the group of farms in north CMDT as well as those of the semi-equipped stratum (which had a negligible market-transaction balance), net gifts made up for the low net purchases and constituted all net outflows. Finally, for the sample farm households in OHV, where the net foodgrain transaction balance was negative over the two years, net gifts represented 83.5% of the net purchases in the south and 8.2% the north.

These findings strongly support the idea that, for most farmers in Mali, coarse grains have a shadow value that often exceeds their market price. This may be possible because of the social risk-sharing involved

in gifts, since the giver at one point in time may expect a gift in return when times become harder. Hence, many transactions reported as gifts may in fact be lagged or forward barter transactions, quasi-loans or social insurance premiums. To support this argument, data in Table 4-22 show that only in the north of CMDT did more than 50% of farmers' grain gifts go to, or come from persons other than relatives, in-laws and friends of the farm household. In the other subzones, 58% to 91% of the gifts made and 63% to 90% of the gifts received were exchanged within the circle of the farm household's relatives, in-laws and friends.

Table 4-22. Distribution of Farmers' Coarse Grain Gifts by Category of Recipients and Sources (1985/86-1986/87 total)

ZONES/SUBZONES	PERCENTAGE OF GIFTS MADE TO OR RECEIVED FROM				
	RELATIVES	IN-LAWS	FRIENDS	RELIGIOUS TIES	OTHER PERSONS
<u>GIFTS MADE</u>					
South CMDT	26.1	0.7	34.3	32.4	6.5
North CMDT	47.8	2.4	7.7	41.7	0.4
South OHV	84.4	1.0	5.4	9.2	0.0
North OHV	34.2	0.8	2.3	53.9	8.8
<u>GIFTS RECEIVED</u>					
South CMDT	46.1	7.7	8.8	24.0	13.4
North CMDT	20.3	11.1	41.9	26.7	0.0
South OHV	68.5	4.8	16.6	8.0	2.1
North OHV	40.0	6.7	2.8	28.6	21.9

Note: Religious ties include religious leaders and poorer neighbors for gifts made, and wealthier persons for gifts received.

In each subzone, more than 70% of farmers' coarse grain gifts were made during the three months (November through January) that immediately follow harvest (Table 4-23). From 78% to 98% of the gifts were made by

the farmers during the six months that follow harvest, while (with the exception of north CMDT) farmers received more than 36% of their grain gifts during the farming season, i.e., between May and October. Although no data are yet available to substantiate this issue, one can hypothesize that farmers substitute between market and non-market transactions, depending on how market prices compare with the perceived social value of foodgrains. In this sense, the use of market prices alone in analyses aiming at explaining farmers' cereal production and transaction decisions may yield misleading conclusions.

Table 4-23. Quarterly Distribution of Farmers' Coarse Grain Gifts (1985/86-1986/87 total)

ZONES/SUBZONES AND EQUIPMENT LEVELS	PERCENTAGE OF GIFTS MADE OR RECEIVED IN			
	NOVEMBER- JANUARY	FEBRUARY- APRIL	MAY- JULY	AUGUST- OCTOBER
GIFTS MADE				
South CMDT	76.0	6.2	9.0	8.8
North CMDT	74.5	9.8	10.8	5.0
South OHV	71.6	8.8	7.1	12.5
North OHV	70.4	24.9	3.9	0.7
GIFTS RECEIVED				
South CMDT	55.1	6.1	15.3	23.4
North CMDT	69.1	12.9	14.7	3.3
South OHV	39.3	21.5	7.7	31.6
North OHV	35.5	26.7	11.0	25.8
Total SAMPLE				
Equipped Farms	71.0	8.8	8.7	11.4
Semi-Equipped	52.5	8.2	19.3	20.0
Non Equipped	32.5	20.7	12.8	34.0

4.5. Net Coarse Grain Transactions

Table 4-24 presents data on average farm household's net coarse grain transactions by zone, subzone and level of animal traction equipment.

**Table 4-24. Farm Household Net Coarse Grain Transactions
CMDT and OHV (1985/86 - 1986/87)**

ZONES/SUBZONES EQUIPMENT LEVELS	NET TRANSACTIONS PER FARM (kg)			AVERAGE NET TRANSACTIONS AS PERCENTAGE OF PRODUCTION
	1985/86	1986/87	AVERAGE	
SOUTH CMDT	626	846	736	16.0
NORTH CMDT	40	319	180	4.2
SOUTH OHV	-142	108	-17	-0.8
NORTH OHV	-186	-749	-468	-35.5
TOTAL CMDT	330	580	455	10.3
TOTAL OHV	-165	-348	-257	-15.8
TOTAL SOUTH	377	607	492	13.1
TOTAL NORTH	-39	-53	-46	-1.4
TOTAL SAMPLE				
Equipped Farms	518	634	576	9.8
Semi-Equipped	25	215	120	4.3
Non Equipped	-105	-110	-108	-7.9
All Farms	164	268	216	6.2

These data indicate that farmers' capacity to generate surplus grain for exchange is strongly related to the three broad factors emphasized in this study: the agroclimatic conditions, the institutional environment and the technology of farm production. In each of the two years of observation, farm households of the southern subzones had a

positive cereals transaction balance, while those of the northern subzones were net importers. In aggregate, CMDT farmers had substantial net outflows of grain, while OHV farm households had sizeable net inflows during each of the two years of survey. Regardless of the year, the groups of fully-equipped farms had net positive transactions of more than a half metric ton per household, the semi-equipped households had a positive net transactions, while the non-equipped farms had net inflows of about 100 kg each.

The combined effects of the agroclimatic and the institutional factors are such that only the groups of farms in the south and the north of CMDT had net positive transactions of foodgrains in both years, while farmers in south OHV shifted from net inflows of 142 kg per household in 1985/86 to net outflows of 108 kg per household in 1986/87. Farmers in northern OHV had to resort to substantial net inflows of cereals to meet their food needs in both years.

In aggregate terms, the net coarse-grain surplus exchanged amounted to 10% or more of total production only for the group of farms in south CMDT, those in CMDT as a whole, those of the two southern subzones combined, and the fully-equipped households. It is only for these farm categories that net market and non-market transactions come close to the percentage of marketable production (10 to 15 percent) assumed in most previous studies of cereals marketing in Mali. The general picture shows that our sample farm households had net coarse grain outflows amounting to only 6.2% of their total production during the two good crop years covered. A larger sample covering more subzones of the survey zones and a more

precise weighing according to the actual farm populations of the two zones may yield higher estimates of net surplus grain outflows, close to the 9% of domestic demand in urban areas estimated from the findings of Rogers and Lowdermilk (1988). We may have missed also some of the women's transactions. Nevertheless, our findings suggest that the amount of surplus domestic production going out of the farms is generally over-estimated, most probably because of a lack of understanding of farmers' security storage strategies.

4.6. Econometric Analysis of Coarse Grain Transactions

The above analysis of cross-tabulated data indicates that farmers' coarse grain transactions are influenced by a complex set of factors. This section attempts to test the significance of the effects of these factors through econometric techniques. The transactions (dependent variables) examined here are the gross sales (QTSL), total purchases (QTPR), net sales (QNSL), and total net outflows (QNTR) including market and non-market transactions. Each of these variables is expressed in terms of total annual quantity per farm household. Separate equations are estimated in each case for 1985/86 and 1986/87, i.e., for each crop year extending from the month of November of one year (harvest) through the month of October of the following year. The independent variables used and the reasons for their inclusion in the estimated equations are as follows:

a) the stock of grain carried over from the previous year (STOCK). As depicted in Figure 3-2 (Chapter III), it is hypothesized that farmers' foodgrain transaction decisions are made in a multi-year

perspective. Hence, the level of remaining stocks from one period influences the total grain availability and transactions of the following period. More explicitly, it is hypothesized that, by increasing the total household cereal availability, the effect of carry-over stocks are positive on gross sales, negative on purchases, and positive on net sales and total net outflows of coarse grains per farm household. The actual level of the carry-over stocks was not measured during the surveys. However, retrospective interviews allowed us to identify farmers who had grain stocks on hand at harvest time for each of the two crop years. This information is used as a proxy to create the dummy variable STOCK, which takes the value one for those with stocks and zero for those without stocks.

b) the level of per capita production of the current year (PCAP). The farm household being a production and consumption unit of foodgrains, its transaction decisions will depend on the extent of the farm family's self-sufficiency in cereals. Coarse grain outflows will normally be an expression of the surplus above the level of desirable consumption security that may be achieved by own-production. The level of the current per capita production reflects not only this surplus, but also the effects on foodgrain transactions of factors associated with coarse grain production, i.e., the agroclimatic conditions, the institutional environment, and the level of farm equipment. Thus, the current per capita production level is hypothesized to be associated positively with gross sales, negatively with purchases, and positively with both net sales and total net grain outflows.

c) farm household's liabilities, including taxes, transaction debts (loans and previous purchases on credit) and social obligations (e.g., expenses related to marriage, births and deaths). These various liabilities constitute the main reasons for the bulk of coarse grain transactions. However, precise data was collected only for total head taxes, which constitute the farm household's most binding cash liabilities. Hence, the variable TAX (total taxes claimed in thousands of CFA Francs) is introduced in each transaction equation. This variable not only reflects the level of liabilities, but also the size of the farm household, since the number of taxable persons strongly depends on the total number of household members. For this reason, taxes are hypothesized to have an increasing effect on gross sales and purchases, and a decreasing effect on net sales and total net outflows, to the extent that deficit-producers who sell grain to pay taxes must subsequently raise the level of their purchases in order to meet family consumption needs.

d) the alternative cash-income sources available to the farm household to meet its cash liabilities. The cash liabilities that the farm household faces can be met by income from a variety of activities, including the sales of foodgrains, cash crops, livestock, products of non-farm activities or sales of family labor. Availability of income from alternative activities will decrease the need for the household to sell coarse grains for cash generation and consequently reduce the need to buy cereals for home consumption. The expected negative effect of non-cereal income on cereals transactions may be diminished by high levels of cash income that may

increase the propensity to sell foodgrains because of the security provided by cash savings. To account for these possible effects, two categories of alternative activities to coarse grain sales are considered here.

First, the area cultivated under cotton (ACOT) is used as a proxy for the extent of the household's income from cash-crop production. A quadratic term of this area (SQACOT, i.e., the square of the cultivated cotton area) is also included, as it is hypothesized that cash-crop income will tend to substitute for cash from foodgrain sales up to a certain level beyond which the farm household adopt a greater commercial behavior towards both food crops and cash crops. Hence, increasing cotton area will first have a negative effect, then a positive effect on both coarse grain sales and purchases.

Second, all non-crop activities are summarized by the dummy variable NAC, which takes the value one for farm households participating in such activities and zero for those without them. The effect of the variable NAC is hypothesized to be negative on coarse grain gross sales, positive on purchases, and therefore negative on both net sales and total net outflows, since non-crop activities reduce the total amount of family labor available for farm production while increasing the amount of cash income that the farm household may spend on foodgrains.

e) farmers' access to grain markets. Physical access to major rural cereals markets may also play a role in shaping farmers' behavior towards coarse grain transactions. In a context of poor transportation facilities, competition among private traders may

decrease as the distance to the market increases. Moreover, the availability of alternative income-generating activities and non-grain consumer goods may be higher in the market villages relative to non-market villages. To account for such factors, two dummy variables (VIL1 and VIL23) are included in the coarse-grain transaction equations. VIL1 takes the value one for the market village and zero for the other villages. VIL23 equals one for the two villages closest to the main market and zero otherwise. Both dummy variables are hypothesized to be positively associated with coarse grain sales and purchases, since proximity to the market is supposed to raise commercial opportunities and behavior. The effect of the two variables on net sales and net outflows will therefore depend on whether market proximity induces a relatively greater specialization in activities other than cereals production and a stronger reliance on the market in meeting the household's consumption needs.

Several functional forms (simple linear, semi-logarithmic and double-logarithmic) of the coarse grain transaction equations were tried. None of them however outperformed the simple-linear form estimated by the ordinary least-square technique (after the appropriate transformation of the square of the cultivated cotton area). Therefore, only the empirical results of the estimated simple-linear equations will be considered in the following discussion. These results are summarized in Table 4-25.

As expected, both the existence of carry-over stocks and the level of current per capita production were significantly associated with farmers' coarse grain transactions. With all other factors held

Table 4-25. Estimates of Equations of Farm Household Coarse Grain Transactions CMDT and OHV (1985/86 and 1986/87)

INDEPENDENT VARIABLES	GROSS SALES (QTSL)		PURCHASES (QTPR)		NET SALES (QNSL)		NET OUTFLOW (QNTR)	
	1985/86	1986/87	1985/86	1986/87	1985/86	1986/87	1985/86	1986/87
Constant	-67.3 (65.6)	-439.2 ** (124.7)	179.1 * (102.8)	-205.6 (151.0)	-246.4 * (125.9)	-233.6 (201.8)	-403.0 ** (142.5)	-342.5 * (206.0)
STOCK0	120.5 * (54.4)	50.0 (90.6)	-214.1 ** (85.3)	-367.7 ** (109.6)	334.6 ** (104.4)	417.7 ** (146.5)	411.1 ** (118.2)	490.8 ** (149.5)
PCAP	0.55 ** (0.12)	0.95 ** (0.21)	-0.35 * (0.18)	0.11 (0.26)	0.90 ** (0.22)	0.84 * (0.35)	1.00 ** (0.25)	0.95 ** (0.35)
TAX	3.5 * (2.1)	10.7 ** (3.8)	11.5 ** (3.4)	33.6 ** (4.6)	-8.1 * (4.1)	-23.0 ** (6.1)	-2.1 (4.7)	-18.5 ** (6.3)
ACOT	-166.7 ** (50.4)	51.9 (107.4)	-39.4 (79.0)	-481.1 ** (130.0)	-127.3 (96.8)	532.9 ** (173.8)	-36.2 (109.6)	654.6 ** (177.4)
SQACOT	55.3 ** (10.2)	-4.3 (22.4)	-2.8 (15.8)	65.9 * (27.2)	58.0 ** (19.6)	-70.2 * (36.3)	41.7 * (22.1)	-88.5 * (37.0)
NAC	-25.9 (44.9)	-71.0 (83.6)	24.1 (70.4)	221.9 * (101.2)	-50.0 (86.3)	-292.9 * (135.2)	-19.5 (97.6)	-273.2 * (138.0)
VIL1	25.1 (61.9)	137.1 (114.6)	144.6 (97.1)	521.6 ** (138.7)	-119.4 (118.9)	-384.5 * (185.4)	-30.6 (134.6)	-362.3 * (189.3)
VIL23	85.0 (55.2)	294.7 ** (101.6)	-7.4 (86.5)	110.3 (123.0)	92.4 (105.9)	184.4 (164.4)	205.0 * (119.9)	276.0 * (167.8)
Adjusted R-Square	0.36	0.23	0.13	0.34	0.27	0.33	0.31	0.39
Observations	190	186	190	186	190	186	190	186

Note: The figures between parentheses are the standard errors of the regression coefficients.
The number of asterisks indicate the level of significance of the regression coefficients according to the following codes:
** = significant at the 1% level
* = significant at the 10% level
No asterisk: not significant at the 10% level.

constant, the net sales and net total outflows increased by more than 330 kg in each year for farm households with carry-over stocks, which increase the total quantity of cereals available for sales and reduce the household's need to buy grain. Likewise, for each additional 10 kg of cereals produced per capita, the annual net sales and total net outflows per household rose by 8 kg to 10 kg. It may be inferred from these findings that all factors associated with farmers' foodgrain productive capacity also affect the farm household's position toward the cereals market. These results further support the conclusions from the cross-tabulation analysis, which showed that both household grain production and transactions are strongly related to agroclimatic conditions, institutional factors and farming technology.

All coarse grain transactions considered here also show significant relationships with the total head taxes that the household had to face in each year. As hypothesized, head taxes are associated positively with gross sales and purchases, and negatively with net sales and total net outflows. In 1986/87 (the second consecutive good crop year), for instance, each additional 1,000 CFAF of taxes were associated with an increase of gross sales by about 12 kg and purchases by some 34 kg, and a decrease of net sales and total net outflows by around 20 kg. Given an average of about 15,000 CFAF of taxes per household and insufficient own-production, taxes could be associated with about 280 kg of net grain inflows per household in northern OHV in 1986/87. This conclusion strengthens the argument about the negative effect of head taxes on the food security of deficit producers in areas with limited cash-earning opportunities,

since most food-deficit households would have to sell some of their insufficient foodgrain output to meet tax-payment obligations and subsequently buy cereals not only to fill the gap between their annual production and consumption needs, but also to replace the portion of own-production sold for tax payment.

The effects of taxes on the farm household's cereals transactions are clearly dampened by the extent of the household's involvement in cash-crop production. As hypothesized, the direct effect of cotton income (beside its indirect effect through production linkages) on coarse grain transactions depends on the extent of the farm household's involvement in cotton production. In 1985/86, this direct effect was negative on gross sales of coarse grains for up to three hectares of cotton per household, and positive above three hectares cultivated under cotton. Cotton showed no significant direct relationship with coarse grain purchases in 1985/86 and gross sales in 1986/87. However, holding all other factors constant in 1986/87, farm households cultivating up to 7.3 hectares of cotton bought less grain. The net result of these trends was that, beside its positive impact on cereal-surplus production and marketing, cotton cultivation was positively related (through direct income-linkages) with net coarse grain sales and total outflows in each of the two years of survey. The differences in the effects of cotton area on coarse grain transactions between the two years are likely attributable to variations in the food strategies of cotton-producers in a good crop year (1985/86) following a bad year in contrast with a second consecutive good year (1986/87). Hence, for up to three hectares of

cotton in 1985/86, coarse grain sales were negatively affected by cotton area. This is most likely because of small cotton-producers' propensity to rely mostly on cotton income for their cash needs and withhold a larger proportion of their 1985 coarse grain production in order to rebuild family security stocks of foodgrains after a few years of relatively bad harvest. Although it did not significantly encourage sales of coarse grains in 1986/87, cotton production (or income) likely reduced farmers' need to buy grain for household-level security storage, since two consecutive good harvests might have brought the security stocks of cereals to desirable levels.

The relationship between farm household's participation in non-crop activities and coarse grain transactions was negative for gross sales, positive for purchases and negative for net sales and total net outflows. Yet these relations were statistically significant only for the total purchases and the net market and non-market transactions of the second good crop year (1986/87). As mentioned earlier, it is possible that these relationships are not linear, as the poorest farms and the wealthiest farms may be involved in different types of non-crop activities, while farm households in the middle rely essentially on farming. It may be inferred from the above finding that, in a context of good rainfall conditions, income generated by non-crop activities becomes an important element of farmers' food-security strategies by allowing farm households with deficient cereals production to acquire substantial quantities (over 200 kg per household) of foodgrain from the market. More detailed income-data on

these activities are required in order to fully understand their effects on farmers' food security.

Finally, coarse grain transactions show some significant relationships with indicators of farmers' access to the main rural markets. Most of these relationships are only significant for 1986/87 (the second good crop year). The general trend was an increase in both gross sales and purchases for farmers living in the market-villages (VIL1) and the closest villages to the market (VIL23), with the increase in inflows outweighing that in outflows in the market-villages in contrast with a positive effect on market and non-market net transactions for the villages in the immediate surroundings of the market. An explanation of these trends may be that, with the relatively higher rural incomes following good rainfall seasons, farm households residing in major weekly market-villages draw substantial cash from alternative activities that are promoted by the physical location of the market. Such households would rely relatively more on the market to supply them the quantity of foodgrain needed for both immediate consumption and security-stock building. Farmers living in villages up to 10 kilometers away from the main weekly market have less cash-earning opportunities than their peers of the market-village, but a much better access to the market than those living in more remote villages. Most of the surplus producers of the closest villages to the market may therefore not only exchange larger quantities of grains for other consumer goods in the weekly market, but also act as small-scale assemblers who buy grains in the most remote villages to help fill their carts before going to the market.

From the above analysis, it appears that farmers' coarse grain transactions are affected by a complex set of variables, including ecological, institutional and technological factors associated with farm production, household's cash liabilities, alternative income sources available to the household, and access to the market-place. All these factors (except agroclimatic conditions) are essentially sensitive to the types of agricultural development institutions and policies implemented in the different rural areas such as CMDT and OHV. To conclude the discussion of the effects of these factors on farmers' coarse-grain production and transaction, the next section concentrates on possible explanations of the variability of net farm household's foodgrain availability, a proxy for family consumption and security-storage of cereals.

4.7. Net Coarse Grain Availability

Overall farmers of the 16 survey-villages of the CMDT and the OHV had, after the deduction of total net outflows, a net average of 217 kg of coarse grains per capita in 1985/86 and 295 kg per capita in 1986/87 (Table 4-26)⁴. These quantities exceeded the per capita foodgrain consumption rate of 188 kg by about 15% (29 kg) in 1985/86 and 60% (107 kg) in 1986/87. Assuming that seeds and storage and processing losses account for 15% of the available grains (CESA, 1982), it may be inferred that, as a group, the sample farmers exchanged all their coarse grain surpluses in 1985/86, while

4. This assumes no carryover of grain from 1984 harvest, although a few farmers reported that they had such stocks prior to 1985 harvest.

withholding about 79 kg per capita beyond annual household consumption and seed needs in 1986/87.

But this relatively adequate overall foodgrain availability does not apply to all farm household categories. When compared with a minimum requirement of 188 kg per capita, the coarse grain availability figures of Table 4-26 clearly show that, in 1985/86, all farm strata in CMDT had excess stocks and in OHV net foodgrain deficits. The same holds for 1986/87, except that farmers in OHV (particularly the small non-equipped households in the south and the fully-equipped households with several members participating in non-farm activities in the north) came close than in 1985/86 to meeting the 188 kg per capita grain requirements.

The effect of agroclimatic conditions on farm household's cereals availabilities was less stable than that of the institutional environment. Net coarse grain availability per capita for the farm foodgrain deficits. The same holds for 1986/87, except that farmers in OHV (particularly the small non-equipped households in the south and the fully-equipped households with several members participating in non-farm activities in the north) came closer than in 1985/86 to meeting the 188 kg per capita grain requirements.

The effect of agroclimatic conditions on farm household's cereals availabilities was less stable than that of the institutional environment. Net coarse grain availability per capita for the farm households in the southern part of the two zones was 43% higher than that of the households of the northern subzones in 1985/86. However, a substantial increase in production in north CMDT and purchases in

**Table 4-26. Farm Household Net Coarse Grain Availability
CMDT and OHV (1985/86 - 1986/87)**

ZONES/SUBZONES EQUIPMENT LEVELS	NET AVAILABILITY PER CAPITA (kg)		MONTHS OF CONSUMPTION AT 188 Kg PER CAPITA		MONTHS OF CONSUMPTION IN SECURITY STOCKS
	1985/86	1986/87	1985/86	1986/87	
South CMDT					
Equipped Farms	342	384	21.8	24.5	22.3
Semi-Equipped	344	326	22.0	20.8	18.8
Non Equipped	236	305	15.1	19.5	10.5
All Farms	327	354	20.9	22.6	19.5
North CMDT					
Equipped Farms	204	386	13.0	24.6	13.7
Semi-Equipped	210	320	13.4	20.4	8.4
Non Equipped	217	310	13.9	19.8	9.6
All Farms	206	366	13.1	23.4	12.5
South OHV					
Equipped Farms	144	163	9.2	10.4	0.0
Semi-Equipped	118	151	7.5	9.6	0.0
Non Equipped	165	192	10.5	12.3	0.3
All Farms	137	164	8.7	10.5	0.0
North OHV					
Equipped Farms	146	190	9.3	12.1	0.1
Semi-Equipped	128	134	8.2	8.6	0.0
Non Equipped	113	173	7.2	11.0	0.0
All Farms	127	165	8.1	10.5	0.0
TOTAL CMDT	259	360	16.5	23.0	15.5
TOTAL OHV	132	164	8.4	10.5	0.0
TOTAL SOUTH	259	286	16.5	18.3	10.8
TOTAL NORTH	181	302	11.6	19.3	7.3
Total SAMPLE					
Equipped Farms	235	345	15.0	22.0	13.0
Semi-Equipped	213	246	13.6	15.7	5.3
Non Equipped	171	231	10.9	14.7	2.7
All Farms	217	295	13.9	18.8	8.7

Note: Security-stock duration is estimated based on 188 kg per capita.

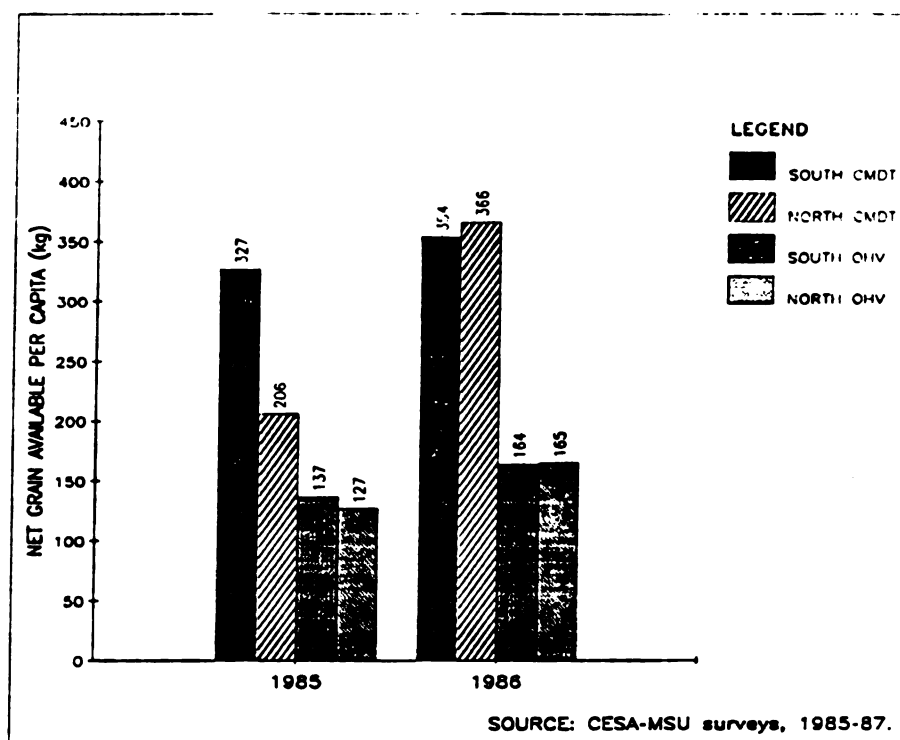


Figure 4-6. Per Capita Net Grain Availability by Zone and Subzone, CMT and OHV

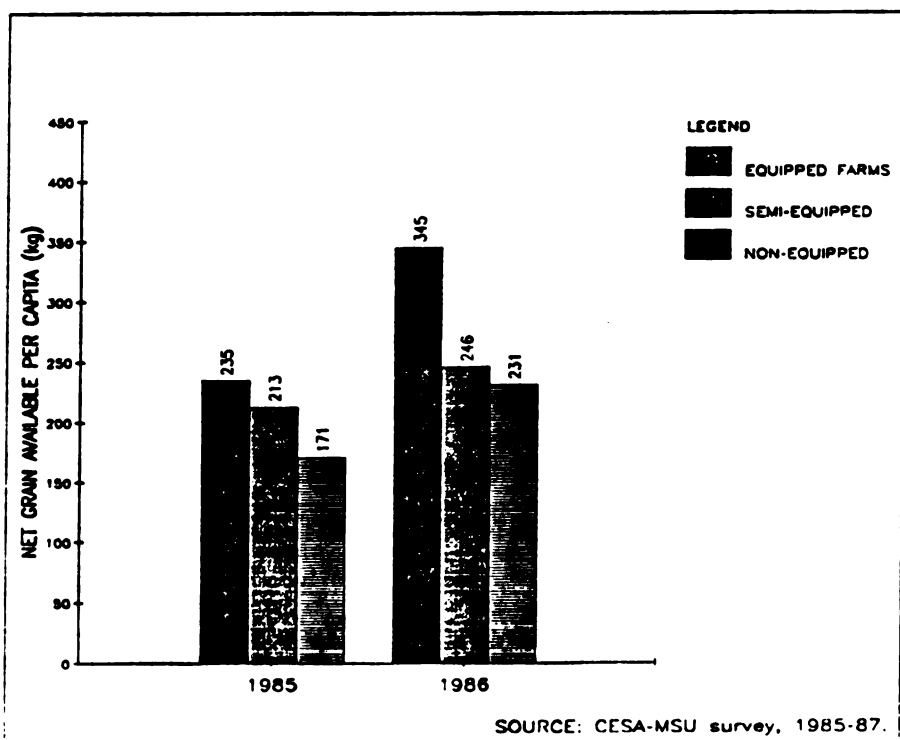


Figure 4-7. Per Capita Net Grain Availability by Level of Farm Equipment, CMT and OHV

north OHV resulted in the per capita net coarse grain availability in the northern subzones being 5.6% larger than that in the south in 1986/87. This finding clearly suggests that farmers' food-security status may not be attributed to rainfall and soil conditions alone.

In this respect, data in Table 4-26 show that while net per capita available coarse grains tended to increase with the extent of animal traction equipment owned in CMDT, no clear trend of improvement in farm household's foodgrain status emerged in association with the ownership of draft equipment and animals in OHV. Here, the lack of profitable activities (particularly cash-crop production) and complementary inputs (especially fertilizers) are among the most important constraints that inhibit the positive effects of animal traction on farm household's cereals security in OHV.

From a multi-year food security standpoint, estimates of the number of months of adequate consumption (at 188 kg per capita per year) secured by farmers' net coarse grain availabilities are also included in Table 4-26. These estimates show that, on average, the net coarse grain availability exceeded the consumption requirements of the sample households by an equivalent of about two months of consumption in 1985/86 and seven months in 1986/87. Assuming that the proposed consumption pattern is respected, it follows that farmers were in a position not only to meet their cereal consumption needs, but also to build up farm-level security stocks for over half a year (8.7 months) of consumption after net outflows amounting to 6.2% of their own production.

Although the position of farm households of the northern subzones improves significantly during the second year, the estimated level of their security stock build-up (7.3 months of consumption) was much lower than that of the southern households (about 11 months of consumption). In fact, all farmers' security stocks of grain in the northern subzones were built only by the households of north CMDT during the second good crop year (1986/87).

The institutional superiority of CMDT over OHV is even more evident here. In none of the two years did the farm households in OHV meet their cereal consumption requirements. On average, their estimated net grain availability was below the recommended consumption level by about 30% in 1985/86 and 13% in 1986/87. It may be assumed that the households in OHV rely more than those in CMDT on sources of energy other than coarse grains (particularly rice in the vicinity of Bamako, tubers, cowpeas, chick-peas, meat and fish) so that the share of coarse grains in their total calorie intake may be lower than that prevailing in CMDT. Nevertheless, our estimates of coarse grain security suggest that, in contrast to the farmers in CMDT who built estimated security stocks for 15 months of consumption, farm households in OHV barely made ends meet even in good rainfall years and were left without any cereal security stocks to face an eventual bad year.

There is also clear evidence that farm household foodgrain security increases with the level of draft equipment and animal ownership. Households of all equipment strata (except the non-equipped in 1985/86) had net available grains in excess of their

consumption needs. Yet the estimated period of consumption secured by their stock build-up over the two years declined from over a full year for the full-equipped, to about five months for the semi-equipped and three months for the non-equipped. Moreover, these variations between farm strata apply only to the CMDT zone, where all farm categories showed substantial excess-grain stocks. It therefore appears that the interaction of equipment ownership and improved institutional environment (rather than animal traction alone) significantly enhances farm household food security. The highest level of food security is achieved by the equipped households of the south of the CMDT which, after net outflows of 19% of their production, were still able to build up estimated security stocks exceeding their hypothetical consumption needs for nearly two additional years beyond the two years considered. Even in the drier northern subzone of the CMDT, equipped households, with net outflows of 5.5% of their own production, were able to meet their consumption needs in both years and build up estimated security stocks for a full year of consumption.

To test for the significance of the relationships described above, similar equations to those used in the coarse grain production analysis are estimated here, with the net per capita coarse grain availability as the dependent variable and the following independent variables:

a) the Dependency ratio, i.e., the number of household members per adult-equivalent farm worker. It is hypothesized that, for a given number of farm workers, the net quantity of cereals available per capita would decrease as the number of household members per

worker increases, given that the largest share of the foodgrains consumed by the household is supplied by own production. In other words, net per capita coarse grain availability is expected to be negatively related to the dependency ratio.

b) the natural environment of production (SZ). Because of their effect on coarse grain production, agroclimatic conditions are also expected to affect the farm household's net foodgrain availability. The relation between the variable SZ and net per capita coarse grain availability is expected to be positive as a result of the positive effect on coarse grain production of the better agroclimatic conditions of the southern subzones ($SZ = 1$) relative to the northern ones ($SZ = 0$).

c) the institutional environment of production (Z). The dummy variable Z reflects here the effect on net coarse grain availability of the institutional differences between the CMDT zone ($Z = 1$) and the OHV zone ($Z = 0$). Its coefficient is expected to be positive as a consequence of the better income opportunities and overall market services in CMDT relative to OHV.

d) household's stock of draft equipment and animals (SEQ and EQP). Given that animal traction increases farm household's coarse grain production, net coarse grain availability per capita is also expected to increase with the ownership of a full set of draft equipment and animals ($EQP = 1$; and 0 otherwise) or a partial set of animal traction equipment ($SEQ = 1$, and 0 otherwise).

e) Cash crop production (ACOTCAP). Cotton production was seen to have a strong positive effect on coarse grain production per farm.

In addition, cotton income reduces to some extent farmers' need to sell foodgrain and may further allow cotton-producers to buy additional cereals for their own food security. As a result, the cultivated area of cotton per capita (ACOTCAP) is expected to be positively related to net per capita coarse-grain availability at the farm household-level.

f) Non-crop activities (NCA). In addition to cash crops, non-crop activities generate income that may be used to acquire complementary foodgrain needed for farm household's consumption. The dummy variable NCA (with value one for households with non-crop activities and zero for others) is therefore hypothesized to be positively associated with net per capita coarse grain availability.

Similarly to the case of the production equations, the double-logarithmic approximation of the net coarse grain availability yielded better statistics (adjusted R^2 , level of significance of regression coefficients, F-statistics) than the simple-linear or semi-logarithmic equations. Consequently, only the results for the double-logarithmic equations are presented in Table 4-27. Although they do not explain more than one third of the variation of the net grain availability per capita (a usual result when using categorical independent variables), these equations, clearly show significant relations between farm household foodgrain status and the explanatory factors examined.

First, the occurrence of a second good rainfall season was associated with an increase in net per capita coarse grain availability (20%) almost equal to the increase in foodgrain production per

household (23%) in 1986/87. This implies that farmers' foodgrain entitlements are closely related to their own production in the subsistence-commercial agriculture of Mali. Hence, any factor affecting agricultural productivity (natural resources, technologies, input and output markets, etc.) will also affect farmers' food security.

Second, the dependency ratio (CPW) had a significantly negative and stable effect on the net availability of coarse grains per capita. For each 10% increment in the number of family members (consumers) per worker, the net quantity of coarse grains available per capita decreased by about 4% in both 1985/86 and 1986/87. This result clearly supports the view that the size and age composition of the farm household strongly affect the farm family's food security. Large families with numerous young children are likely among the most food-insecure portions of the farm population.

Third, the institutional environment of production (Z) shows a much higher and more significant effect than the natural conditions (SZ) on farm-level foodgrain availability. Holding all other factors constant, the net availability per capita in CMDT ($Z = 1$) rose above that in OHV by 31% in 1985/86 and 39% in 1986/87. It is only in 1985/86 that the better agroclimatic conditions in the southern subzones relative to the northern ones were significantly associated with a 19% increase in net foodgrain availability. This further strengthens the argument that the quality of the agricultural support services (research, extension, credit, input provision, output marketing, etc.) provided by the rural development organizations strongly influence farmers' food security through their effects on both production-based and exchange-based entitlements.

Table 4-27. Estimates of Equations of Net Coarse Grain Availability Per Capita (Log(NAVCAP)), CMDT and OHV (1985/86-1986/87)

INDEPENDENT VARIABLES	1985/86	1986/87	1985/86 and 1986/87
Constant	5.06 ** (0.17)	5.47 ** (0.17)	5.17 ** (0.13)
Dependency Ratio (Log(CPW))	-0.38 ** (0.11)	-0.39 ** (0.12)	-0.39 ** (0.08)
Zone (Z)	0.31 ** (0.12)	0.39 ** (0.12)	0.35 ** (0.09)
Subzone (SZ)	0.19 * (0.10)	-0.15 (0.10)	0.02 (0.07)
Semi-Equipped (SEQ)	-0.03 (0.11)	-0.13 (0.11)	-0.08 (0.08)
Equipped (EQP)	-0.06 (0.13)	-0.03 (0.13)	-0.04 (0.09)
Cotton Area (Log(ACOTCAP))	1.23 ** (0.33)	1.26 ** (0.33)	1.25 ** (0.24)
Non-Crop Activities (NCA)	0.13 (0.10)	0.03 (0.10)	0.08 (0.07)
Year (YEAR)	-- --	-- --	0.20 ** (0.06)
Adjusted R ²	0.32	0.33	0.33
Number of Observations	190	186	376

Note: The figures between parentheses are the standard errors of the regression coefficients.

The number of asterisks indicate the level of significance of the regression coefficients according to the following codes:

** = significant at the 1% level.

* = significant at the 10% level.

No asterisk: not significant at the 10% level.

Fourth, none of the two levels of farm equipment for animal traction (EQP and SEQ) was significantly associated with net per capita coarse-grain availability. This result is mostly attributable to a problem of multicollinearity between the level of animal traction equipment and the extent of cotton cultivation in CMDT, where the cross-tabulated data showed that net coarse grain availability per capita varied most between the different equipment strata (Table 4-26). In OHV, the compensation of own-production by net inflows from the market brings farm households of the different equipment levels to very similar foodgrain availabilities per capita. In CMDT, where farmers rely essentially on own-production of coarse grains, both the level of farm equipment and per capita cereals availability are strongly influenced by the size of cotton income. Therefore, the cotton area per capita (a continuous variable) picks up most of the effects of the two dummy equipment-variables (EQP and SEQ).

Fifth, cash-crop (cotton) production shows a strong positive and stable relationship with farm-level foodgrain availability. In each of the two years, a 10% increase in the per capita cotton area was associated with a 12% to 13% increase in net coarse grain availability per capita, *ceteris paribus*. This finding is important to the extent that it shows that, rather than reducing farm-level self-reliance, income from relatively high-value cash-crop production complements farmers' own cereals production to enhance the overall level of household food security. Cotton production along with the relatively high-quality institutional environment sustained by cotton income thus constitute the essential ingredients of CMDT's success in agriculture relative to other rural development zones in Mali.

Finally, the net per capita availability of coarse grains also tended to be positively related to farm household's involvement in non-crop activities (NAC). But this relationship was not statistically significant in any of the two years, most likely because of the lack of more precise data on the amount of income derived from non-crop activities. Nevertheless, it may be safely argued that income from such activities constitutes a critical element of the food-security strategies of farmers with marginal or no cash-crop production, as illustrated by the wide variety of non-crop sources of income used by farm households to finance their foodgrain purchases in OHV (Table 4-13). As Reardon, Matlon and Delgado note, the role of non-crop activities in food-security strategies becomes even more important in the drier Sahelian subzones, where most farmers cannot produce enough of their own cereals needs and must rely heavily on trade-based entitlements for their food security.

The above evidence and the analysis of transactions of the previous sections lead to the conclusion that, outside the good rainfall zones covered by relatively well-performing rural development institutions (such as CMDT), very few farm households presently have the capacity to secure their own cereal consumption needs. Most of them are deficit cereal producers who also lack adequate income from other activities that would enable them to purchase the necessary complement of foodgrains on the market, and most of their coarse grain sales are likely motivated by relatively rigid cash liabilities such as payment of taxes and debts. Farmers who own at least draft equipment and animals in the improved rural development environments (e.g., the CMDT) have, beside their production of substantial quantities of cash crops (such as cotton), the capacity to

generate an important marketable surpluses of foodgrains. Even for these real surplus producers, however, there is evidence that farm households withhold a substantial part of their "marketable" surpluses of cereals to assure a higher level of food security in a multi-year perspective.

It therefore seems that even if the liberalization of the cereal market had a positive impact on total foodgrain availability, farmers still perceive a certain level of risk of food shortage and price increases due to uncertainties related to both rainfall and market supply reliability. As a result, the difference between the expected value of the surplus grains for the periods of shortage and the present market value of the same surplus would probably more than offset farmers' storage costs. Farmers' propensity to keep part of their annual surplus foodgrain in security stocks is likely strengthened by the absence of strong rural savings/loan institutions. The perceived risk associated with uncertainties about both market foodgrain supply and timely access to adequate financing may well explain why Malian farmers often assert that, to feed their households, "market foodgrains are nutritionally poorer than home-produced cereals."

4.8. Policy Implications

The above analyses establish empirically that farmers' coarse grain production and transactions in Mali are significantly influenced by many interactive factors, chiefly the natural conditions (rainfall, soils, etc.), the institutional environment of rural development, and the level of improved farming equipment owned by the farm household. These findings have implications for several macro-level policies pertaining particularly

to domestic foodgrain marketing and pricing, credit, food aid and taxation in the rural milieu.

4.8.1. Price policies

The cereal market restructuring program (PRMC) agreed upon by the Government of Mali and the major food aid donor community in 1981 called for both market liberalization and public sector intervention to regulate/support producer prices. On the assumption that low official producer prices were one of the major disincentives to increasing production, the initial objectives of the program sought to double, in nominal terms, coarse grain prices from CFAF 35/kg in 1980/81 to CFAF 70/kg in 1985/86 and 1986/87 (Humphreys). Although the official price target was adjusted downward to CFAF 55/kg for the last two years, this still implied a substantial public support effort given the relatively abundant coarse grain production in 1985 and 1986 (Dioné and Dembélé, 1986b; Dioné and Dembélé 1987). In spite of the lack of reliable estimates of coarse grain supply and demand price elasticities, it seems safe to argue that the purchase and storage in 1985/86 by the public system of a substantial proportion (20% or more) of the marketable surplus of millet, sorghum and maize exerted an upward pressure on both producer and consumer prices of these domestic foodgrains, which are assumed to have very weak substitution relations with imported cereals (rice and wheat particularly) throughout the Sahel.

As a result, the substantial public buying campaign likely had a significant effect on both producer selling and buying prices (which are very closely related to each other in rural markets) in 1985/86, even

though the observed average price (CFAF 47.3/kg) remained 24% below the official target level of CFAF 55/kg. The benefits of such price support, however, were very unequally distributed among farmers, as shown by their different positions in the coarse grain market. In the sample villages of this study, the support effort was beneficial for two-thirds of the households in CMDT, 77% of the fully-equipped households and 62% of the households of the more humid southern subzones. Yet high prices depressed the real income of 72% of the households in OHV, 54% of those of the drier northern subzones, 52% of the semi-equipped and 62% of the non-equipped households, which were all net coarse grain buyers. Moreover, the bulk of the subsidy to production went to the top 28% of the farms which made 90% of all net sales. Because of their privileged location in higher rainfall areas and their improved farming techniques, these farms likely face the lowest production costs. As Mellor (1978) notes, such price-support policies ultimately imply an income transfer from consumers, including deficit producers (43% of our sample farmers) who are net foodgrain buyers, to farmers who are most able to produce and sell cereals profitably without any subsidy.

The explicit objective of supporting coarse grain producer prices was officially abandoned in 1987/88, mainly because of its temporary financial infeasibility. Any future attempts to support prices above their market level should take full account of likely income-distribution effects on different population groups in the market. In this sense, reasoning in terms of net sellers versus net buyers rather than producers versus consumers may lead to the conclusion that well-intentioned price support

policies are often neither economically justifiable nor socially desirable.

4.8.2. Mode of public-sector participation in the market

The suitability of the mode of public sector participation in the coarse grain market is a critical issue. Over two decades, including the first six years of the PRMC-induced market liberalization, the government applied each year a fixed and unique pan-territorial producer and consumer price to all three coarse grains (millet, sorghum and maize). This approach to price stabilization did not account for seasonal and spatial price variations; spatial, technological and commodity differentiation in production costs; and consumer preferences for the three commodities. It also failed to take into account the location and commodity-specificity of the marketed coarse grain surplus.

As a result, OPAM dispersed its purchasing personnel and funds all over the country and made as much as 16% of its regulatory purchases in obviously deficit production areas such as the regions of Kayes and Mopti. In contrast, our findings show that (perhaps beside the region of Ségou, not covered by our surveys) the bulk of the coarse grain marketable surplus was located in the CMDT zone, and nearly 70% of it was in the form of sorghum. The uniform intervention of OPAM for all commodities, in all the regions, of the country certainly imposed higher transaction costs to the public sector and reduced the effect of the price support effort on the true surplus producers.

It is therefore recommended, in the event of another price support program, that the intervention be selectively targeted to those regions

of the country where there is evidence that a substantial surplus production is depressing market prices received by producers to levels such as to create a significant disincentive for future production expansion. Even in this case, distinction should be made between commodities with regard to both their production potential and consumer preferences. During the National Seminar on Food Policy in June 1987, it was argued that there is a high potential for increasing maize production through more intensive cultivation exists in the CMDT zone, but that the expansion of the output of this product is more limited by its low effective demand due to both consumption habits and processing problems. It is then not surprising that the bulk of the marketed surplus of this zone is sorghum, the second highest-yielding coarse grain after maize.

Above all, the thinness of the market constitutes one of the major constraints to increasing coarse grain production for the market (Dioné and Dembélé, 1987). Millet, sorghum and maize account for less than 45% of the total cereal consumption in urban areas (Rogers and Lowdermilk), which contain about 20% of the total population of the country, and cereal consumption is higher in rural than urban areas (Mondot-Bernard). It follows that only 9% or less of the aggregate demand for coarse grains is from urban consumers. The dichotomy of rural producer/supplier versus urban consumer then loses much of its sense when more than 90% of the total demand is located within the farming population itself, even though all the rural demand for cereals is not market demand.

By failing properly to identify and locate the specific segments of the aggregate domestic coarse grain supply and demand, most of the past

policies that aimed at stabilizing both producer and consumer prices of these commodities have been ill-conceived and proven unsustainable. The theoretical model used assumed that inter-annual price fluctuations are explained solely by shifts in the supply due to changes in rainfall. In reality, changes in domestic production cause both the aggregate market supply and demand to shift simultaneously, and in opposite directions. During good rainfall years, a larger proportion of farmers become self-sufficient or excess producers, causing at the same time a sharp drop in market demand and a substantial increase of surplus supply. Together these forces depress market prices below what would be expected from an expansion of supply without a shift in demand. On the opposite side, production decreases during poor rainfall years are accompanied simultaneously by an expansion of market demand (a larger proportion of deficit producers) and a reduction of surplus supply, resulting in price levels that are much higher than those expected under the assumption of a fixed demand curve.

It is even logical to believe that both domestic coarse grain supply and demand are more price-inelastic during those years of shortage, as surplus producers become more concerned about their own household food security and are reluctant to sell their surplus. Deficit producers are willing to bid as much as they can to meet their relatively fixed foodgrain consumption needs. Such variations in short-term elasticities will contribute further to widening the gap between price levels in good and bad production years, as illustrated by the quadrupling in south CMDT of the producer price of millet from CFAF 25/kg in March 1987 (following

a good harvest) to CFAF 100/kg in July 1988 (following a poor harvest) (Staatz, Dioné, and Dembélé 1988).

In the light of these facts, future efforts of price stabilization or support should be defined for specific commodities (not an indistinct group of commodities) and be targeted to specific surplus versus deficit production zones rather than to rural producer versus urban consumer groups.

4.8.3. Fiscal policy

Direct taxes aimed at the income of the rural population in Mali can be classified into three broad categories: the "minimum fiscal tax", the "development tax" and the tax on livestock. All three tax categories are inspired by the head tax introduced during the colonial period as an incentive to stimulate agricultural (and particularly cash crop) production, by encouraging farmers faced with such an additional burden to produce above subsistence levels and enter the modern commercial sector (Koné 1983). All three taxes are therefore determined as a cash amount per head (of taxable person or livestock) which is fixed within, but variable between, fiscal regions.

In view of the difficulty of getting even a reasonable approximation of the income of the illiterate population of the informal and rural sectors, the definition of the fiscal regions and their corresponding tax rates is designed as a substitute which reflects an implicit attempt to link the levels of the head taxes to the perceived income levels in different geographic areas. As Koné notes, the levels of the tax rates by geographical location reflect the nature of soils, the normal regime

of rainfall, the nature of the dominant (cash) crop (e.g. cotton, groundnuts) and the existence of the activities of the agricultural development agencies, which are all considered as indicators of wealth of the rural population.

As a result, farmers of most of the fiscal districts in CMDT (including the areas covered by this study) have been charged the highest taxes since the differentiation of the rates in 1970. A comparison of official tax rates of the National Direction of Taxes for the zones covered by this study shows that, relative to the OHV zone, the minimum fiscal tax in CMDT was 36.4% higher in 1970 and 47.3% higher in 1976. Our own survey data showed that in 1985/86, the total tax claims per taxable person in the south of CMDT were 19.1% higher than those in north CMDT, 47.2% higher than those in south OHV, and 31.2% higher than those in north OHV (Table 4-28).

The minimum fiscal tax or head tax claimed for each resident person aged 14 to 65 (except for exempt persons such as full-time students, workers paying income tax, mothers of four or more children, indigents, etc.) constituted the bulk (89% to 92%) of the total taxes imposed to the farm households in the survey zones. Although they contribute less than 12% of the total state budget (Koné), the total direct taxes of the rural population weigh heavily on farm household income. They amounted to a proportion of the total value of 1985 coarse grain production ranging from about 12% in south CMDT to 23% in north OHV. They also represented the worth of 6.5% to 7.5% of the total available rainy season working time (valued at the daily rate of CFAF 600 per worker) of these households. Furthermore, these taxes would represent 9% to 12% of the gross annual

Table 4-28. Farm Household Fiscal Data (1985/86)

	SOUTH CMDT	NORTH CMDT	SOUTH OHV	NORTH OHV
<u>Total Taxes Claimed:</u>				
CFAF per Farm	21837	19999	13003	15178
CFAF per Taxable Head	4022	3378	2732	3066
As % of Cereal Production Value (a)	11.8	14.2	18.1	23.0
Head Tax Share (% of total)	91.7	90.7	90.1	88.9
<u>Total Taxes Paid:</u>				
CFAF per Farm	21859	19999	12160	15383
As Percent. of Total Tax Claimed	100.1	100.0	93.5	101.4
<u>Income Sources Used (% of farms)</u>				
Coarse Grains	6.6	1.8	15.2	53.3
Cotton	80.2	69.6	24.2	0.0
Livestock	0.0	7.6	29.2	22.1
Other Income Sources	15.7	29.0	40.2	50.1
<u>Timing of Payment (% of farms)</u>				
November-January	16.7	3.3	100.0	--
February-April	83.3	96.7	0.0	--
November-April	100.0	100.0	100.0	100.0
<u>% of Cereals Sales in Nov.- April:</u>				
All farms	29.8	56.0	76.9	83.4
Farms using Grains to Pay Taxes	51.7	77.8	90.2	100.0
<u>Taxes as % of Coarse Grain Deficit (b)</u>	--	--	39.0	39.1

Note: (a) Coarse grains are valued at their weighted average price for the official period of tax collection (November-March). These prices were CFAF 51.1/kg in south CMDT, CFAF 52.0/kg in north CMDT, CFAF 50.0/kg in south OHV, and CFAF 53.1/kg in north OHV.

(b) The percentage of coarse grain deficit corresponding to total taxes is estimated on the basis of 188 kg of grain per capita per year, with coarse grains valued at their weighted 1985/86 average price of CFAF 49.9/kg in south OHV and CFAF 52.8/kg in north OHV.

income of OHV farm households even in good rainfall years, under the very conservative assumption that coarse grain production contributes no more than 50% of their total income.

The administration of rural tax collection, which makes each village chief fully accountable for his taxpayers, ensures very high rates of collection, reaching a national average of 95% and even exceeding the claims by as much as 3% in some regions (Ibid., pp.124-28). Indeed, except for the south of OHV, which had a 6.5% default rate, the sample farm households of this study made timely payment of at least 100% of their taxes in 1985/86.

In any rural zone, farmers have to rely on more than one income source to pay their taxes. As the importance of cash-crop (cotton) production decreased, the proportion of households using income from coarse grain sales as well as livestock and other activities to pay taxes increased from less than 7% in the CMDT zone to 15% in south OHV and more than 50% in north OHV.

The negative impact of this reliance on cereal sales for tax purposes on the food security of the households with limited or no access to cash-crop production is further compounded by the very rigid timing of the tax collection. To ensure that most farmers pay their dues, rural taxes are claimed immediately after harvest (between December and March), when all households have a certain income, no matter how insufficient it may be. In fact, all tax payments by the farmers of the sample villages were made before the end of the dry season, that is by April or May. This explains in large part the early sales of coarse grains observed in low or non-cotton-producing zones such as OHV, which, unlike CMDT, is not privileged

by the administrative provision that prevents tax collection from beginning before the opening of the official cotton marketing season (January-April). The effect of cash-crop income on farmers' cereals sales strategies was evident even in the south of the CMDT, where the percentage of coarse grain sales made between November and April was, for the households using cereal income to pay taxes, 73.5% above the overall average.

The main implication is that head taxes, and particularly the timing of their collection, constitute major constraints which prevent a significant proportion of farmers (mainly those without important alternative cash-income sources such as cotton) to achieve a higher household food security, or even to adopt coarse grain sale strategies that would increase their total income, i.e., by selling mostly during the rainy (hungry) season when prices rise to their highest annual levels.

Taxes constituted the first-ranking coarse grain sales motive for more than 50% of the sellers in south OHV and more than 90% of those in the north of this zone (Table 4-7), where farmers subsequently bought 4.7 times more foodgrains than they sold (Table 4-9). As a result, taxes accounted directly or indirectly for about 39% of the estimated average cereal deficit of the farm households in both the south and the north of OHV (Table 4-28). These alarming figures would further increase with major crop failures in years of bad rainfall.

In the light of the above findings, it is recommended that the whole fiscal policy toward the rural population be thoroughly revised for two major reasons. First, the above analysis clearly indicates that the determination of fixed tax rates on the sole basis of rough natural or

institutional indicators of wealth, and the assumption that all farmers produce some surplus to be extracted leads, in many regions, to pushing the majority of the population further below minimum subsistence. A thorough revision of the tax burden based on an improved estimation of the level of income of the farming population in different zones and subzones may prove that, in most cases, the reduction or elimination of head taxes represents a better policy alternative than unsustainable producer price-support programs in order to improve farmers' real income and food security.

Second, for those regions where the level of income is proven sufficient to maintain some level of taxation, more flexibility should be introduced in the timing of tax collection. Unless farmers are given alternatives in timing their tax payment, they will hardly be able to adopt rational transaction strategies, which would enable them to capture most of the potential benefits of the liberalized cereal market. Ensuring that only households of surplus production zones pay taxes also ensures that the taxpayers have a real capacity to pay throughout the year, while the fine-tuning of the timing of their market transactions would allow them to maximize their total income.¹

4.8.4. Food-aid and foodgrain supply-management policies

Since the severe drought of the early 1970s, OPAM and a national drought-relief commission (CNAVS, now renamed CNAUR) have been the prime

1. A recent PRMC-sponsored village association credit program attempts to address this problem by giving farmers liquidity during the post-harvest period to allow them to sell later in the year (Dembélé and Steffen 1987).

managers of food aid received by the Government of Mali. The food-aid management role of OPAM has been strengthened under the PRMC, while its commercial functions have been reduced. As of 1988, OPAM no longer performs market regulation or price stabilization activities.

The deficit zones in which the bulk of food aid is distributed in Mali are almost always defined as the four northern, low-rainfall administrative regions of Kayes, Mopti, Tombouctou and Gao. The remaining three regions of Sikasso, Koulikoro and Ségou are generally perceived as self-sufficient, at least. As a result, with the exclusion of the large urban district of Bamako, as much as 71% of the total quantity of cereals and 87% of the food aid managed by OPAM is distributed in the four "deficit regions", which contain 48% of the population. Only 29% of the total distribution and 13% of the food aid goes to the three "self-sufficient/surplus regions," even during years of general cereal shortages following a poor rainy season such as 1984/85.

It has been shown above, however, that even in good years such as 1985/86 and 1986/87, most farms in OHV (part of the Koulikoro region) do not produce enough cereals to meet their home consumption needs. This finding is further supported by estimates of the degree of 1985/86 cereal self-sufficiency computed by the Statistical Office of the European Community (OSCE 1986) at a more disaggregated (cercle) level than the regional one (Table 4-29). These estimates indicate that, within a given administrative region, the capacity of a subzone to be self-sufficient varies significantly with the institutional (rural development) zone in which it is included. As an illustration for the Koulikoro region, 1985/86 cereal production in all OHV sectors was 26% (Banamba) to 73%

(Kangaba) below consumption requirements estimated at the low official rate of 167 kg per capita, while the ODIPAC sector of Nara and the CMDT sector of Dioila produced respectively 36% and 90% more cereals than needed for their own consumption. Except for the most urban subzones of Sikasso, Bougouni and Yanfolila and the most northern sector of Tominian, subregions of CMDT had excess cereal production. Since the degree of deficit in the OHV subzones was much higher than the percentage of the total population living in the urban areas of the Koulikoro region, one must conclude that the estimated deficit was not a mere result of higher urbanization, but mainly a consequence of low rural self-sufficiency even during good rainfall years.

Our own analysis clearly indicated that a large majority of farm households of both the south and the north of OHV do not produce enough cereals and often do not have an adequate capacity to buy the complement of foodgrains needed for their consumption. It follows that such zones should also be included in the official list of deficit areas for food aid planning purposes, since their foodgrain deficit estimated at two to three months of home consumption during the two years of this study could increase at least to four months if their own production fell by 20% below the 1985/86-1986/87 level due to low rainfall.

In other words, unlike most farms of the CMDT, which are able to ensure their food security with own-produced cereal stocks and cotton income savings, most farm households in OHV very likely face each year, two to four months of low consumption, particularly during the energy-demanding season of farming activities (June through September). Such deficits are most likely in sub-parts of the alleged self-sufficient or

Table 4-29. Degree of Self-Sufficiency in Cereals of Selected Administrative Districts (Cercles) in 1985/86

REGIONS AND CERCLES	RURAL DEVELOPMENT INSTITUTIONS	DEGREE OF CEREAL SELF- SUFFICIENCY (PERCENTAGE)	PERCENTAGE OF URBAN POPULATION IN TOTAL POPULATION
<u>Region of Koulikoro</u>	CMDT-OHV-ODIPAC	88	7.8
Koulikoro	OHV	55	
Banamba	OHV	74	
Kangaba	OHV	27	
Kati	OHV	46	
Kolokani	ODIPAC	43	
Nara	ODIPAC	136	
Dioila	CMDT	190	
<u>Region of Sikasso</u>	CMDT	142	10.4
Sikasso	CMDT	85	
Bougouni	CMDT	98	
Kadiolo	CMDT	189	
Kolondièba	CMDT	128	
Koutiala	CMDT	244	
Yanfolila	CMDT	98	
Yorosso	CMDT	247	
<u>Region of Ségou</u>	CMDT/ON/ORS/DRA	135	14.8
Ségou	DRA/FDV	100	
Barouéli	CMDT	112	
Bla	CMDT	166	
San	CMDT	129	
Tominian	CMDT	68	
Macina	ORS/DRA	110	
Niono	ON/DRA	341	

Source: Office Statistique des Comumautés Européennes (OSCE), 1986

Note: Degree of self-sufficiency = percentage of consumption needs (at 167 Kg of cereals per capita) covered by own-production. The sample villages of our study are part of the cerles of Koutiala (South CMDT), Bla (North CMDT), Kati (South OHV) and Koulikoro (North OHV).

excess-production regions of Koulikoro and Ségou and deserve an explicit account in food aid matters. Finally, it must be recognized that the public sector is not the most appropriate market participant in dealing with the management of either rural surplus supply or security storage of cereals. Up to 1987, the official trend has been for the public system to play, through the direct operations of OPAM, a major role in managing national foodgrain security stocks in different regional locations in the country. This approach is not only financially unsustainable as far as rainfed coarse grains are concerned, but it also lacks the operational flexibility required to properly meet the security needs of most rural areas of the alleged self-sufficient regions. For the farm households of these zones, a more decentralized management of both market surplus supply and security stocks as close as possible to the village level may yield, if backed by an appropriate financing policy, an overall increased income and food security for the rural community.

Farmers' associations at the village level (AV and Tons) appear as potential institutions to play both regulatory and security storage functions (Dioné and Dembélé 1987; Gagnon 1987).² The reliance on the collective intervention of farmers' associations to play such roles is appealing for several reasons. First, collective management increases the scale of farmers' transactions and give them a greater bargaining or countervailing power than their individual atomistic supplies (Shaffer 1980). Second, an operational and properly financed cooperative organization may discipline the timing of farmers' transactions in such

2. The Ton is a traditional youth organization. A political decision was recently made to promote Tons as the main grassroots organizations for rural development in Mali.

a way as to increase their overall income. Third, through their potential cereals-bank functions, village-based institutions are in a much better position to manage coarse grain supply in both directions, i.e., from and to the farm population itself, since farmers would have a much easier access to them than to any public marketing network, no matter how decentralized the latter may be. Finally, by combining the storage, distribution and credit functions, village associations will likely be able to bring some solutions to the problems of early sales of cereals for tax and loan payment coupled with hungry season purchases and loans at high market price levels, particularly in the zones where both surplus and deficit producers are found in the same villages.

As shown by the experience of the first year (1986/87) of effort to promote village association participation in cereal marketing in Mali, however, there is still a strong propensity by the public sector to try to control at least some aspects of the activities of cooperative institutions. Although it may be argued that the high degree of farmers' illiteracy prevents them from performing "formally sophisticated functions" such as seasonal price projections (Dembélé and Steffen 1987), it still remains true that many farmers have learned from experience to manage their own inter-annual surplus stocks better than the public system has regulated the cereal market over the past two decades. What is most important in promoting a successful market participation of such cooperative institutions is the development of trust and sense of shared interests group solidarity among the members (Shaffer, et al.). In this sense, the rules governing participation in the decision-making process

(price determination, financing, buying, storage and selling decisions) become even more important than the mere principle of association itself.

Finally, public sector provision of such services as seasonal credit, market information and functional training in cooperative marketing management are likely to yield a higher payoff in improving the performance of village associations (in supply, stock and credit management accounts) than any direct public attempts to preset the details of transaction procedures to be followed by these associations.

4.8.5. Food self-sufficiency policies

The official document of the Malian food strategy states that "food security is achieved when two fundamental objectives are simultaneously met: food self-sufficiency and adequate nutritional level" (République du Mali 1982b, 22). Furthermore, food self-sufficiency is defined as "the capacity of a country to provide to its population in general, and to each particular individual and family sufficient food." Finally, it is officially stated that "food self-sufficiency will be achieved only when the country reaches such a nutritional level through domestic production."

These official statements clearly point to a "food first" orientation of future agricultural development efforts. This trend is obviously translated in the 1987 agricultural sector assessment by the Ministry of Agriculture, which puts the major emphasis on the development of food crop production and deals with cash crops in a subsidiary manner. Furthermore, there is a strong tendency to address the development issues of different

activities (e.g., food crop production, cash crop production and non-farm activities) in a piecemeal way, i.e., in isolation.

This lack of an integrated approach to either food self-sufficiency (as defined in the official food strategy) or food security is clearly in conflict with the whole-farm management strategy followed by farm households in coping with their own consumption and income needs. As discussed earlier, both cash-crop (cotton) production and non-crop activities contribute, through the positive effects on coarse grain production of farm equipment and inputs acquired with their income, or the additional cereals purchased with this income, to improve rural households' capacity to secure their consumption needs and generate marketable surpluses. Therefore, planning the development of the production and marketing of foodgrains separately from considerations regarding the other activities of the farm household becomes an incomplete exercise, which may ultimately miss the cereal self-sufficiency goal itself.

Even if foodgrain self-sufficiency from domestic production was to be retained as a justifiable objective on the basis of available agricultural resources (land and labor particularly) that might become more productive with improved technologies, the above analyses indicate that such an objective is better achieved through the simultaneous promotion of a mix of income-generating activities rather than the development of a single activity. As a result, it is recommended that future efforts to increase food grain production take into account the full integration of the productive activities at the farm household-level. Special attention should be paid to those activities that are less

vulnerable to rainfall fluctuations (mainly the off-farm activities) or to agricultural commodities that can generate substantial income to be saved in order to secure farmers' own needs in difficult years.

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INFORMING FOOD SECURITY POLICY IN MALI:
INTERACTIONS BETWEEN TECHNOLOGY, INSTITUTIONS AND MARKET REFORMS

VOLUME II

By

Josué Dioné

A DISSERTATION

Submitted to

Michigan State University

in partial fulfillment of the requirements

for the degree of

DOCTOR OF PHILOSOPHY

Department of Agricultural Economics

1989

**INFORMING FOOD SECURITY POLICY IN MALI:
INTERACTIONS BETWEEN TECHNOLOGY, INSTITUTIONS AND MARKET REFORMS**

CONSTRAINTS ON IN VOLUME II IN NEW TECHNOLOGIES

By

Josué Dioné

The agricultural sector in Mali, as in all Sahelian countries, is characterized by low land and low labor productivity. According to official data of the Direction Nationale de l'Agriculture (DNA) and the Direction Nationale de la Statistique et de l'Informatique (DNSI), during the 10-year period extending from 1977 through 1986, average yields never exceeded 1030 kg/ha for millet and sorghum 1660 kg/ha for cotton and 1740 kg/ha for groundnuts. The average area cultivated per worker ranges between 0.58 ha (in OHV) and a maximum of 1.09 ha (in CMU) in the rainfed zones, and between 0.87 ha (in ORS) and 1.20 ha (in OH) in irrigated rice perimeters (IER 1986)¹. Major investments in improved agricultural technologies are therefore **A DISSERTATION** increase both labor and land productivity in the low-input agriculture of Mali.

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1. ORS stands for Opération Riz Ségou, a rice development agency for the region of Ségou.

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same critical conclusions about such policies which, although not directly related to the cereals market restructuring, may constitute serious impediments to most of the positive effects expected from product market liberalization. To do so, the functions examine the agricultural

CHAPTER V

CONSTRAINTS ON INVESTMENT IN NEW TECHNOLOGIES

research process and outputs in Mali. It identifies investment and disinvestment in draft equipment and animals, and identify and discuss the

The agricultural sector in Mali, as in all Sahelian countries, is characterized by low land and low labor productivity. According to official data of the Direction Nationale de l'Agriculture (DNA) and the Direction Nationale de la Statistique et de l'Informatique (DNSI), during the 10-year period extending from 1977 through 1986, average yields never exceeded 1030 kg/ha for millet and sorghum 1660 kg/ha for cotton and 1740 kg/ha for groundnuts. The average area cultivated per worker ranges between 0.58 ha (in OHV) and a maximum of 1.09 ha (in CMDT) in the rainfed zones, and between 0.87 ha (in ORS) and 1.20 ha (in ON) in irrigated rice perimeters (IER 1986)¹. Major investments in improved agricultural technologies are therefore required to increase both labor and land productivity in the low-input agriculture of Mali.

This chapter explores some of the major constraints on improved technology, with a special emphasis on the use of animal power in the CMDT and the OHV zones. The central hypothesis explored is that public policies related to crop development, research, credit, extension and taxation interact with price incentives in determining the adoption of farming technologies in Mali. Accordingly, this chapter aims at reaching

research (ORA) and farming systems research (OFSA). Some of these broad

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some critical conclusions about such policies which, although not directly related to the cereals market restructuring, may constitute serious impediments to most of the positive effects expected from product market liberalization. To do so, the following sections examine the agricultural research process and outputs in Mali, farmers' investment and disinvestment in draft equipment and animals, and identify and discuss the major constraints on the adoption of animal traction.

The agenda of specific research activities carried out by IER

5.1. Overview of Technology Improvement and Improvement of local seed

Since the colonial era, agricultural research has remained almost entirely a public-sector activity in Mali. Until independence (1960), all crop research was conducted at the cotton research station created in 1925 at M'Pessoba (CMDT zone), and the rice production project of the Office du Niger created in 1932. During the first year of independence, 1961, the Government of Mali took administrative control of agricultural research through the creation of the Institut d'Economie Rurale (IER). IER is responsible for the design and implementation of agronomic and farming systems research, the planning and evaluation of agricultural development projects, the supervision and the coordination of other research organizations and agencies, and the building and preservation of the national scientific patrimony (Ministère de l'Agriculture 1987).

To carry out its mission, IER has several special branches, dealing with administration (DAF), documentation and information (DDI), planning and evaluation (DPE), technical (feasibility) studies (DET), agronomic research (DRA) and farming systems research (DRSPR). Some of these broad divisions are further subdivided into Special Services such as the

sections for cereals and oilseeds (SRCVO), cotton and textile fibers (SRCJF), fruits and vegetables (SRFM), tobacco and new crops (SRTPN) and selected seed (SRCSS) of the Division of Agronomical Research. The agricultural research organization is operationally represented at the field-level by more than 30 research and experiment stations, spatially distributed so as to cover the representative agro-ecological zones of the country. 0 to 1985. This growth results not only from extensification

effort. The agenda of specific research activities carried out by IER presently encompasses the selection and improvement of local seed varieties of millet, sorghum, maize, cowpeas and tobacco, the breeding and experimentation of new and imported seed varieties of sorghum, maize, rice, groundnuts, soybean and cotton, and experimentation on new cultivation techniques for cowpeas, sugar cane, fruits and vegetables, tea and tobacco. to improvement of maize yields during the 1980s, following

the In addition to IER, the Division of Agricultural Engineering (DMA), created in the Ministry of Agriculture in 1970, has the responsibility for the design, development and adaptation of a wide variety of tillage equipment. The DMA carries out the bulk of its research, development, and training activities through three centers located at Samanko (near Bamako), Sikasso (CMDT) and Kayes. Finally, many rural development agencies (ODRs such as CMDT, ON, ODIPAC, ORS, ODIK and OHV) have their own research divisions which undertake, in agreement with IER, specific research projects related directly to the realm of their interventions. However, such complementary research efforts remain significant only in CMDT and the Office du Niger (ON). No significant extension of the total

cultivated area took place, and the gains in yields for millet and sorghum (1.5% increase per year) may be attributed to a certain degree of adoption

In spite of this impressive picture of the research network, few improved technologies have resulted from the agricultural research efforts in Mali. The trends reported in Table 5-1 show that relative successes have been achieved only for cotton and maize, both produced predominantly in the CMDT zone. Among all major crops, cotton production shows the highest continuous growth (9.2% per year adjusted for rainfall variation) from 1960 to 1986. This growth results not only from extensification efforts (3.7% annual increase in area), but also and more importantly from a sustained improvement of yields (5.5% increase per year) realized through the progressive adoption of more productive varieties and farming techniques (use of fertilizer and insecticides, land preparation and weeding with multiculteurs, etc.).

The 3.5% annual increase in maize production from 1960 to 1986 is mainly due to improvement of maize yields during the 1980s, following the promotion of maize by the CMDT over the life of the projects Mali-Sud I (1977-1984) and Mali-Sud II (1983-1990). Although the total cultivated maize area remained relatively constant (0.4% increase per year) since 1960, the area supervised by CMDT rose from 6000 hectares in 1975 to 30,000 hectares in 1983 and 51,000 hectares in 1987 (Ministère de l'Agriculture 1987). With the use of fertilizer and selected local seeds, maize yields steadily increased during the 1980s to reach, in 1985-86, 1.6 tons per hectare, double their 1960-65 level.

Unfortunately, the estimated annual growth rates of the production of millet and sorghum (2.2%) and rice (2.4%) remained below the population growth rate (2.7% per annum). No significant extension of the total cultivated area took place, and the gains in yields for millet and sorghum (1.6% increase per year) may be attributed to a certain degree of adoption

Table 5-1. Evolution of Area Harvested, Yields and Production of Major Crops, Mali: Average Annual Indices per Period (1960-1986).

CROPS	1960-1965		INDICES (BASE 1960-1965 = 100)					1960-86
	LEVEL (a)	INDEX	1966- 1970	1971- 1973	1974- 1979	1980- 1984	1985- 1986	ANNUAL GROWTH RATE (c)
RAINFALL (b)	--	104	99	77	94	79	89	--
MILLET/SORGHUM								
Area	1490	100	85	78	86	92	107	0.6%
Yield	584	100	105	98	120	104	139	1.6%
Production	870	100	90	76	103	96	148	2.2%
MAIZE								
Area	105	100	81	105	100	90	119	0.4%
Yield	810	100	124	62	88	111	198	3.1%
Production	85	100	100	65	88	100	235	3.5%
RICE								
Area	145	100	110	100	124	100	124	1.3%
Yield	1138	100	82	82	110	88	103	1.1%
Production	165	100	91	82	136	88	127	2.4%
COTTON								
Area	60	100	142	125	167	183	242	3.7%
Yield	333	100	159	240	330	355	372	5.5%
Production	20	100	225	300	550	650	900	9.2%
GROUNDNUTS								
Area	225	100	76	71	76	51	42	-2.6%
Yield	578	100	122	135	153	113	155	1.6%
Production	130	100	92	96	115	58	65	-1.0%

Source: Ministère de l'Agriculture, République du Mali: Revue du Secteur Agricole du Mali, 1987 (pp. 39, 41).

Notes: (a) Average annual levels in 1960-65 are in thousands of hectares for area harvested, kilograms per hectare for yield, and thousands of metric tons for production.

(b) Rainfall indices are computed using as a base the long-term (1936 - 1985) average rainfall in Kayes, Bamako, Sikasso, Ségou, Mopti, Tombouctou and Gao.

(c) Estimates of annual growth rates of area harvested, yields and production are adjusted for variations in rainfall by the inclusion of rainfall indices as an independent variable in the regression equations.

of short-cycle local varieties and the residual effects of cotton fertilizer on coarse grains grown in crop rotation in the CMDT zone.

The area of groundnuts (the only significant cash crop of the central zones of the country) declined following the fall of world prices in the late 1960s and the 1970s. With only a 1.6% annual increase in yields achieved through more careful seed selection and preservation, total groundnut production has dropped by 35% between 1960-65 and 1985-86.

Many factors explain the limited impact of agricultural research in Mali. First among these are severe financial constraints due to the very low funding level of the research institutions. Since 1961, the share of the agricultural sector in total development planning funding oscillated around 20% and has shown a declining trend since 1978. Moreover, from 1980 to 1987, the Ministry of Agriculture obtained only between 3.6% and 4.8% of the total state budget (Ministère de l'Agriculture 1987).

Research is, in turn, given a very low priority within the agricultural sector. Official data of the Ministry of Agriculture show that the share of research in total agricultural development funding has declined from 6% in 1970-73 to 4.5% in 1974-78, 4.8% in 1981-85, and 2.2% for 1986-91. As a result, most research stations and offices are ill-equipped and can barely meet staff payroll requirements. The magnitude of this problem is reduced to some extent by the multiplication of research projects with external funding, which provide, in most cases, the bulk of operating funds. Such efforts include the USAID/ICRISAT project on sorghum and millet breeding, the SAFGRAD millet, sorghum and maize improvement project, the French IRAT and IRCT collaborative efforts in research dealing with almost all major crops in the country, the WARDA

project on rice, the IDRC support in cowpea research, the USDA Cooperative Research Support Programs (CRSPs) in soils (TropSoils) and sorghum and millet (INTSORMIL), the IFDC collaborative program on the use of natural rock phosphate as fertilizer, and the IDRC and USAID farming systems research projects. (1) the reform of IER in 1981, all plant improvement

Second, the multiplicity of quasi-independent research institutions and externally-funded (and designed) projects compounds research coordination problems, which stem in part from the location of livestock/forestry/water resource management activities and crop production in two different ministries and the frequent lack of collaboration between research teams of projects with external funding.

Third, in almost any sector of the Malian economy, project ineffectiveness or failure has often been attributed to inadequate numbers of sufficiently skilled people (Simmons 1987). Probably more than any other field, agricultural research has long suffered from the lack of highly trained and experienced professionals. In 1985, for instance, only seven researchers of the two key divisions of IER (the divisions of Agronomic Research and Farming Systems Research) had at least a master's level professional degree and some field experience (USAID 1985). Substantial training efforts undertaken during the 1980s, particularly with the financial support of USAID, the French Assistance and Cooperation Fund (FAC), the CILSS, and the Ford Foundation, provide some hope for long-term institutional development. In the meantime, the personnel of IER (a total of 715 employees of whom 358 were permanent civil servants in 1982) remains dominated, at more than 95%, by middle and junior level staff holding bachelor's degrees or less.

and As a consequence, most of the research programs are designed and technically managed by expatriate technical assistants, many of whom have professional training below the PhD level, little previous research experience or background knowledge of the Malian agricultural system. For instance, until the reform of IER in 1981, all plant improvement research was actually led by researchers of institutes belonging to the French Study and Research Group for the Development of Tropical Agronomy (GERDAT), including the Research Institutes for Tropical Agronomy (IRAT), cotton and textiles (IRCT) and oil-seed crops (IRHO) (CRED 1976; and USAID 1985). In addition, virtually all research projects with external funding are designed and implemented under the technical leadership of expatriate technical assistants provided by the donor organizations. It is only through such projects that the various branches of the national agricultural research network can obtain an acceptable level of funding to purchase research inputs and supplies and to allow some field travel for the Malian research counterparts of the foreign technical assistants (USAID 1985). is much more relevant to the actual farming system of the

country Communication barriers among researchers, extension personnel, and farmers hinder even the few improved technical packages resulting from research efforts from having an impact on farm-level production. A traditional top-down approach dominates the communication in the research-extension system. The lack of linkage between research and extension is well-illustrated in a recent study on the adoption of new cowpea varieties around the agricultural research station of Cinzana, where the author notes that "the extension agency has no connection with the research station...[and therefore] is not aware of research carried out on station

2. In January 1989, IER began publishing its own journal in an attempt to improve communication among its researchers.

and there are no on-farm tests conducted by the researchers to inform extension of appropriate technologies to recommend to farmers" (Coulibaly 1987, 73-74). This problem is further compounded by the lack of publications beyond the annual research reports to transfer research outputs to extension services, the lack of written materials available at farmers' level in their languages, and the absence of joint agreement on objectives and approaches between the research organization and the rural development agencies (USAID 1985).²

To deal with the manpower and network communication problems, the Ministry of Agriculture and USAID agreed, in 1985, to give a high priority to the long-term (10 year) development of a sound farming systems research and extension division (FSR/E) as the main thrust in building an autonomous, effective and integrated research and extension capacity within IER. It is believed that, with an appropriate staffing by highly-trained local professional researchers and the adoption of a new integrated approach to research and extension, such a unit will carry out research that is much more relevant to the actual farming systems of the country and bridge the communication gap between the research stations and farmers' fields.

In summary, the problems discussed above have severely limited the impact of research on the performance of the Malian agricultural sector for the simple reasons that very few improved and appropriate technical packages have resulted from the research efforts, and even the small number of technologies on the shelf have had a very limited diffusion.

2. In January 1989, IER began publishing its own journal in an attempt to improve communication among its researchers.

For crop production, the successfully developed technologies which are suited to farmer adoption include new varieties of cotton and groundnuts, selected local varieties of maize and rainfed rice, fertilizer recommendations and animal traction cultivation methods for cotton, and a rotation of cotton followed by maize or sorghum (and even longer-cycle millet) enabling the cereals to benefit from the residual cotton fertilizer (CRED 1976; USAID 1985).

Among these technologies, animal traction cultivation methods have clearly received the highest degree of adoption by farmers, and continue to constitute "a primary element in the Malian Government's efforts to increase crop production and productivity (and to be) seen as a prerequisite to the effective use of other improvements" (CRED 1976). This dedication to animal traction is confirmed by the 1976 prospective study of the FAO which notes that in 1975 Mali had more than half of the plows, about one quarter of the ox-carts and some 40% of the draft animals found in all the seven Sahelian countries combined.

The use of animal traction was first introduced in the irrigated rice production zone of the Office du Niger and the cotton production zone of the French Textile Development Company (CFDT, which was replaced in 1974 by the Malian CMDT) in the 1930s (Sargent et al. 1981). These two agricultural development programs were subsequently used as models in designing and implementing all the other rural development operations (ODRs) initiated in the late 1960s and 1970s.

The emphasis placed on animal traction since the country's independence was translated into a considerable and sustained increase in the number of units of tillage/weeding equipment distributed, from about

16,000 in the 1960s to more than 170,000 between 1976 and 1985 (Table 5-2). Similarly, the number of seeders and carts distributed rose from none to more than 43,000 between the first six years of independence and 1985, while the number of carts distributed rose from 400 to 75,500 over the same period. Under the conservative assumption that most of this equipment will last 10 years, it may be inferred that, in 1985, the country had more than 170,000 tillage/weeding implements, nearly 47,000 seeders and over 57,000 carts still in working condition. However, even these impressive figures would imply that fewer than 30% of the estimated 600,000 farm households of the country presently use their own plows, particularly when one considers that part of the equipment may not be used because of needed repairs or lack of complements.

Table 5-2. Evolution of the Number of Animal Traction Equipment Distributed, Mali (1960-1985)

TILLAGE/WEEDING EQUIPMENT						
PERIOD	SINGLE-PURPOSE PLOWS	MULTI-PURPOSE TOOLBARS	HARROWS AND HOES	TOTAL	SEEDERS	CARTS
1960-65	6,550	620	0	7,170	0	400
1966-70	5,270	3,530	130	8,930	170	4,710
1971-75	12,550	10,300	3,460	26,310	6,260	12,820
1976-80	48,720	30,265	22,820	101,805	23,470	35,950
1980-85	40,420	10,690	19,100	70,210	13,460	21,620
TOTAL	113,510	55,405	45,510	214,425	43,360	75,500

Source: Ministère de l'Agriculture, Mali (1987); Lecaillon et Morrisson (1986), Office Statistique des Communautés Européennes (1986).

The overwhelming use of oxen for draft energy is probably encouraged by the fact that Mali is second only to the much more populated Nigeria in terms of the size of the national cattle herds in West Africa. Despite the drought of the early 1980s, the number cattle has fluctuated between 4.3 million and 7.1 million since 1977, with over 200,000 animals used for traction (USAID 1978; OSCE 1988). This is more than double the total animal power used in agriculture in the other most advanced Sahelian countries in animal traction, Chad and Sénégal. For these reasons, and because of the effects of draft equipment on farm household's foodgrain security discussed in the previous chapter, the analyses that follow will concentrate on animal traction, which is perceived as a catalyst for the adoption of the other components of the technical packages available to Malian farmers.

As indicated in Table 5-3, sample farmers of this study unanimously

5.2. Profitability of Animal Traction

There is a clear paucity of empirical facts on the profitability of animal power in Malian agriculture. Only a few studies have indirectly or implicitly addressed the question (Niang 1980; Fleming 1981; Whitney 1981; Sargent et al 1981; Cissé 1987; and Pingali, Bigot and Binswanger 1987). None of the existing studies deals explicitly with the subject or attempts to single out the marginal contribution of animal power to farm output and income through its potential effects on either cultivated area or yields (or both), or the additional income generated from the use of the draft animals in custom work and off-season activities. The present study, which is not based on a typical production economics or farm management field research, also fails to quantify the marginal

productivity of animal traction. The following discussions are therefore based on farmers' perceptions of the profitability of the use of draft equipment and animals, complemented by findings of other studies which give an implicit indication of such profitability.

INCREASE OF AREA:

Less than 2 times	0.0	0.0	0.0	0.0
2 to 4 times	0.0	0.0	0.0	21.7
More than 4 times	38.0	4	100.0	78.3

5.2.1. Effects on cultivated area and yields

The most commonly expected effect of animal traction is an expansion of the cultivated area through a reduction of labor constraints during certain agricultural tasks such as land preparation, planting and weeding, which must be performed within a relatively short time. Obviously, the extent of this extensification effect will be limited by other constraints, particularly labor bottlenecks in the remaining manual tasks and land availability.

As indicated in Table 5-3, sample farmers of this study unanimously perceived that animal power makes it possible for a household to at least double its cultivated area. The potential extensification effect perceived here relates only to those farming tasks (particularly land preparation and weeding) that can be currently performed mechanically with the existing equipment; it does not necessarily reflect the actual levels of area expansion achieved by farmers who shifted from manual cultivation to a fully-equipped status. The fact that a unit of tillage/weeding equipment operated by two workers is rented at daily rates of four to six man-days of manual labor in CMDT and OHV tends to support the view that farmers of these zones really obtain at least a one-to-two substitution ratio of animal power for human labor, ceteris paribus.

(Table 5-5).

TABLE 5-3. Farmers' Perceptions on the Effects of Animal Traction on Yields and Cultivated Area (Percentage of Farms)

EFFECTS OF ANIMAL TRACTION	SOUTH CMDT	NORTH CMDT	SOUTH OHV	NORTH OHV
INCREASE OF AREA:				
Less than 2 times	0.0	0.0	0.0	0.0
2 times	81.7	42.6	0.0	21.7
More than 2 times	38.3	57.4	100.0	78.3
EFFECT ON YIELDS:				
Increase	100.0	95.7	100.0	84.8
No change	0.0	0.0	0.0	0.0
Decrease	0.0	4.3	0.0	15.2

Source: CESA-MSU Food Security Project farm household surveys, 1987.

When all farming tasks are taken into account, most studies show that animal traction presently allows farmers of the Sahelian region to reduce labor inputs for most crops by as much as 40%, and to increase the area cultivated per worker by some 10% to 33% (Sargent et al.). These figures are very much in line with the findings of the few empirical studies on dryland farming techniques in Mali. Indeed, although their stratification of farms with respect to production techniques differ to some extent, it is quite instructive to note that, in the CMDT zone, the extent of land expansion per worker from the non-equipped to the well-equipped farms of Whitney's 1981 study (43%), and from the traditional to the intensive farms of Cissé's 1987 study (37.3%) points to a 40% extensification effect of animal traction (Table 5-4). Similarly, data from IER's costs of production study for the 1984 cropping season show about 30% labor savings for fully-equipped over manual farming in both the CMDT and the OHV zones (Table 5-5).

Source: Columbia, Mariko and Touya (IER), 1986.

Table 5-4. Effects of Animal Traction on Cultivated Area per Worker and Net Returns to Labor (CMDT/Mali-Sud Zone)

	WHITNEY'S STUDY			CISSE'S STUDY		
	NON EQUIPPED	PLOW ONLY	WELL EQUIPPED	TRADI- TIONAL	SEMI- INTEN- SIVE	INTEN- SIVE
Area per Worker (Ha) Increase Over Least Equipped Farms (%)	0.51 --	0.78 52.9%	0.73 43.1%	0.75 --	0.81 8.0%	1.03 37.3%
Net Returns to Labor (CFAF/Worker) Increase Over Least Equipped Farms (%)	19,118 --	34,221 79.0%	37,242 94.8%	28,361 --	27,944 -1.5%	43,981 55.1%

Source: Whitney 1981; Cissé 1987.

Table 5-5. Effects of Animal Traction on Labor Requirements and Net Returns to Labor, CMDT and OHV (1984/85)

	CMDT			OHV		
	MANUAL	SEMI- EQUIPPED	FULLY- EQUIPPED	MANUAL	SEMI- EQUIPPED	FULLY- EQUIPPED
LABOR (Man-Days/Ha)						
Millet	--	49	39	83	60	55
Sorghum	73	87	75	100	103	88
Maize	94	111	45	84	82	46
Cotton	160	138	72	97	132	57
Groundnuts	--	148	123	284	104	57
Total	94	99	65	98	89	70
Labor Savings Over Manual Farming (%)	--	-5.3%	30.9%	--	9.2%	28.6%
NET RETURNS TO LABOR (CFAF/Worker) Increase Over Manual Farming (%)	714 --	748 4.8%	1125 57.6%	459 --	459 0.0%	981 113.7%

Source: Doumbia, Mariko and Touya (IER), Mali 1986.

In any case, it may be argued that the extensification effect of animal traction is accompanied and restricted by a simultaneous intensification effect as farms moving up the mechanical ladder become more aware of, and receptive to, other technological improvements (e.g., the use of mineral fertilizers, selected seeds and improved techniques of land preparation and weeding), which bring along an additional demand for labor. It is in this sense that the separation of the pure effects of animal power from those of the other components of the technological packages actually applied to the farmers' fields becomes an intricate exercise. This probably explains why, contrary to findings of other studies reported by Pingali, Bigot and Binswanger, 85 to 100% of our sample farmers perceived that the use of animal traction increases not only the area cultivated per worker, but also yields (Table 5-3). This must be the case, since the percentage increase of the net returns to labor of the most equipped over the least equipped farms in the results presented in Table 5-4 and Table 5-5 exceeds by 48% to nearly 200% the percentage increase of cultivated land per worker or the percentage of labor saved. *on not in isolation, but in complementarity with the use of other* The few findings on research stations reported by Sargent et al. indicate that, even without additional inputs, the use of animal traction has a positive impact on yields through improved and more timely land preparation and weeding, early planting, and balanced cropping rotations which improve soils when increasing population pressure cut back on the duration of natural fallow under the traditional system of shifting cultivation. These authors present data from the cereal and oilseed research division of IER (SRCVO), which show increments of yields under

oxen traction over manual tillage of 6% for millet, 36% for sorghum, 37% for maize, 9% for cotton and 17% for groundnuts, without any mineral fertilizers. Likewise, research results from Sénégal show that simply plowing before planting can increase the yields of sorghum, maize and cotton by 32 to 46%, while early plowing and planting (at the beginning of the rainy season) can boost these yields by as much as 39% for cotton, 47% for sorghum and 62% for maize (Ibid.). Pingali, Bigot and Binswanger report that most studies found no significant on-farm yield effect of animal traction. A key question yet to be addressed by experimental studies is whether such positive yield effects are only short-term gains which may not be sustained in the long-run once animal traction tillage has allowed crops to use up in a few years some of the nutrients located in lower levels of the soil (Ibid.). Although this may be true, animal traction should be considered not in isolation, but as part of more comprehensive technical packages that include moisture retention, and soil fertility restoration and conservation techniques.

It seems that farmers perceive the profitability of investment in animal traction not in isolation, but in complementarity with the use of other technologies such as mineral fertilizers in particular. This complementarity suggests a conditional rather than a pure profitability, as indicated by the net increase in labor productivity estimated by IER, Whitney and Cissé, as well as the difference in coarse grain production per worker and the increase in the value of cereal and cotton produced per worker observed in Chapter IV between farm households at different equipment levels. Food Security Project farm household survey, 1983

Note: Multiple responses were allowed; hence column totals exceed 100%

5.2.2. Conditions determining the profitability of animal traction

Table 5-6 presents the distribution of our sample farmers according to their perceptions regarding the necessary conditions for an investment in animal traction to be profitable. Beside the necessity of a reliable supply of animal feeds and veterinary products and services, more than 70% of the farmers in each of the survey subzones perceive cash crop production and the use of fertilizer as two basic factors conditioning the profitability of animal traction. In fact, these two conditions are very interrelated, since previous research and extension efforts on fertilizers have been almost exclusively devoted to cash crops such as cotton and groundnuts grown using animal traction. As a result, farmers tend to associate cash-crop production with the need to use fertilizers.

Table 5-6. Farmers' Perceptions of the Conditions Determining the Profitability of Animal Traction, CMDT and OHV (% of households)

CONDITIONS	CMDT			OHV		
	SOUTH	NORTH	TOTAL	SOUTH	NORTH	TOTAL
Cash crop production	93.6	95.7	94.7	72.3	91.3	82.4
Use of fertilizer	91.5	74.5	82.9	78.7	95.7	87.7
Custom work	63.8	6.4	34.8	2.1	65.2	35.7
Off-season use of draft animals	33.3	66.7	50.2	6.4	91.3	51.6
Reliable supply of animal feed	95.7	100.0	97.9	95.7	100.0	98.0
Reliable supply of veterinary services	97.9	95.7	96.8	63.8	100.0	83.1

Source: CESA-MSU Food Security Project farm household surveys, 1987.

Note: Multiple responses were allowed; hence column totals exceed 100%.

The strongly perceived need for cash crop production clearly indicates that output market conditions play a central role in farmers' capacity and decision to invest in draft animals and equipment (Barrett et al. 1982). Demand considerations, such as the reliability of outlets which may guarantee prices high enough to secure a steady payoff of the implements used, are important determinants in the farmer investment strategy. Such demand attributes have always favored cash (export) crops as opposed to foodgrains, which are characterized by a very thin and volatile domestic market.

Mali being a price-taker for all its export crops in the world market, the public sector has always been able to guarantee the purchase of virtually all the output of these commodities at official prices, which are taxed by as much as 24% to 61% for cotton and 48% to 65% for groundnuts, without completely cutting back on farmers' incentives to expand their production (Lecaillon and Morrisson). In contrast, any significant increase in coarse grain production in the context of the very limited effective demand for these commodities may depress producer prices to the extent that no further long-term and steady expansion of output is profitable. Under such conditions, investment in either labor-saving or yield-increasing technologies may not be profitable in the long run, if no alternative profitable uses of the resources (labor and land) saved are available. This further stresses the importance of complementary activities in dealing with the profitability of investment in domestic coarse grain production.

The use of mineral fertilizer for both cotton and other crops in cotton-producing subzones depends on the extent of cotton production,

which in turn is significantly determined by the level of farm equipment. In the two subzones of CMDT and the south of OHV, 78% to 100% of the total quantity of fertilizer used by the sample farms in 1985 was applied to cotton (Table 5-7). The correlation between the area of cotton per worker and the level of farm equipment on the one hand, and the amount of fertilizer used and the extent of cotton cultivation on the other hand, supports the argument that farmers' investment in most technologies that may increase labor and/or land productivity in coarse grain production, are in fact induced, driven and very likely financed by other activities, particularly cash crop production.

Hence, the variations in farm household coarse grain production and transactions discussed earlier (Chapter IV) are very much related to the differences in cotton area per worker and fertilizer use per hectare observed between institutional zones, natural subzones and farm equipment strata in Table 5-7. In the south of CMDT, where cotton production is more generalized among farmers who have also learned from extension services to apply mineral fertilizers directly to the maize fields, fully equipped farms cultivate 31% more cotton area per worker and use 34% more fertilizer per hectare than non-equipped households. In the north of the same zone, where lower rainfall levels reduce the potential for cotton production, the gap between the equipped and the non-equipped households widens to 69% for the area of cotton per worker and 265% for the amount of fertilizer used per hectare. Finally, in South OHV (cotton is not grown and hardly any fertilizer is used in North OHV), fully-equipped farms cultivate 7.7 times more cotton area per worker and use 9.2 times more fertilizer per hectare than non-equipped households.

Table 5-7. Mineral Fertilizer Use by Farm Equipment Level (1985)

SUBZONES	EQUIPPED FARMS (EQP)	SEMI- EQUIPPED (SEQ)	NON EQUIPPED (NEQ)	VARIATION (%)	
				EQP/SEQ	EQP/NEQ
<u>SOUTH CMDT</u>					
Cotton area (ha/worker)	0.42	0.40	0.32	5.0	31.2
Fertilizer Used:					
Cotton (kg/ha)	141.0	133.2	128.2	5.9	10.0
Total (kg/ha)	48.7	44.8	36.4	8.7	33.8
Percent. on cotton	89.7	83.0	78.1	--	--
<u>NORTH CMDT</u>					
Cotton area (ha/worker)	0.22	0.23	0.13	-4.3	69.2
Fertilizer Used:					
Cotton (kg/ha)	100.0	113.6	58.3	-12.0	71.5
Total (kg/ha)	17.5	18.2	4.8	-3.8	264.6
Percent. on cotton	87.5	88.3	87.5	--	--
<u>SOUTH OHV</u>					
Coton area (Ha/worker)	0.26	0.07	0.03	271.4	766.7
Fertilizer Used:					
Cotton (kg/ha)	81.1	76.4	49.9	6.2	62.5
Total (kg/ha)	20.3	12.4	2.0	63.7	915.0
Percent. on cotton	91.4	87.5	100.0	--	--

Source: CESA-MSU Food Security Project farm household surveys, 1986.

Note: Fertilizer use for total area concerns only the 1985 field plots for which farmers could give an estimate of area. Most of these fields had previously been measured by rural development agencies for cash-crop (cotton/groundnut) fertilizer extension purposes. North OHV is left out because fertilizer use was negligible in this subzone.

Table 8 The institutional dimension of farmers' access to inputs is also evident here, since the equipped households in the south of OHV, which cultivate 18% more cotton area per worker than their peers in the north of CMDT, use 19% less fertilizer per hectare of cotton than those north CMDT farmers (and 42.5% less than fully equipped farmers in south CMDT).

Many farmers also perceive the opportunity to use their draft animals and equipment in custom work and/or off-season activities as an additional condition to make investment in animal traction profitable. As shown in Table 5-6, the need for a rental market is felt much more by farmers of subzones where farming techniques are relatively more intensive and labor becomes the major constraint to any further expansion of land (south CMDT), and in areas where there is no significant cash crop production (north OHV). Likewise, the need for off-season use of draft animals mostly concerns farmers of the drier northern subzones where cash crop production is lower than it is in the south, and the cost of feeding the animals can rise considerably during the dry season. Here the potential use of draft animals is for the transportation of persons and commodities to weekly markets and hauling firewood over long distances (often 5 km or more), which may be highly profitable.

Note: The extent of equipped farmers' participation in custom work depicted in Table 5-8 shows that, except in the north of OHV, where there is no significant cash (export) crop production, more than one-third of the households owning plowing equipment rent or lend their plows or draft animals to other farmers. To a lesser extent, weeding equipment is rented or loaned to other farmers by 17.5% of the owners of such equipment in south CMDT and 10.7% of those in north CMDT.

Table 5-8. Custom Work with Animal Traction Equipment, CMDT and OHV
Percentage of Equipped Farms by Type of Activity (1986/87)

ACTIVITIES	CMDT			OHV		
	SOUTH	NORTH	TOTAL	SOUTH	NORTH	TOTAL
PLOWING:						
1-2 days	17.1	19.0	18.1	48.6	0.0	22.7
3-4 days	5.8	11.9	8.9	5.4	12.0	8.9
5-7 days	11.5	4.8	8.1	0.0	4.0	2.1
Total	34.4	35.7	35.1	54.0	16.0	33.8
WEEDING:						
1-2 days	8.8	10.7	9.8	48.3	0.0	22.6
3-4 days	2.9	0.0	1.4	6.9	0.0	3.2
5-8 days	5.8	0.0	2.9	0.0	5.9	3.1
Total	17.5	10.7	14.1	55.2	5.9	29.0
HARVEST TRANSPORT:						
1-2 farms	19.2	9.1	14.1	11.5	10.5	11.0
3-4 farms	26.9	9.1	17.9	50.0	0.0	23.4
5-6 farms	26.9	0.0	13.3	15.4	15.8	15.6
7-9 farms	15.3	4.5	9.8	0.0	31.6	16.8
Total	88.3	22.7	55.2	76.9	57.9	66.8
TRANSPORT TO MARKET	19.2	31.8	25.6	11.5	52.7	33.4

Source: CESA-MSU Food Security Project farm household surveys, 1987.

Note: The percentage of farms for each activity relates exclusively to the total number of farms owning the type of equipment required to perform this activity.

The very low frequency of custom work with plowing and weeding equipment (26% and 6% respectively) in the north of OHV further reflects the probable linkage between the profitability of investment in animal traction and cash crop production. In the south of OHV, the combination of a certain level of cotton production and a lower proportion of fully-

equipped farms relative to CMDT opens up a rental market for more than half of the owners of plowing and/or weeding equipment. In north OHV, in contrast, the potential for such custom work is likely restricted by the lack of adequate cash income sources for non-equipped farm households, who must pay their equipment rent mostly with family labor and face increased labor constraints for other manual farming tasks.

As a result, in north OHV, the rural transportation activities, which are present throughout most of the year, are more popular and concern more than 50% of the cart owners in that subzone. In fact, the use of carts for either harvest transport or transportation to weekly markets is the most common off-farm use of draft equipment throughout the subzones: it is practiced, respectively, by 39.1% of cart owners in north CMDT, 73.7% in north OHV, 76.9% in south OHV and 88.5% in south CMDT.

Although no systematic surveys were carried out to estimate the income that equipment owners obtain from custom work, the partial information gathered on the rental costs indicate that these earnings may be substantial. Plowing and/or weeding equipment is rented at daily rates of CFAF 1,000 to CFAF 2,500 or four to six man-days of labor in OHV, while transportation with carts typically yields between CFAF 1,000 and CFAF 2,500 per day. At those rates, three to seven days of custom work with either tillage or transport equipment may generate enough income (in cash or labor) to pay for most of the additional labor needed by equipped farms and support a significant proportion of the maintenance costs of their draft animals.

In summary, the wide adoption of (or the high propensity to acquire) animal traction by Malian farmers is based on their perception of the

profitability of investment in draft equipment and animals, in a context of relatively abundant land resources. The perceived profitability is subject to many conditions, chief among which is the availability of activities producing an output for which there is a reliable demand that guarantees adequate income inflows over a period of several years. Historically, given the thinness of the domestic markets, only cash crops with export outlets have offered such opportunities to Malian farmers. For this particular reason, it seems that there will not be significant direct investments in coarse grain production as long as the production and market prices for these commodities remain very uncertain.

5.3. Process of Investment/Disinvestment in Animal Traction

The analysis of the adoption of technologies by farmers requires not only basic profitability studies, but also a thorough understanding of the process by which farm households acquire and maintain these technologies. The following sections discuss some of the critical variables of the process of investment and disinvestment in animal traction.

5.3.1. Investment process

Two basic questions on the process of investment in animal traction are addressed here. The first refers to the nature of the process, i.e., whether the investment is made at once or in a cumulative way over time. The second question concerns the financing of the investment, i.e., the sources of income used by the investors. These two questions are interrelated, since farmers' capacity to acquire a complete set of draft

Except for only 4.8% of the investors in the sample who had no farm

equipment and animals at once obviously depends on the level of funds available to them from alternative sources.

The answers to these two questions are crucial in understanding some of the major constraints to investment in animal power. As discussed in Chapter IV, in some subzones (particularly those where cash crops are less grown and the marginal returns to rented equipment are perceived to be low), possessing an incomplete set of equipment does not significantly improve the overall productivity of farm household labor.

The sequence of acquisition of draft equipment and animals by farm households is depicted in Table 5-9. This table presents, for each number of times of investment, frequency distributions of the farm households which invested by types or combinations of draft equipment and animals that they owned as a result of a cumulative process. The frequency distributions for each number of times of investment relate exclusively to the number of farm households which invested at least that many times, including all households who were fully or partially equipped during the survey, as well as all non-equipped households who once invested at least one time but failed to recuperate after experiencing disinvestment. Of the 36 households that invested at least one time in animal traction in south CMDT, for instance, only 12 invested five times.

The data in Table 5-9 clearly show that the process of farmers' investment in capital-consuming technologies such as animal traction is gradual. The observed gradual pattern relates to the notion of stepwise adoption, where farmers adopt various components of a technological package through a process of trial and error (Byerlee and Polanco). Except for only 4.8% of the investors in the north of CMDT, no farm

75% of the households in the south of CMDT initially resorted to plow

acquired a complete set of tillage and transportation equipment and draft animals all at once. Still after three times of investment, fewer than 43% of the farms of any subzone owned a set of equipment including a plow, a cart and oxen. It is therefore only after four to five times of investment that most of the investors obtain a full set of animal traction equipment. From its initial step, this gradual accumulation of animal traction capital takes an average of four to five years, most of the cases falling between two and four years in the south of CMDT, three and seven years in the north of CMDT, and three and nine years in both subzones of OHV.

Even when transport equipment is disregarded, fewer than 20% of the farm households who invest can simultaneously afford a plow and a pair of oxen in their first round of investment. However, over 80% of the second-round investors in CMDT, and 70% of those in OHV own at least a plow and oxen, implying that carts are given a low priority relative to tillage equipment. In fact, it is only in the fifth round of investment that all investors of the study zones own a cart, while more than 90% of them already possess tillage equipment and draft animals at their third step of acquisition.

For the majority of the households who cannot afford both a plow and oxen at once, the acquisition of the draft animals precedes that of the equipment. In CMDT, 50% of the first-round investors in the north and 61% of those in the south invested initially in oxen alone, in contrast with fewer than 27% who first acquired a plow without oxen.

In OHV, where farm income is much lower relative to CMDT, investment in both tillage equipment and draft animals is more gradual. More than 75% of the households in the south of OHV initially invested in plows

Table 5-9. Sequence of Acquisition of Farm Households' Draft Equipment and Animals

ZONES/SUBZONES AND NUMBER OF TIMES OF INVESTMENT	FARMS HOUSEHOLDS		PERCENTAGE OF FARM HOUSEHOLDS OWNING						
	NUMBER	PERCENTAGE	PLOW and CART and OXEN	PLOW and OXEN	PLOW (Total)	OXEN (Total)	CART (Total)	MULTI- CULTEUR (Total)	SEEDER (Total)
SOUTH CMDT									
Households which invested									
At least one time	36	100.0	0.0	16.7	33.3	77.8	5.6	5.6	0.0
At least two times	35	97.2	5.7	94.3	97.1	97.1	11.4	14.3	0.0
At least three times	31	86.1	35.5	100.0	100.0	100.0	35.5	67.7	6.5
At least four times	24	66.7	87.5	100.0	100.0	100.0	87.5	95.8	20.8
Five times	12	33.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0
NORTH CMDT									
Households which invested									
At least one time	42	100.0	4.8	19.0	45.2	69.0	9.5	14.3	0.0
At least two times	39	92.9	12.8	87.2	94.9	89.7	23.1	28.2	0.0
At least three times	28	66.7	42.9	92.9	100.0	92.9	50.0	60.7	0.0
At least four times	21	50.0	85.7	95.2	100.0	95.2	90.5	85.7	4.8
Five times	13	31.0	100.0	100.0	100.0	100.0	100.0	92.3	15.4
SOUTH OHV									
Households which invested									
At least one time	37	100.0	0.0	10.8	89.2	18.9	2.7	40.5	0.0
At least two times	35	94.6	8.6	82.9	97.1	85.7	17.1	51.4	0.0
At least three times	35	94.6	22.9	97.1	100.0	97.1	25.7	60.0	2.9
At least four times	27	73.0	66.7	100.0	100.0	100.0	66.7	70.4	3.7
Five times	17	45.9	100.0	100.0	100.0	100.0	100.0	100.0	11.8
NORTH OHV									
Households which invested									
At least one time	30	100.0	0.0	0.0	30.0	43.3	13.3	13.3	0.0
At least two times	30	100.0	0.0	70.0	76.7	86.7	13.3	36.7	0.0
At least three times	21	70.0	28.6	90.5	90.5	100.0	38.1	76.2	4.8
At least four times	19	63.3	84.2	100.0	100.0	100.0	84.2	78.9	15.8
Five times	11	36.7	100.0	100.0	100.0	100.0	100.0	100.0	72.7

Source: CESA-MSU Food Security Project farm household surveys, 1987.
Note: Plows include single-purpose plows (charrue) and multi-purpose toolbars (multiculteurs).

The percentages of farm households owning the different types of equipment/animals for each number of times of investment relate exclusively to the number of farms which invested at least that number of times. This number includes fully-equipped and semi-equipped farm households, as well as the few non-equipped households which once invested in animal traction, but subsequently lost their draft equipment or animals as a consequence of disinvestment without recovery.

alone. This outcome may be partly explained by the strong incidence of migration and off-farm employment on the investment preferences of the farms of this subzone, which is under the direct influence of Bamako, and has a direct access to the big cattle markets in the vicinity of the national capital. In contrast, farmers of the other subzones may find that their best investment strategy is to first acquire young oxen, and then plan for the purchase of a plow while the animals grow.

The complementarity between the plow and the oxen is so strong that, for virtually all the farmers who invest in animal traction, either one missing in the first round of investment is acquired in the second round. Thus, in any subzone, fewer than 17% of the second-round investors own either a plow or oxen alone.

Among the different types of tillage equipment, the multi-purpose toolbar (multiculteur) is the most expensive and, generally the last to be acquired. In 1986, for instance, a multiculteur cost CFAF 47,950, i.e., 81% more than the single-purpose plow (charrue) sold at CFAF 26,500 (Clark 1986). As a result, fewer than 53% of the farm households who acquired plows after two rounds of investment owned a multiculteur. These more sophisticated toolbars were acquired mostly in the third to the fifth rounds of investment, that is, after the lighter equipment acquired in the first rounds has enabled the farm household to generate and save income to undertake costlier investment.

Finally, the seeder ranks as a luxury and the lowest-priority equipment which, after four rounds of investment, is acquired by fewer than 21% of the investors in any of the study subzones. As previously mentioned, in rainfed agriculture, labor constraints are much lower for

planting than other farming tasks such as land preparation and weeding, to which children below age 14 can contribute very little. A seeder would therefore become profitable only when the mechanization of plowing and weeding induces an expansion of the cultivated area to the extent that planting can no longer be timely with the available labor, including women and older children.

The general picture of the gradual process of investment in animal traction shows that most farmers first acquire some draft animals, simultaneously with, but more often followed by a simple plow (charrue), then a multi-purpose toolbar, a cart, and finally, a seeder. The investment preferences revealed by this sequence become important for policies that aim at increasing investment in animal traction, particularly when farmers' financing strategies are taken into account. In this respect, the data in Table 5-10 show that, in every subzone, more than 60% of the farm households who invested in animal traction used farming income to acquire their first set of draft animals and/or equipment. Formal credit was used by fewer than 25% of the first-round investors in any subzone.

The south of OHV displays the highest percentage of farm households which used formal credit as source of initial capital (20.5%). This fact also explains in part why, in the south of OHV, more than 75% of the fully-equipped and semi-equipped households first acquired a plow without oxen. As Clark (1986) points out, agricultural credit in OHV applies very little (and not at all since 1981) to investment in draft animals.

Following the poor loan-recovery, experienced due to a lack of an adequate insurance program for draft animals, all formal loans distributed of the donkeys owned by farmers in eastern Senegal were insured in 1978/79 (p. 43).

in south OHV through the credit programs of the National Agricultural Development Bank (BNDA) and USAID apply only to equipment and seasonal inputs such as fertilizers and seed.³ As a result, most farmers are limited to the use of formal loans, complemented by their own cash-earnings from off-farm employment and migration, to acquire tillage equipment in their initial step of investment. In the north of OHV, which

draft equipment and animals. The frequency of the use of income sources other than Draft Equipment and Animal Acquisition importance of cotton production decreases.

PERCENTAGE OF EQUIPPED AND SEMI-EQUIPPED FARMS				
INCOME SOURCES	SOUTH-CMDT	NORTH-CMDT	SOUTH-OHV	NORTH-OHV
INITIAL INVESTMENT:				
Formal Credit	2.9	10.8	20.5	3.7
Farming	62.8	64.9	70.3	70.4
Trade	8.6	0.0	5.8	22.2
Livestock	2.9	5.4	11.6	0.0
Handcraft	8.6	2.7	2.9	0.0
Off-Farm Wages	2.9	5.4	55.7	0.0
Remittances from migrants	5.7	2.7	38.1	11.1
TOTAL INVESTMENTS:				
Formal Credit	14.3	16.2	35.3	22.2
Farming	71.4	86.5	91.2	81.5
Trade	11.4	0.0	8.8	22.2
Livestock	2.9	13.5	32.4	25.9
Handcraft	8.6	2.7	2.9	3.7
Off-Farm Wages	2.9	18.9	82.4	0.0
Remittances from migrants	5.7	32.4	47.1	11.1
Formal Credit:				
Equipped Farms	30.8	18.8	54.5	33.3
Semi-Equipped	4.5	14.3	26.1	16.7

Source: CESA-MSU Food Security Project farm household surveys, 1987.

Note: Because multiple responses were allowed for total investment, column totals exceed 100%.

3. Barrett et al (1982) also found that only 20% of the oxen and 13% of the donkeys owned by farmers in eastern Burkina Faso were insured in 1978/79 (p. 43).

is currently not covered by any significant formal credit program, trade and migration are also among the important sources of initial capital, as they concern respectively 22.2% and 11.1% of the farm households who invested in animal traction. *per percentage of farm households used formal credit* Farming remains the most common source of income used by more than 70% of the equipped and semi-equipped farms of every subzone to acquire draft equipment and animals. The frequency of the use of income sources other than farming increases as the relative importance of cotton production decreases. *credit for investment in animal traction increases with* In the south of CMDT, where farmers can generate substantial income from cotton production, farming is the single-most important source of income for investment in animal traction, and, except for formal credit and trade, fewer than 10% of the investors use each of the other income sources. In north CMDT, almost one third of the farms use remittances from migration, while 18.9% of them use off-farm wages and 43.5% use livestock income to invest in animal traction. *ate the gradual process of invest* As mentioned previously, off-farm employment and migration are frequently used as income sources for investment (as well as foodgrain purchases and tax payment) by farmers in the south of OHV. Thus, 82.4% of the equipped and semi-equipped farms of this subzone used income from off-farm employment to at least partially finance their investment in animal traction equipment, while 47.1% used remittances from migrants. In addition, livestock production contributed more to farmers' investment in animal traction in OHV than CMDT. Nearly one third of the households in the south and 26% of those in the north of OHV listed livestock among the sources of income that they used to acquire their equipment, and most

specifically their draft animals. This fact also helps understand why the majority of farmers in the south of OHV first acquired the equipment alone, as the draft animals were partly supplied from their own herds.

In every subzone, a higher percentage of farm households used formal credit for their total investment than their initial investment in animal traction. Moreover, in every subzone (except the north of CMDT), the percentage of fully-equipped households who used formal credit is at least double that of the semi-equipped households. These findings suggest that farm access to formal credit for investment in animal traction increases with the level of equipment that the farm has already reached. In other words, the more the farm household is equipped, the greater its chances to obtain formal loans for additional equipment, mainly because the formal lender perceives that a more equipped farm has a higher capacity to reimburse the loan.

As a consequence, the majority of the farms have to use all sources of income available to them in order to initiate the gradual process of investment in draft equipment and animals, and get access subsequently to formal credit to upgrade their equipment status. Under such circumstances, farm size (particularly with respect to available family labor) becomes a critical factor that determines the capacity of the household to generate enough income from farming and/or other available non-farm activities to acquire a first set of equipment.

As a corollary, in subzones with a poor present base of income-generating activities (including cash crop production and non-farm activities), small non-equipped farms, which are the least endowed with labor, have very little hope of becoming mechanized. In this sense, the

lack of alternative income-generating opportunities combined with a poor access to formal financing constitute, for most of the poor small farms, constraints to investment in improved farming technologies that the cereal market liberalization alone cannot overcome. It shows the lowest frequency of disinvestment, most likely because of its drier conditions, which are less

5.3.2. Disinvestment process as compared with the south of this zone,

comb In addition to the usually lengthy process that they have to undergo to acquire their farming equipment gradually, most equipped and semi-equipped farm households frequently face constraints that result in a reduction of their stock of draft equipment and animals. Thus, of the sample households who reported investment in animal traction, 97.2% in south CMDT, 45.3% in north CMDT, 64.8% in south OHV and 80% in north OHV experienced disinvestment in animal traction at least once (Table 5-11). The higher percentage of households which disinvested in the south of CMDT may be explained in part by the fact that, on average, farmers in this subzone have owned animal traction equipment longer than producers in other zones and hence have had more time to disinvest. In south CMDR virtually all disinvestment cases concerned draft animals lost because of diseases, where outbreaks of cattle diseases had occurred just prior to our survey. This suggests that most cases of disinvestment in this subzone were very recent. They had lost as a result of disinvestment without

recov The repetitiveness of the disinvestment phenomenon is related to both the natural environment and the institutional context, which strongly condition the capacity of the farm household to cope with various types of natural or policy-induced hardships. As an illustration, only 20% of the farm households which experienced disinvestment in the south of CMDT,

disinvested more than once, in contrast with 42.2% in north CMDT, 70.8% in south OHV and 91.6% in north OHV.

The recovery rate of farmers' lost capital is very low; it exceeds 30% only in the north of CMDT, which also shows the lowest frequency of disinvestment, most likely because of its drier conditions, which are less conducive to animal diseases as compared with the south of this zone, combined with the availability of savings of cotton income to face family needs in difficult years. These low recovery rates are partly explained by the fact that our surveys were carried out during a period immediately following years of low rainfall and outbreaks of cattle diseases in most areas (particularly the south) of CMDT. It may therefore be assumed that most farmers who disinvested during this period had not been able to recover in the short period of one year.

In any case, the combination of high disinvestment frequencies and low capital recovery rates implies that many farm households moved down the technological ladder of animal traction. In fact, a detailed examination of the survey data shows that, of the households classified as semi-equipped, 28.6% in CMDT and 20% in OHV were fully-equipped prior to their disinvestment. Likewise, respectively 25% of the non-equipped farms in CMDT and 20.9% of those in OHV had once acquired oxen or a piece of equipment that they had lost as a result of disinvestment without recovery. Farmers' disinvestment in animal traction is caused by natural calamities and by policy-induced or policy-sensitive distresses (Table 5-11). In CMDT, animal diseases and malnutrition constitute the most common cause, reported by 91.4% of the households who experienced disinvestment in the south and 73.7% of those in the north. As mentioned above, this

Table 5-11. Frequency and Causes of Farmers' Disinvestment in CMDT zone
Animal Traction, and Capital Assets Lost

	SOUTH-CMDT	NORTH-CMDT	SOUTH-OHV	NORTH-OHV
Percentage of Farms by Disinvestment Frequency (a)				
One time	77.8	26.2	18.9	6.7
Two times	8.3	16.7	32.4	30.0
Three times or more	11.1	2.4	13.5	43.3
Total CMDT	97.2	45.3	64.8	80.0
Full-Recovery Rate (%) (b)				
	22.9	47.4	29.2	20.8
Percentage of Farms by Cause of Disinvestment (b)				
Food Shortages	0.0	21.1	37.6	87.5
Taxes	2.9	5.3	71.0	0.0
Animal Diseases and/or Malnutrition	91.4	73.7	41.7	16.7
Other causes (c)	5.7	10.5	8.4	8.3
Percentage of Farms by Type of Asset Lost (b)				
Plow	0.0	5.3	4.2	16.7
Cart	2.9	5.3	4.2	4.2
Seeder	0.0	0.0	0.0	8.3
Draft Animals	97.1	100.0	95.9	95.9

Source: CESA-MSU Food Security Project farm household surveys, 1987.

Notes:

- (a) The percentages of farms by disinvestment frequency relate to the number of farms reporting investment in draft equipment and animals. Farmers were asked how many times their stock of draft equipment and animals had decreased since their first investment.
- (b) The percentages of farms by cause of disinvestment, by type of asset lost and for full-recovery rate, relate only to the number of farms reporting disinvestment. Because of multiple responses, column totals exceed 100% for the causes of disinvestment and the types of assets lost.
- (c) The other (unspecified) causes of disinvestment relate mostly to expenses for social reasons, mainly marriage.

result is, to a large extent, explained by the fact that the CMDT zone had been the scene of cattle disease outbreaks related to the sustained drought just prior to our surveys. As a consequence, virtually all farmers' animal traction capital loss in CMDT bears on draft animals. Almost all the households that disinvested lost at least an ox, while fewer than 6% of them had to liquidate either a plow or a cart. Besides animal diseases, no other significant cause of disinvestment is reported in the south of CMDT. In the north of the zone, however, food shortages following years of bad rainfall explain, at least in part, draft equipment and/or animal losses of 21.1% of the households who experienced disinvestment.

Although CMDT and OHV are similar in that disinvestment for more than 95% of the farmers in both zones involves draft animals, the zones differ significantly as far as to the causes of disinvestment. In the south of OHV, taxes are the most frequent cause, reported by 71% of the households that experienced disinvestment, followed by food shortages and animal diseases, each involving 37.6% of the households reporting disinvestment. In contrast, food shortages constitute the single-most important cause of animal traction capital loss for 87.5% of the households in the north of OHV. Although farmers did not explicitly list taxes among the causes of disinvestment in this subzone, it may be inferred that taxes, which constitute the most important motive for coarse grain sales for 91.6% of the households of the north of OHV (Table 4-10, Chapter IV), contribute significantly to increasing food shortages and inducing losses of draft animals and/or equipment. To cope with their severe food shortages, expansion of animal traction. About the 1970-71

nearly 17% of the farm households who experienced disinvestment in the north of OHV liquidated even their plows. In sum, the majority of the farm households who invest in animal traction are vulnerable to natural and/or policy-induced constraints that often compromise their technological advance. The data indicate that the most important of these constraints are animal diseases in almost all the study areas and food shortages caused by poor rainfall as well as taxes, particularly in OHV. These findings, along with the discussion of the constraints to the expansion of the adoption of animal traction by farmers, may shed light on some of the critical policy variables to take into account in promoting farm equipment. Shortages constitute only a second or third-order constraint to extensification via animal traction.

5.4. Major Constraints on Extensification through Animal Traction

Financing appears as the most important constraint on the adoption of animal traction. The lack of personal funds and the limited access to formal credit rank as first constraint for 44.2% of the households in the south of CMDT, nearly 60% of those in the north of CMDT, 96% in the south of OHV and 98% in the north of OHV (Table 5-12). As discussed earlier, the subzone differences between the percentage of farm households who rank the lack of financing as first constraint strongly reflects the potential differences in cash crop (cotton) income, which gives most farmers in CMDT an easier access to formal credit and enables them to initiate their investment in draft animals and equipment. Fewer than 46% of the farms in south CMDT (regardless of equipment level) and 38% of the equipped farms in north CMDT rank financing as the first constraint to the expansion of animal traction. Among the farmers who produce relatively

less or no cotton, the proportion of those ranking financing as the most important constraint rises to more than 70% for the semi-equipped and non-equipped farms of north CMDT and more than 90% of the households of every level of equipment in OHV. In addition, it is only in the south of CMDT, where the bulk of cotton production is located, that more than 15% of the farms rank a factor other than financing as first constraint to investment in animal traction. For 44.2% of the farms in this subzone, household income from cotton production or available credit would seem adequate to undertake the acquisition of draft equipment, but the lack of labor impedes acquisition of further equipment.

Outside of the south of CMDT, labor shortages constitute only a second or third-order constraint to extensification via animal traction. In contrast with the financing constraint, labor shortages constitute the most binding constraint to further investment in animal traction for a larger proportion of farm households that likely produce more cotton than those with marginal or no cotton production. Hence, 36% to 50% of the farm households of the different equipment strata in south CMDT and 18.7% of the equipped households in north CMDT rank the labor constraint first, as compared with fewer than 12% of all the other households, regardless of the subzone and the level of equipment. This finding may imply that labor constraints in farming activities that are not mechanized (particularly cotton harvesting) are so binding (even for the non-equipped farms) that very little room exists for further expansion of animal traction without an influx of outside labor in major cotton producing areas such as the south of CMDT. The labor constraint is likely much less severe in subzones with marginal or no cotton production (especially in OHV),

Note: Because multiple responses were allowed, the totals exceed 100% for the first three constraints.

because relatively low proportions 263 fully-equipped farms and a small

Table 5-12. Farmers' Perceived Constraint to Expansion of Animal Traction
(Percentage of farm households)

SUBZONES and EQUIPMENT LEVELS	FINANCING SHORTAGE	LABOR SHORTAGE	LAND SHORTAGE	EQUIPMENT SHORTAGE	ANIMAL FEEDING	ANIMAL CARE
SOUTH CMDT						
First Constraint:						
Equipped Farms	45.4	36.4	0.0	9.1	9.1	0.0
Semi-Equipped	45.0	50.0	0.0	0.0	5.0	0.0
Non-Equipped	41.7	41.7	16.6	0.0	0.0	0.0
Total	44.2	44.2	4.7	2.3	4.7	0.0
First 3 Constraints:						
Equipped Farms	81.9	45.5	9.1	63.7	45.5	9.1
Semi-Equipped	75.0	65.0	5.0	50.0	20.0	10.0
Non-Equipped	58.4	66.5	16.6	24.9	16.6	16.6
Total	74.4	60.5	9.3	46.5	25.6	11.6
NORTH CMDT						
First Constraint:						
Equipped Farms	37.5	18.7	25.0	12.5	6.3	0.0
Semi-Equipped	72.8	4.5	9.1	9.1	4.5	0.0
Non-Equipped	77.8	11.1	11.1	0.0	0.0	0.0
Total	59.6	10.6	14.9	8.5	4.3	0.0
First 3 Constraints:						
Equipped Farms	87.5	56.2	93.8	50.0	6.3	12.5
Semi-Equipped	100.0	54.6	40.9	50.0	18.2	18.2
Non-Equipped	88.9	66.7	55.5	77.8	11.1	0.0
Total	91.5	57.4	63.8	55.3	12.8	10.6
SOUTH OHV						
First Constraint:						
Equipped Farms	100.0	0.0	0.0	0.0	0.0	0.0
Semi-Equipped	95.7	4.3	0.0	0.0	0.0	0.0
Non-Equipped	92.3	7.7	0.0	0.0	0.0	0.0
Total	95.7	4.3	0.0	0.0	0.0	0.0
First 3 Constraints:						
Equipped Farms	100.0	90.1	0.0	27.3	81.8	0.0
Semi-Equipped	100.0	95.7	0.0	17.4	78.3	4.3
Non-Equipped	100.0	100.0	0.0	0.0	69.3	0.0
Total	100.0	95.8	0.0	14.8	76.6	2.1
NORTH OHV						
First Constraint:						
Equipped Farms	100.0	0.0	0.0	0.0	0.0	0.0
Semi-Equipped	94.4	0.0	0.0	5.6	0.0	0.0
Non-Equipped	100.0	0.0	0.0	0.0	0.0	0.0
Total	97.6	0.0	0.0	2.4	0.0	0.0
First 3 Constraints:						
Equipped Farms	100.0	0.0	0.0	0.0	0.0	0.0
Semi-Equipped	100.0	0.0	0.0	11.1	0.0	0.0
Non-Equipped	100.0	0.0	0.0	0.0	0.0	0.0
Total	100.0	0.0	0.0	4.8	0.0	0.0

Source: CESA-MSU Food Security Project farm household surveys, 1987.

Note: Because multiple responses were allowed, row totals exceed 100% for the first three constraints.

because relatively low proportions of fully-equipped farms and a small harvest-period demand for labor allow an adequate supply of labor by the least equipped households to the most equipped ones.

Consistent with most assessments of land availability in Mali, land shortages may constitute a secondary limitation to investment in animal traction only in the north of CMDT, where more extensive cultivation may have reduced available land relative to the south of the zone. In fact, the largest proportion of farms that rank land shortage as the most important constraint to further investment in animal traction (25%) is found among the fully-equipped households of north CMDT.

The above data indicate that most farmers presently perceive that both available land and labor allow further adoption of animal traction. What seems most to prevent them from investing in the mechanical technology is the lack of financing (for 74.4% of the farms in the south of CMDT to 100% of those in OHV). In addition to the weak self-financing capacity of most households, shortages of equipment supply itself may limit the extent of acquisition of equipment for about one half of the farms of CMDT, where farm income may allow some investment. This is particularly so since the dismantling of the agricultural credit and equipment parastatal (SCAER) in 1980, following which the number of farm equipment units distributed annually in CMDT fell from more than 20,000 in 1978 and 1979 to less than 9,000 thereafter (Ouédraogo 1984). The short supply of equipment was not listed among the first three constraints faced by most farm households of OHV, most likely because of the dominance of the financing problem in this zone, where less than 500 units of equipment are distributed each year.

of this zone. All these different feeds are in short supply during the dry season, when the highest needs

Agricultural credit and equipment availability and distribution are two of the most critical variables that presently limit the scope for increasing farm production through further extensification via animal traction. This statement needs to be qualified, however, by taking into account the conditionality of the profitability of animal traction perceived by farmers. As discussed earlier, more than 70% of the farm households of the study areas do not believe that investment in animal traction can be profitable without cash crop production and its related use of mineral fertilizer. Hence, it is unlikely that making credit and equipment more available will induce much more investment in the absence of crops for which there is a sizeable and relatively stable demand, which can guarantee profits over several years.

Other conditions to the profitability of animal traction, such as the reliability of the supply of animal feed and veterinary services, seem not to be major constraints to investment reported by the majority of the sample farms. As shown in Table 5-13, however, more than 80% of the households who own draft animals face problems in feeding their animals, particularly during the dry season. Pasture grass and salt licks are essentially the only feeds used during the rainy season by almost all farmers, except those of the north of OHV who also use tree leaves as complementary feed even during this period of relative abundance of grass.

During the dry season, the lack of pasture grass forces all draft animal owners to use a variety of feeds, including crop residues and hay (especially from cowpeas and peanuts) for more than 75% of them, salt licks, tree leaves mostly in the southern subzones, cotton meal in CMDT either shortages and high prices of pasture grass. All these different feeds are in short supply during the dry season, when the highest costs

Table 5-13. Draft Animal Feed and Farmers' Perceptions of Problems Related to Draft Animal Feeding and Health Care

TYPES OF FEED AND PROBLEMS	PERCENTAGE OF HOUSEHOLDS OWNING DRAFT ANIMALS			
	SOUTH-CMDT	NORTH-CMDT	SOUTH-OHV	NORTH-OHV
RAINY SEASON FEED:				
Pasture Grass	100.0	100.0	100.0	100.0
Tree leaves	0.0	12.2	0.0	83.3
Cotton meal	11.1	12.2	5.4	0.0
Salt Lick	97.2	7.3	94.6	83.3
DRY SEASON FEED:				
Pasture Grass	2.8	51.2	97.3	0.0
Tree leaves	75.0	19.5	48.6	0.0
Crop Residues	100.0	78.0	97.3	83.3
Forage	100.0	87.8	78.4	100.0
Cotton meal	38.9	82.9	13.5	3.3
Coarse Grains	80.6	9.8	0.0	3.3
Salt Lick	94.4	14.6	100.0	50.0
FEEDING PROBLEMS:				
Shortage of Grass	91.7	81.0	100.0	83.3
Shortage of Forage	2.8	33.4	0.0	73.0
Shortage of Leaves	11.6	7.2	16.2	16.5
Supply of Meals	8.4	24.0	94.5	69.7
Cost of Meals	55.9	54.9	83.7	43.1
	75.4	62.0	51.3	36.5
HEALTH CARE PROBLEMS:				
Lack of Specialists	77.8	35.7	35.1	26.7
Supply of Products	0.0	9.5	0.0	0.0
Cost of Products	0.0	2.4	27.0	0.0
Cost of Services	50.1	21.4	27.0	26.7
	66.7	11.9	2.7	23.3

Source: CESA-MSU Food Security Project farm household surveys, 1987.

of feeding the animals are incurred. Although some farmers sell cowpea hay, which is grown in mixed-cropping with coarse grains in every subzone, a reliable supply of forage from specialized producers has yet to develop. As a result, most farmers tend to relate animal feeding problems with either shortages and high prices of purchased feeds such as cotton seed

meal or shortages of natural and free vegetation such as pasture grass and tree leaves.

Beside these severe feeding constraints during the dry season, animal diseases were found to be among the most frequent causes of disinvestment in animal traction in CMDT and OHV. In fact, 26.7% of the draft animal owners in the north of OHV, more than one third of those in the north of CMDT and the south of OHV, and more than 75% of those in the south of CMDT report problems related to animal health care (Table 5-13). Little concern is expressed about the availability of skilled field-level veterinary personnel who are trained locally and in good supply in almost all the regions of the country.

The bulk of the supply of both veterinary products and personnel remains under the control of the public sector, however, through the regional and local administrations. Consequently, shortages of products and farmers' bidding for fast service during periods of epizootic diseases likely push up the prices charged by the veterinary agents for the medicines and their services to levels that many farmers cannot afford. Consistent with this view, in every subzone, at least 60% of the draft animal owners who report animal health care problems list the high cost of veterinary products among these problems. In addition, more than 85% of those in the south of CMDT and the north of OHV complain about the fees charged by the veterinary personnel, and 76.9% of those in the south of OHV point explicitly to the lack of medicines.

5.5. Summary and Policy Implications

This chapter has shown that in Mali few improved technologies have been developed by research and extended to farmers to increase

agricultural production in general, and cereal production in particular. Among the few successful technical packages that apply to rainfed food crops, animal traction has received the highest degree of adoption by farmers and continues to be perceived by the Malian government as one of the primary ingredients in helping achieve cereal self-sufficiency.

Farmers' enthusiasm for animal traction is mainly explained by its labor-saving effects in the relatively land-abundant context of Mali. The few empirical studies and research station results available show that animal traction may enable farmers to expand their cultivated area by some 30 to 40%, and to increase yields by as much as 40 to 60%. However, more than 80% of the farm households covered in this study perceive that cash crop production, the use of mineral fertilizers and a reliable supply of animal feeds and veterinary services, are major conditions to assure the profitability of animal traction.

Few farmers have access to formal credit, particularly to finance their initial investment. As a result, investment in animal traction is a gradual process that most farm households initiate with their own income, earned mainly from farming and a range of other activities such as livestock production, off-farm employment and migration.

Farmers who invest in animal traction often experience disinvestment caused by constraints of natural and/or policy order. Chief among such constraints are the frequent food shortages resulting from low production in low rainfall years, compounded by head taxes which must be paid each year regardless of the actual level of farm income, and animal diseases. Frequent disinvestment combined with low recovery rates leads to the result that, instead of further moving up the animal traction technological ladder, most of the households which invest in animal

traction are periodically forced back to a lower equipment status than the one previously reached through their investment.

In every study subzone, most farmers perceive the lack of financing as the most important constraint to investment in animal traction. Additional constraints include labor shortages (mostly for presently equipped farms), shortages in equipment supply (in relatively high income zones such as CMDT), and the risks caused by the unreliability of the supply of animal feed and veterinary services.

These major constraints, along with farmers' perceived conditions to the profitability of animal traction, point to a number of policy implications which are discussed below.

5.5.1. Agricultural credit and input distribution policies

As discussed above, most farmers who perceive that investment in animal traction may be profitable are prevented from undertaking such investment, primarily because of the low level of their current income. This lack of money is particularly severe in subzones where no significant export (or cash) crop production guarantees substantial farm income that can be sustained over a relatively long term.

Paradoxically, farmers' access to formal credit depends, to a large extent, on their current production capabilities (particularly for cash crops), which in turn are highly determined by their current equipment levels. As a corollary, it seems that to be entitled to formal equipment credit, the majority of the farms are expected to initiate investment in animal traction with their own income. Such an approach obviously discriminates against the farm households in the areas of the country that are not presently covered by any rural development project promoting the

production of a highly profitable cash crop, which might not only provide a guarantee for the formal loans, but also enable farmers to autonomously initiate the process of acquiring equipment. Moreover, the linking of access to formal credit to the perceived current production capacity of the farm discriminates against small farm households which, because of their limited number of workers, are the most in need of labor-saving technologies and the least capable of reaching high production levels without such technologies.

The removal of some of the current barriers to small farms' access to formal credit, combined with the research and development of cash-crop production in high agricultural potential areas similar to CMDT, might have some of the highest impacts on the adoption of animal traction and most other improved technologies, particularly the use of mineral fertilizers. The focus on small farms is particularly relevant to the extent that one would expect these generally non-equipped and food deficit households to have the highest propensity to increase their foodgrain production and thereby improve their food security.

As discussed in Chapter IV, most equipped farms of the present cash-crop production zones (e.g., CMDT) do not seem to find the coarse grain market attractive enough to induce them to initiate the production of substantial surpluses for sale. Beyond the production of the quantity of cereals which is perceived to be sufficient for their own food security, the bulk of the resources of these advanced farm households are likely allocated to more profitable cash-crop production and non-farm activities. Given present production technologies and market conditions, no significant increase in the aggregate cereal production should therefore

be expected from those farmers who presently have the greatest capacity to generate marketable surpluses.

Our survey data show, on the other hand, that the value of the total 1985 coarse grain and cotton production of the non-equipped farm households of the study subzones could at most cover only a proportion of the acquisition costs of a simple plow and a pair of oxen, ranging from a maximum of 96% in south CMDT, to 52% in north CMDT and about 30% in both the south and the north of OHV. When home consumption needs are taken into account, it would take at least savings of three consecutive good-rainfall years to enable even the average non-equipped farm of the south of CMDT to acquire a simple set of draft equipment and animals, while virtually none of the non-equipped households of the other subzones would be able to realize such an investment only with savings from their farming income.

Although one might object that a small household size is itself a constraint to obtaining farm equipment, there is no clear-cut definition of a minimum farm size below which the under-utilization of draft equipment and animals would lead to unprofitable investment. In fact, 39.2% of the 687 equipped and semi-equipped farm households of the sample villages of this study had fewer than four family workers each; 68.1% of them comprised five family workers at most. It therefore seems that, even with two to three permanent workers, a farm household can operate a set of animal traction equipment to an extent that justifies the investment.

In addition, prospects for collective investment by two farm households, for instance, should not be excluded as a possible solution to the potential problems posed by the limited available labor and the small holdings of small farm households. Such cost-sharing is favored by

40% of the semi-equipped households and 47.6% of the non-equipped households of our sample villages. As perceived by almost all the sample farms, the major constraint on sharing equipment concerns the rules determining access by each of the associated households to the common equipment, particularly for farming tasks which need be performed at a very precise period of the cropping season (e.g., weeding and plowing immediately after the first significant rain).

Farming systems research efforts can help deal with the above issues, regarding the minimum farm size and the types of farm enterprises required for a rational investment in animal traction, as well as the conditions under which investment cost-sharing among farm households can be successfully implemented. The solution to the problem of the lack of small farmers' access to formal credit may reside, to a large extent, in a greater participation of the farm community itself in deciding who is eligible for credit. Until the mid-1970s, all formal credit matters were entirely managed by the rural development operations (ODRs), with very little farmer participation. Hence, the determination of farmers' needs for equipment and seasonal inputs, the approval of individual loan applications, the distribution and the recovery of these loans, all occurred in an administrative process where the principal client was perceived as a passive entity.

It is only in the late 1970s that the CMDT, faced with rising farmer complaints about the conduct of its credit and cotton marketing agents, began to consider the direct involvement of farmers' associations in managing some of the activities held by its field personnel as a valid alternative way of providing services to the rural population. This approach was further supported by the government, which now considers it

as one of the official pillars of its rural development policy. Thus, in 1984/85, the OHV and the BNDA initiated an experimental credit program with 11 village associations in the OHV zone (Eriksen 1984).

Although the CMDT acceptance of village associations was primarily motivated by its perception of a potential reduction of its operating costs and an anticipated increase of the rate of credit recovery (while safeguarding a positive image before its constituency), farmers turn out to be the biggest winners of the approved groupings.

As far as formal credit is concerned, members of all the approved village associations covered by this study agree that one of the major advantages of the management of agricultural credit by their own organizations is a more equitable access for all to formal financing. As noted by other analysts, the acceptance of group solidarity as sole guarantor of credit allows a higher level of risk-sharing, which enables the association to extend formal credit eligibility to individual small farm households that would otherwise be excluded (Matt 1983; Clark 1986). This is very likely so, because the village community is in a better position than the ODRs to appreciate the potential production capacity of the individual farms, and to collectively bear the risk of sponsoring more households that the ODRs would not find solvent.

Village association participation in managing formal credit programs should therefore be promoted in every high agricultural potential zone, along with the identification and the development of high-income cash crops. In this respect, any remaining ODR propensity to study each individual loan application should fade out in favor of more investment in training efforts, which aim at improving the capacity of farmers' own institutions to manage their activities.

The problems of farmers' access to formal credit also stem directly from the rationing imposed by the severe limitation of funds available to the different credit programs. Virtually all credit funds are provided by the public banking system and the funding agencies and organizations of the rural development programs. In order to increase the aggregate supply of credit to the rural population, the private banking system should be encouraged, within the limits of credit volume set by the Central Bank of the West African States (BCEAO), to extend loans directly to farmers' associations. In so doing, it is essential that the private banks be allowed to apply to rural loans a set of terms which are compatible with their general credit policy, rather than be forced to comply with the often subsidized terms applying to most credit programs managed by the public sector or rural development projects. These banks should also be encouraged to undertake rural savings mobilization by offering attractive returns to savings accounts. Such mobilization would reduce dependence on donor funds.

Similarly, the shortage of supply of equipment in high-income zones such as CMDT can be partly solved by a greater participation of private traders in farm input and implement distribution. However, as Ouédraogo (1984) notes, private traders' participation in farm input marketing is constrained by several factors. First, to the extent that most inputs are sold by ODRs at subsidized prices, private traders who must charge full-cost prices would have to face unfair competition.

Second, despite Government efforts to encourage agricultural production by reducing taxes on imports of agricultural inputs, private traders must still face import taxes and duties of 5% plus CFAF 5/kg on fertilizers, 10% plus CFAF 5/kg on animal traction equipment, and 20% plus

CFAF 5/kg on spare parts of animal traction equipment. These import taxes and duties further limit private traders' capacity to compete with the bilateral and multilateral funded ODRs, virtually all of which benefit from special agreements that exempt farm input and equipment imports of all taxes.

Third, the general propensity of the state to control or administer prices of all goods and services severely curtails private traders' capacity to adjust smoothly to changing market conditions. Finally, all importers are subjected to a constraining list of regulations and administrative procedures. They must be registered upon the deposit of a guarantee fund CFAF 1,000,000 in a bank, pay an annual trading tax (patente) which varies with the location of the business and the anticipated volume of sales, and obtain a title of importation after proof of ability to pay the supplier, and pay for a licence tax which varies with the value of imports. All these conditions compound the financial burden that private traders' must face with a very limited access to short-term bank credit and foreign exchange restrictions.

Accordingly, a greater participation of the private sector in farm input and equipment marketing may be achieved only through the implementation of more in-depth policy reforms for licensing, financing, foreign exchange, import regulations and price setting and control.

5.5.2. Fiscal policies

Fiscal policies, particularly head taxes, which were seen to affect farm household food security by forcing most food deficit households to sell coarse grains at post-harvest low prices, also constrain farmers' investment in more productive technologies. As discussed above, financing

is the most important constraint to the acquisition of draft equipment and animals for the majority of the farms of CMDT and OHV. Therefore, any policy that further reduces farmers' available income depresses the already insufficient autonomous investment capacity of farm households.

In addition to reducing farmers' capacity to initiate investment in improved technologies, taxes further jeopardize the long-run productive capacity of a significant proportion of the already equipped and semi-equipped farm households, by forcing them to disinvest in animal traction during periods of drought. A farmer who must, at the same time, meet his household food requirements, honor payments on his equipment loan, and pay taxes will very likely run out of available income and begin to liquidate his capital.

There is presently a striking conflict between Government fiscal policies on the one hand, and policies aiming at promoting more investment in agricultural production, on the other hand. If taxes are meant to be a means of extracting agricultural surplus, they should be determined and collected on the basis of farmers' real income. The determination of taxable income should further take full account of farm investment needs. In contrast with the investors of the industrial sector who benefit from various tax exemptions to ease their initial steps, farmers are not allowed to forgo paying head taxes (a substitute for income taxes) even when their net income is negative. As a result, the taxes often apply to their working capital.

It should be emphasized that, even for industrialization purposes, the capacity of the agricultural sector to generate more tax revenue in the long run is directly determined by investment in more productive farming technologies. The excessive taxation of farmers at low income

levels severely undermines such investment and the long-run prospects of generating higher farm surplus income that can be extracted. To be consistent, fiscal incentives such as tax exemptions during the initial years of investment and, subsequently during years of low farm production, should apply to farm households that undertake major investment in relatively costly technologies such as animal traction. Although the available data do not allow more substantiation of the case, it may be hypothesized that for most farm households, such reforms of fiscal policies would have a higher impact on farmers' capacity to increase overall agricultural production and therefore contribute more to the official food self-sufficiency goal than the unsustainable producer price support efforts.

A major objection to such fiscal policy reforms resides in their administrative implications. Although it may be argued that the administrative capacity of the Malian government is presently too weak to implement a complex tax system, the feasibility of a differentiated taxation system for the farm population will depend, to a large extent, on the degree of collaboration between the fiscal administration and the rural development agencies, which generate and maintain a substantial amount of information on agricultural production and farmers' investment. These agencies can therefore be assumed to be able to provide the fiscal administration with the appropriate information required to identify investors for tax exemption purposes.

5.5.3. Complementary actions to ensure draft animal health and feed

Problems relating to animal feeding and health care were reported, respectively, by 89% and 44% of the sample farm households who owned draft

animals. These findings indicate a lack of an integrated package of complementary actions in the animal traction programs of most rural development projects. Although some efforts may be made to help farmers acquire and learn to use the equipment and the animals, very little is done to train them to produce adequate feeds for the draft animals, and insufficient specific actions (e.g., targeted vaccination programs) are taken to protect these animals against epizootic diseases.

Forage production and conservation techniques should be an integral part of the technical packages extended to farms using animal traction. Crops such as cowpeas, which can simultaneously contribute to improving household food security and providing storable animal feed, should be promoted as cash crops.⁴ Although farmers may be reluctant to grow forage because of labor conflicts with food crops, the degree of adoption of forage production as an integral part of animal traction technical packages largely depends on the identification of optimal varieties and their desired sequence in crop rotations (Sargent et al., 46). Research should therefore focus on identifying and developing alternative fodder crops which are best suited for the different agro-ecological zones and farming systems of the country.

Beyond the small population of draft animals, the recent emergence of cattle fattening activities may open some prospects for the commercial production of animal feed, particularly when the frequent droughts are considered as a structural rather than a circumstantial variable. A more integrated planning of crop and livestock production development could

4. This requires prior studies of market prospects to see if an expanded production of such crops would be economically viable.

therefore be pursued as a means to increase the income of both crop and livestock producers.

In addition to forage, the production of more concentrated animal feed should be viewed as an essential instrument in promoting both animal traction use and livestock fattening. The most widely sold concentrated feed, cotton meal, is in short supply even in the cotton-producing and processing south CMDT, where 75% of the draft animal owners complain about its high prices (officially, CFAF 20,000 per ton in 1986/87). The production of animal feed from coarse grains should be considered among the alternative ways of increasing the demand for these cereals, particularly during good rainfall periods, when the production exceeds the demand for human consumption at remunerative prices.

As far as farmers' disinvestment in animal traction due to animal diseases is concerned, the CMDT has undertaken an insurance policy covering draft animals acquired with formal credit. The insured value per animal (50% of the acquisition price) applied in CMDT and suggested in OHV, however, is low, and does not take into account any increase in the replacement cost of a lost animal (DRSPR 1988). Moreover, these insurance schemes apply only to farmers who buy draft animals with new loans, and do not offer any coverage possibilities for those who already own animals or those who buy them with cash from sources other than formal credit.

Draft animals, particularly oxen, presently represent the highest capital investment that most Malian farmers make in rainfed agriculture. At an average of CFAF 60,000 per animal, a pair of oxen is worth 4.5 single-purpose plows, 3.5 seeders, 2.5 multi-purpose toolbars and 1.4 tons of fertilizer. Moreover, farmers likely invest much more in the maintenance of their draft animals than equipment. The loss of a single

ox would therefore have a higher negative financial impact on the farm household than disinvestment in most types of equipment.

Consequently, major efforts should be made to increase and spread farmers' insurance against draft animal mortality. Besides pure financial insurance coverage, special veterinary programs should be designed and implemented in the zones covered by all rural development projects that promote the use of animal traction. Such programs should aim at ensuring that all draft animal owners have an adequate access to immunization services that protect their expensive capital from the risks caused by common epizootic diseases. The recent reforms aiming at liberalizing veterinary services may help fill the gap left by public-sector veterinary services, if an appropriate incentive system is put in order to bring more competition among veterinary product traders and animal health specialists.

CHAPTER VI

INSTITUTIONAL CONSTRAINTS TO INCREASING COARSE GRAIN PRODUCTION

The Cereals Market Restructuring Program (PRMC) initiated in 1981 in Mali proceeded from the basic contention that in addition to severe climatic constraints (prolonged and repeated droughts), major policy-induced distortions of agricultural incentives were important determinants of the stagnation or the regression of foodgrain production. Chief among the perceived distortions were OPAM's legal monopoly on the grain trade and the state-fixed official producer and consumer prices for cereals, which favored the provision of cheap grain to the cities and the extraction of a surplus from agriculture. Market liberalization was consequently designed as the centerpiece of a strategy aiming at restoring both producer and trader incentives through the idea of "getting the prices right" in order to stimulate cereals production and marketing.

Potential benefits from the market liberalization were expected at several levels. First, the legalization of private grain trading and the subsequent elimination of the risk premium that arose from private traders' operating illegally would reduce transaction costs and therefore induce private traders to increase the scale and the degree of specialization of their operations so as to reduce marketing costs. Second, reducing the risk of trading foodgrains would stimulate entry and competition in cereals marketing, expand farm-level demand and raise

farmers' incentives to increase marketable surplus. Third, eliminating barriers to interregional cereals flows would allow more flexible market arbitrage over time and space, contribute to stabilizing the market and encourage greater private investment in foodgrain production and marketing. Finally, cereals-buying consumers (assumed to be mostly urban) would benefit from the reduction in marketing margins resulting from larger scale and overt private trader operations.

The analyses in Chapters IV and V have shown, however, that a significant proportion of farm households are not presently in a position to take advantage of the potential market liberalization benefits listed above. We found that during the two good cropping campaigns of 1985/86 and 1986/87, over half of the farm households of two zones with the highest agricultural production potential did not produce enough coarse grains to meet minimum home consumption requirements of 188 kg per capita. In addition, only 53% of farm households were net sellers of coarse grains, while 43% were net buyers. Moreover, only 16% of the farm households accounted for 75% of total net sales. Finally, more than 70% of the farm households who had previously invested in animal traction reported some experience of disinvestment because of a combination of factors including food shortages and tax obligations following crop failures caused by low rainfall, as well as animal malnutrition and outbreaks of epizootic diseases.

The preceding analyses have focussed on the variability of farm households' coarse grain production, transactions and net availability as well as farmers' investment/disinvestment strategies, mainly with respect to ecological, technological and institutional factors. This chapter

concentrates on the institutional dimension of the growth of foodgrain production and marketing. More explicitly, it reviews and discusses some of the major factors that qualify the CMDT as the "success story of rural development" relative to other rural development agencies in Mali, and identifies some of the main characteristics of the coarse grain market that may constitute serious obstacles to increasing foodgrain production and marketing.

6.1. Goals and Extension Policies of the Rural Development Agencies

The history of what is presently known as the CMDT is very closely linked to the development of cotton production in Mali. For centuries before the colonial era, cotton had been produced traditionally for local clothing needs in the west African region now covered by Mali. Cotton was first produced for export in 1920 when, in search of an independent supply of raw material to its textile industry, the French colonial power granted 100,000 hectares to the Compagnie de Culture Cotonnière du Niger (CICCONIG), later succeeded by the Office du Niger (Ministère de l'Agriculture 1987, 65-66). Both these schemes aimed at developing cotton production in the Central Delta of the Niger River through the settlement and the organization of peasants under coercion. The area cultivated in cotton reached fewer than 1,000 hectares under the CICCONIG and fewer than 8,000 hectares under the Office du Niger, which eventually gave priority to irrigated rice production.

Following these two failures, the Compagnie Française de Développement des Fibres Textiles (CFDT) was officially charged in 1949 by the colonial administration to promote rainfed cotton production in the

present cotton zone through a strategy of intensive agricultural extension and voluntary participation of farmers in cultivating the new cash crop (deWilde 1967). At independence in 1960, 32,000 hectares of cotton were cultivated, with an average yield of 300kg/ha in the CFDT zone (Ibid.). The geographic extension of cotton cultivation as well as the first intensification efforts continued during the first five years of independence, and both cotton area and yield increased to reach respectively 85,000 hectares and 360kg/ha in 1964.

The government of Mali then signed a ten-year agreement with the CFDT to continue the cotton development program over the period 1964-74. This period was characterized by the stagnation of cotton area around 80,000 hectares per year combined with considerable intensification efforts, particularly the use of mineral fertilizer, the development and adoption of high-yielding varieties, and the extension of improved cultivation and plant protection techniques. These efforts resulted in the tripling of cotton yields to about 1,160kg/ha in 1975/76 (Lecaillon and Morrisson). It was also during this period that the scope of the intervention of CFDT as a rural development agency was progressively broadened to tend toward an integrated rural development program. The number of crops promoted increased to include kenaf in 1967, millet and sorghum in 1970, groundnuts in 1971 and maize in 1972. Two non-crop activities were added, i.e., livestock production in 1969 and a blacksmith program for the local manufacturing and maintenance of animal traction equipment in 1970. Finally, a rural functional literacy program was initiated in 1971 (Club du Sahel 1983, 71-76).

A joint venture between the government of Mali (60% of the shares) and CFDT (40% of the shares), called the Compagnie Malienne de Développement des Textiles (CMDT), was created in 1974 to take over the CFDT program. Following the gradual integration of activities under the CFDT from 1965 to 1975 and the official adoption of the "Rural Development Operation" (ODR) strategy in 1972, CMDT received its first explicit mandate to promote integrated rural development through the first Mali-Sud Rural Development Project, which lasted from 1976/77 through 1982/83. This project was co-financed by the International Development Agency (IDA) of the World Bank, the French Fonds d'Aide et de Coopération (FAC) and Caisse Centrale de Coopération Economique (CCCE), and the International Fund for Agricultural Development (IFAD). The objectives of this major undertaking were to (a) expand cotton, rice, maize, and kenaf production by providing project farmers with extension services, seed multiplication facilities, seasonal and medium-term credit and applied research, (b) extend processing facilities for cotton, kenaf and rice, (c) improve livestock production techniques, (d) extend the health program in the area, and (e) train CMDT staff, farmers and blacksmiths (World Bank 1983, 8-9; Club du Sahel 1983, 71-72)). The relative success of this first project led the funding agencies to approve a second Mali-Sud Project for the period 1983/84-1987/88. The main objectives of this second phase are to (a) promote cotton production through an input and output pricing program that reduces both taxes and input subsidies, (b) improve the control and use of cotton sector revenues by CMDT in order to protect the system from temporary price and volume fluctuations, (c) increase production of cotton, millet, sorghum, maize, cowpeas, rice and livestock

through specific input delivery and extension programs, (d) strengthen applied research for cotton and other crops, (e) promote independent farmer organizations through economic incentives and training, (f) improve village water supplies and health services under the direct responsibility of village (farmer) associations, and (g) reinforce CMDT capacity for to maintain its 3,000km dirt-track network (World Bank 1983, 11-15).

The "Opération Haute-Vallée" (OHV) was designed in 1964 as the first integrated rural development project in Mali. In contrast with the commodity-specific programs (e.g., the millet, groundnut, and cotton programs) created during the same period, OHV was meant to be an integrated rural development scheme aiming at improving all aspects of the living conditions of farmers in a given rural zone, without any reference to a specific crop (Club du Sahel 1983, 62; Ministère de l'Agriculture 1987, 150-51). Thus, with its first financing from the FAC (1965-1970), OHV sought simultaneously to develop several crops (cotton, millet, groundnuts and bottomland rice), expand the use of animal traction and organic fertilizers, and implement anti-erosion actions. Almost at the same time, the European Development Fund (FED) extended financing in 1969 and 1975 for the development of tobacco production in OHV. By 1978, OHV was involved in a wide range of activities, including the integrated development of food as well as cash crops, the organization of agricultural marketing and credit, the promotion of village-level associations to handle input and output marketing, the implementation of a functional literacy program, and the improvement of rural health services, water supplies and roads (Club du Sahel 1983, 63).

From 1978 up to the present, USAID has been the main and almost exclusive external financial source for OHV. Still using the integrated development approach, there have been some major changes in focus under the USAID financial regime in OHV. The officially stated goal of USAID's assistance to OHV was "to increase the income and improve the quality of life of the rural poor" through an "increase [of] agricultural productivity, production and marketing throughout the Haute Vallée region" (USAID 1978, 1). More specifically, the USAID project concentrated on the following areas:

- (a) animal traction to increase productivity;
- (b) improved irrigation to increase rice production;
- (c) credit to expand access to basic agricultural technology;
- (d) road rehabilitation and upgrading to facilitate marketing;
- (e) disease control to improve welfare and labor efficiency;
- (f) functional literacy to facilitate access to agricultural information and for general welfare;
- (g) support for OHV in crop research and administration (Ibid. 4).

Though this list of concerns seems very broad and inclusive, the real priorities assigned to the project by USAID were rather restrictive. The project paper clearly stipulates that the "[improvement of] the incomes, employment opportunities and the quality of life of the rural population in the Haute Vallée...can be made possible only (1) by increasing productivity in food crops, and (2) by an approach to agricultural development which reaches the population of the target zone" (USAID 1978, 171). Despite serious presumptions that (1) "OHV might be tempted to encourage farmers to produce non-food crops over which it has

a near monopoly in marketing," and (2) "the present marketing system provides incentives for the farmers to increase production in cash crops - cotton, peanuts, tobacco," "the mix [of crops] which the farmer considers optimal was considered indeterminant" in the project analysis, which "assumed that only millet will be grown by the farmers outside the polder" (Ibid., 142-43). The emphasis of USAID's assistance on food crop production exclusively proceeded from the contention that only cash crops had benefited from previous outside financial support (Ibid., 173). This emphasis probably also reflected Congressional restrictions on USAID's providing assistance to promote the production of cotton and tobacco, which are two major U.S. export crops.

From this brief history, significant differences emerge between CMDT and OHV as far as their main goals, their global approach to rural development and their extension policies are concerned. First, CMDT (like its predecessor CFDT) was created, developed and maintained for a clear and sustained leading goal: the promotion of cotton production. As a consequence, all CMDT development resources were and are still allocated in priority to cotton production, which was promoted initially to supply raw materials to CFDT's cotton mills and, later, to provide export earnings. However, cotton production became a powerful development engine because of its interactions with other crops and the multiplier effects of the income it generates on virtually all the economic activities at the regional as well as the national level. Additional development activities were gradually and cautiously included in the CMDT agenda only as cotton production was strengthened to generate enough income to support these activities. This gradual approach to integrated rural development is

formally stated in the second Mali-Sud Project, which sought "to increase production of cotton, of coarse grains (maize, sorghum, millet), cowpeas, rice, and livestock, all of which depend directly or indirectly on a healthy cotton sector" (World Bank 1983, 17).

In contrast, the OHV project began and evolved around an ambitious set of goals with ambiguous and changing strategic priorities. Under the FAC financing, priority was given to cotton production from 1965 to 1970. With the FED financing, priority shifted to tobacco from 1969 to 1975. Finally, a "food first" strategy with emphasis on cereals production has prevailed under USAID financial assistance since 1978. The foremost consequence of this lack of clarity and continuity in the development priorities of OHV is that, after more than twenty years of design and implementation of integrated rural development projects, no single activity has emerged to generate substantial and sustained rural incomes capable of supporting investments required in order to expand other economic activities in the Haute Vallée zone.

Second, there is a major difference between the research/technical bases of CMDT and OHV. Through its links with CFDT, CMDT has always been tied into the French research program on cotton carried out by IRCT and research efforts by IRAT on other tropical crops, including coarse grains. These research efforts have likely resulted in CMDT having more profitable technologies to extend relative to OHV, although one may argue that most of the technologies developed in CMDT could be directly transferred to OHV (some of the southern subzones of which were part of CMDT until 1979/80).

Third, the extension policies of CMDT and OHV have directly reflected their strategic development priorities. To reach more effectively most

farmers of its zone, the CMDT administration developed and maintained a very intensive extension service, with each extension agent well equipped with transportation means (first bicycles, then motorbicycles) reaching about 77 farm households living in two to three villages (Ministère de l'Agriculture 1987, 153). This extension network, as well as the content of the extension program, have also evolved gradually with research results and the crops and other activities covered, so as to enable CMDT to develop and maintain personal contacts with at least 86% of the estimated 100,000 farms of the Mali-Sud zone. Moreover, CMDT has continuously upgraded the professional quality of its extension staff through an autonomous training program. Finally, in collaboration with the Ministry of Education, CMDT has successfully developed a functional literacy training program which now reaches over 12,000 individuals of the 950 village associations of the region each year, therefore increasing the efficiency of extension information transmission and even allowing a gradual transfer of some extension functions to the farmer associations themselves (Ibid., 127-29).

Reflecting its ambiguous and shifting development priorities and strategies, OHV has been the scene of inconsistent extension policies over time. An intensive extension network inherited from CMDT in the southern subzones (Kati and Ouélesseboucou), and from the former Opération Arachide et Cultures Vivrières (OACV, also inspired by CMDT) in the northern subzones (Koulikoro and Banamba), still allows OHV to maintain a ratio of 92 farm households per extension agent (Ibid., 153). Yet the effectiveness of the OHV extension program is severely limited by its poor content, the lack of a clear consensus between the headquarters of OHV administra-

tion and the main funding agency (USAID) on the extension program and strategy to follow, the low-level and inadequate training of the extension staff, and the lack of means necessary for the field agents to perform their tasks. These deficiencies are well documented in the SATEC study of ODRs, which concludes that, "because of its success, CMDT has incited rainfed ODRs [such as OHV] to implement a dense network of extension agents, who disseminate standard technical themes and watchwords by parcel and by crop without any differentiated approach" (SATEC 1982, 7).

In the absence of appropriate technical packages for food crops, and despite the lack of significant investment in cotton production since 1978, the OHV extension service still encourages farmers to adopt the same rotations between cotton and coarse grains that evolved in the CMDT zone as a result of the expansion of cotton production and applied cropping systems research. Likewise, OHV farmers are taught by extension agents to use improved inputs such as mineral fertilizers and selected seeds without the guarantee of timely input supply and output outlets that farmers have in CMDT. Moreover, since 1978, the geographic focus of USAID's financial assistance on the southern part of OHV has severely isolated the northern subzones (Koulikoro and Banamba), where virtually no agricultural credit or inputs are distributed and most extension agents do not even have a bicycle to contact farmers in the four to six villages assigned to each of them. In fact, in the absence of a useful message to convey, no incentive exists for these extension agents to keep a close contact with farmers. Even in the southern subzones of OHV (Kangaba, Bancoumana, Ouélessébougou and Kati), there was a clear divergence between OHV's propensity to follow a mass extension strategy and USAID's choice

of a "cautious approach" to limit project focus to a target population of 2,000 poor farm families in the rainfed area and 160 polder farm households (USAID 1978, 172-73). This divergence in goals was even widened by the actual extension policy adopted by USAID, the initial design of which called for farmer training in animal traction at the level of eight training centers, while the final choice was to proceed by demonstration through direct actions at the level of 80 pilot farms to be selected among non-equipped households (Club du Sahel 1983, 69).

In sum, the superior performance of the agricultural sector in CMDT relative to OHV stems in part from differences in (a) the clarity of the goals and priorities of the two rural development institutions, (b) the continuity of these goals and priorities, (c) the strategic approach to the integration of various development activities followed by the two rural development organizations, (d) their research/technical base, and (e) the consistency between their extension networks and programs and their evolving activities over time. Since 1949, CFDT and CMDT have progressively built up a cumulative capital of human resources around the central goal of cotton production growth. Cotton production was developed in a coordinated system linked to a reliable market. Cotton income helped finance this system and induce synergies that became very instrumental in the gradual development of other support and diversification activities, such as food crop production, livestock production, and small-scale local manufacturing of farm equipment by blacksmiths. In contrast, OHV has suffered from too ambitious and frequently shifting sets of development goals, often defined without sufficient clarity or continuity in

priorities and/or strategies, which has prevented its programs to yield any significant cumulative gains.

6.2. Major Income Sources of CMDT and OHV Farm Households

Table 6-1 presents a breakdown of the 990 farm households of our survey villages according to their participation in major income-generating activities. All farm households engage in food crop production. The extent of farmer participation in the production of the different food crops largely reflects the ecological specificity of the crops, with millet and cowpeas being grown by a higher percentage of farms in the northern subzones and sorghum and maize being relatively more important in the south. The CMDT and the OHV zones clearly contrast even for these traditional food crops. Regardless of the subzones, a significantly higher percentage of farm households in CMDT grow sorghum and maize. On average, these two crops yield much more per hectare, but also require higher levels soil of fertility and moisture than millet. Their expanded cultivation in CMDT relative to OHV may be attributed to the explicit efforts undertaken by CMDT to integrate them into its cotton-cereals rotation systems, which not only increase soil fertility through the use of fertilizer on cotton, but also improve soil-moisture retention capacity through better land preparation techniques. In addition, the 95% adoption rate of maize cultivation farms in south CMDT and 63% of those in north CMDT (as compared with only 53% the farms in south OHV and none in north OHV) is a direct consequence of the maize-development program initiated by CMDT in 1972/73. This induced improved production

Table 6-1. Percentage of Farm Households Participating in Major Farm and Non-Farm Activities, CMDT and OHV Survey Zones, 1985

ACTIVITIES	CMDT			OHV		
	SOUTH	NORTH	TOTAL	SOUTH	NORTH	TOTAL
<u>Food Crop Production:</u>	100.0	100.0	100.0	100.0	100.0	100.0
Millet	88.2	100.0	94.2	73.2	96.9	85.8
Sorghum	97.8	79.1	88.4	76.3	43.9	59.1
Maize	95.5	63.4	79.3	52.7	0.0	24.7
Cowpeas	46.2	73.3	59.9	54.1	79.6	67.7
<u>Cash Crop Production:</u>	92.7	88.7	90.7	65.6	3.9	32.8
Cotton	92.7	87.0	89.8	30.9	0.0	14.5
Groundnuts	2.2	48.5	25.6	51.7	3.9	26.3
<u>Non-Crop Activities:</u>	30.8	21.7	26.2	50.0	49.7	49.8
Among which:						
Livestock production	12.9	8.7	10.8	3.2	4.0	3.6
Trade	9.5	4.2	6.8	16.7	14.1	15.3
Handicrafts	9.8	8.4	9.2	12.8	17.5	15.3
<u>Migration</u>	8.6	22.3	15.5	32.1	67.2	50.8

Source: CESA-MSU Food Security Project farm household surveys, 1985.

Note: A farm household may participate in more than one activity. The percentage of households practicing livestock production is very likely underestimated and may rather reflect the proportion of households with relatively sizeable herds while omitting those with very few small ruminants or poultry. Cash crops grown in OHV include tobacco. However tobacco production in this zone remains marginal, with 200-300 hectares cultivated annually. In addition, the bulk of tobacco production is located outside of our survey areas (mainly the sectors of Kangaba, Bancoumana and the southern parts of the sectors of Kati and Koulikoro).

techniques (e.g., use of animal traction, selected local seeds, urea, etc.) and guaranteed outlets and prices for the increasing maize output.

Outside the food-crop subsector, the gap in income-earning opportunities between the CMDT and the OHV zones becomes even wider. For cash crops in general and cotton in particular, the impact of the development priorities and strategies is quite striking. Fewer than one-third of the farm households in OHV, compared with nearly 91% of those in CMDT participated in cash crop (cotton and/or groundnut) production in 1985. Moreover, groundnuts are no longer a significant export/cash crop in Mali (Lecaillon and Morrisson, 1986). Nearly 90% of the farms in CMDT and only 14.5% of those in OHV (none in north OHV) were engaged in the production of cotton, the major cash crop of the country. It follows that the only crop income source remains food crop production for 85% of all the farm households in OHV and 100% of those in the north of this zone. These low-value food crops (particularly coarse grains) currently show limited potential for export and have few prospects for a significant expansion of their domestic demand. This significantly limits the income that farmers may derive from their production and marketing.

The impact of cash crop (especially cotton) production on farm household mix of income-generating activities clearly shows up in the percentage of households participating in activities other than crop production. Only 26% of the farm households in CMDT and nearly 50% of those in OHV were involved in activities other than crop production in their respective villages in 1985 (Table 6-1).¹ Among these activities,

1. This does not imply that CMDT's economy is less diversified than OHV's. It is possible that in CMDT there is more specialization of households into farm and nonfarm activities.

livestock production, which bears the highest initial investment cost, is practiced by a higher percentage (10.8%) of farmers in CMDT, most likely because of the use of their savings of cotton income to acquire small ruminants or even cattle.²

Besides participation in a more diversified range of activities in the village, a farm household's involvement in out-migration increases as the importance of cash crop production diminishes. Of the 990 households in our survey villages, 8.6% in south CMDT, 22.3% in north CMDT, 32.1% in south OHV and 67.2% in north OHV had one or more members searching for employment and additional income outside of their village in 1985. Although it may be argued that the proximity of the national capital (Bamako) favors off-farm employment in the OHV zone, the weakness of farm production and income offers a powerful economic explanation of the spread of rural out-migration in this zone. In other words, because of the absence of adequate access to major cash crops and farm inputs and implements in OHV, labor productivity in farming is low and income from crop production is insufficient to meet the needs of most farm households. Consequently, members of these households must undertake a variety of other activities, including selling part of their labor outside the village (or even the zone) for additional income. This argument is strongly supported by aggregate 1986/87 data of the Direction Nationale de l'Agriculture (DNA), which show that, with about 17% of the 600,000 farm households of Mali, CMDT's share in area harvested was 29% for all

2. The extent of participation in livestock production is likely underestimated for the 990 farm households of the survey areas. The percentages reported here would reflect more the proportion of farm households that practiced sizeable livestock production, while omitting most of the households with very few sheep, goats, or poultry.

crops, 24% for coarse grains, 23% for all cereals and 96% for cotton (OSCE, 1988). Its share in the national output was 32% for coarse grains, 29% for all cereals and 96% for cotton. In contrast, with about 7% of the country's farm households, OHV's share in area harvested stood at 6% for all crops as well as for coarse grains and all cereals and 4% for cotton, while its contribution to the domestic output was 8% for coarse grains, 7% for all cereals and 4% for cotton (Ibid.).

6.3. Erratic Evolution of Agricultural Credit and Input Institutions

Until 1980, the Société de Crédit Agricole et d'Équipement Rural (SCAER) was the exclusive agency in charge of the provision of agricultural credit and the distribution of farm inputs and implements to farmers in Mali. SCAER acted primarily as a supply parastatal for the different ODRs, which it used as intermediaries to reach farmers throughout the country. Its credit funds were provided by the Banque de Développement du Mali (BDM), while its operating costs were to be covered, through the official price schedules (barèmes), by special taxes levied on the sale price of cotton and groundnuts. SCAER supplied only short-term loans for seasonal inputs (e.g., fertilizers, seeds, insecticides, etc.) and medium-term credit for farm equipment payable in two years until 1976, extended to three years thereafter. Mostly imported at the beginning, almost all farm implements distributed by SCAER were purchased locally from the Société Malienne d'Études et de Construction de Matériel Agricole (SMECMA) by the mid-1970s (CRED 1976, 88). No credit was extended for the acquisition of draft animals.

Although SCAER had a legal monopoly power to intervene in all agricultural zones, the bulk of its activities were concentrated in the ODRs that produced the country's major export crops (cotton in CMDT and groundnuts in OACV). This focus on zones with a sufficiently dense extension service discriminated against the rest of the country, particularly those areas relying almost exclusively on food crop production, where the effective demand for agricultural inputs remained very weak because of low farm incomes. Even in the major cash crop production zones, the credit/input distribution system was considered to be very inequitable, because it made "the poorer farmers pay for a substantial portion of the subsidies given to, and the bad debts of, the richer farmers" through the taxes levied, which amounted to 22% of the producer's price in OACV and 15% of this price in CMDT (Ibid., 90).

After operating 13 years, several problems contributed to SCAER's collapse in 1980 (Ibid, 87-92). First, the agricultural credit and input distribution parastatal was considered by most ODRs to be a bottleneck to their extension programs, mainly because of the slowness and often inadequate timing of input and implement provision, as well as frequent quantity and quality differences between inputs ordered and delivered. Second, SCAER was required to bear all credit risks without any direct contact with its individual client farmers. As credit intermediaries, the ODRs took no risk and had therefore no particular incentive to improve the performance of the credit system, as illustrated by loan recovery rates as low as 40.5% in OACV in 1974/75. Third, maturities were not considered by farmers to be long enough to acquire more expensive equipment, and no credit was available for the purchase of draft animals.

Fourth, the ODRs tended to use funds collected from creditors by their field agents to finance their own buying campaign, rather than returning these funds directly to SCAER. Fifth, just as for OPAM in foodgrain marketing, a government policy of heavy subsidization of farm inputs and implements by 20% to 50% (which persisted until 1976) imposed severe deficits on SCAER, since the cost of the subsidy imposed on SCAER was not entirely offset by the low interest rate on farmers' loans (3.1%) and the special taxes levied on the major cash crops, most of which were used as operating funds for ODRs in financial difficulties (CRED 1976; SATEC 1982; Ouédraogo 1984). Therefore, unable to maintain a self-sustaining credit program, SCAER's cumulative deficits resulted in its bankruptcy and its elimination in 1980.

SCAER's disappearance left a big vacuum in the agricultural credit and input distribution system because neither another public enterprise nor the private sector was prepared to take over the parastatal's functions. Even though the Banque Nationale de Développement Agricole (BNDA) was created in 1981 to administer agricultural credit, the ODRs were and continue to be left alone to undertake their own farm input and implement procurement and distribution. BNDA extends mainly direct seasonal and medium-term credit to farmers through and under the guarantee of group liability of approved village associations. It extends indirect credit through ODRs and other rural development organizations (such as the Direction Nationale de l'Action Coopérative) as co-signers for farmers' loans and operating funds to agro-industrial enterprises such as CMDT (Ministère de l'Agriculture 1987, 182-85). Nevertheless, an "adequate" level of production of a cash crop that is sold through an official

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marketing channel remains a prime condition to the approval of BNDA loans. As a result of the priority given to cash-crop production zones and the disappearance of SCAER, farmers' access to formal credit and farm input/implement markets varies considerably among the different rural development zones.

Relative to the other agricultural zones of Mali, CMDT has always had better input and formal credit provision. The main explanation is that cotton has become a strategic crop for Mali's entire economy. Cotton accounts for more than one-half of Mali's export earnings; provides edible oil, animal feed and the basic raw material for two domestic textile mills; facilitates a greater use of fertilizer in farming systems; and generates the cash income needed to acquire equipment for animal traction (Simmons 1987, 2). Given CMDT's incorporated status, its links with the French CFDT and the fact that it produces roughly 95% of the total cotton output, CMDT has always enjoyed priority access to funds of the banking system. In 1985/86, for example, CMDT alone accounted for 68% of the 1,958 agricultural loans made by BNDA through farmers' associations and nearly 50% of the total amount of these loans (CFAF 1,939 million). During the same campaign, BNDA provided an additional CFAF 2.5 billion to finance CMDT's crop purchasing operations, which were formerly financed by BDM (Ministère de l'Agriculture 1987, 181-85). In fact, during the first three years of its existence, virtually all the credit activities of BNDA were concentrated in CMDT, which currently accounts for three of the six main branch offices and all the five sub-regional offices of the agricultural bank. Furthermore, CMDT has extended to its farmers even higher amounts of credit (over CFAF 5,000 million in 1986) for seasonal

inputs from its own financial resources obtained through funds of the Mali-Sud project and margins on cotton marketing and processing.

CMDT's privileged access to formal credit results from the overall outstanding solvency record that the company and the farm population of the zone have sustained over time, thanks to increasing cotton income. It also has a strict credit discipline, whereby no farmer with unpaid credit due is eligible for a new loan except for proven cases of crop failure caused by natural calamities. CMDT records show that loan repayment rates in the zone have never been below 90% for any given year over the eight-year period of 1980/81-1987/88. Moreover, an increasing participation of farmers' associations in credit management in CMDT has recently resulted in repayment records close to perfection, loan recovery rates standing at 97% in 1986/87 and 97.4% in 1987/88. Because of this strong and consistent solvency record and the importance of cotton for Mali's economy, all banks are urged and willing to extend credit to CMDT.

For the same reasons, CMDT has not suffered the disturbances and discontinuities in input procurement and distribution that characterize all the other ODRs, and CMDT farmers have constantly had a disproportionate share of farm inputs and implements distributed in Mali. Estimations from data of the National Direction of Agriculture (DNA) show that, of all agricultural inputs and implements distributed from 1980/81 to 1985/86, the shares of CMDT farms (about 17% of all farms) were 42% for all crop cultivation equipment (plows, multi-cultivators, harrows/hoes and seeders), 98% for multi-purpose toolbars, 41% for carts and 80% for mineral fertilizers (OSCE, 1988). With an annual renewal rate of farm equipment of 10% to 15%, CMDT is also considered to be the only zone with

almost all agricultural equipment in good working condition, thanks to a major effort of financing, equipment and training of 155 independent blacksmiths who manufacture all spare parts and approximately 60% of all plows and multi-purpose toolbars presently sold in the region (SATEC 1982, 38; World Bank 1983, 10).

In contrast with CMDT, the history of agricultural credit and input distribution in the OHV zone has been characterized by a lack of institutional consistency and continuity. Prior to 1980, SCAER supplied agricultural credit and inputs to both the south and the north of OHV, the south through the former "cotton operation" and the north through the former "peanut operation" (the defunct OACV). In fact, of all the plows, multi-purpose toolbars and seeders owned by our survey farm households, 77.2% in south OHV and 72.8% in north OHV were acquired before SCAER's disappearance. For the two years (1981/82 and 1982/83) following the elimination of SCAER, CMDT played the role of input supply agency for OHV as well as all other ODRs, by pooling their respective input needs with its own (Ouédraogo 1984, 9). Because of the other ODRs' poor repayment records, however, CMDT ceased to provide them credit after these two years.

In the light of the past deficiencies and failures of SCAER, USAID's involvement in credit matters of the OHV was designed in 1978 and began in 1980/81 with the ambitious long-term goal of creating "an improved credit system that can be used as an example nationwide", and the immediate objective of "improving the [existing] credit system to make it both service the needs of the farmers for improving farm production and to eventually make [it] a viable one" (USAID 1978, 27). However, as

Ericksen notes, "the initial conception of the credit component...seems to have changed almost before the ink was dry on the Program Agreement" and, paradoxically, "the position of credit advisor on the [USAID] technical assistance team was inexplicably dropped" (Ericksen 1984, 2-3). As a result, the credit program (which initially applied only to draft equipment and oxen) functioned until 1981 largely in conformity with the standard operating procedures established under SCAER, with the only differences being that the terms of maturity of loans were extended from three to five years while the interest rate was almost doubled from 3.1% to 6%. In 1981, OHV requested and obtained USAID's approval to expand its assistance to the credit component to include short-term production credit for seasonal inputs. However, USAID's assistance to the OHV credit program was blocked from December 1981 to March 1984 (Ericksen 1984; Matt 1984; Clark 1986). This was mainly because of OHV's failure to comply with the new credit conditions and terms proposed by USAID (e.g., full-cost pricing, 12% interest rate on all loans, and respect of USAID's procurement regulations), which diverged from government's overall credit policies. Thus, from the elimination of SCAER in 1980 to the resumption of USAID's credit program in 1984, the bulk of agricultural credit extended to OHV farmers came exclusively from the limited supply forwarded by CMDT and OHV's own scarce resources obtained from cotton and tobacco marketing.

Since 1984, BNDA has been progressively expanding its credit program in the OHV zone. The number of village associations covered by this program rose from 11 in 1984/85 to 30 in 1985/86 and 47 in 1986/87. Yet BNDA's intervention is still limited to fewer than 6% of OHV's 830

villages, and despite its increasing involvement and the reinstatement of the USAID credit component, only an estimated 4,750 OHV farms (about 12% of all farms) obtained some type of formal credit in 1985/86 (Ibid., 35). Moreover, out of a total of 1,111 applications, only 261 loans were extended for investment in animal traction equipment in 1986/87 (Ibid., 28-29). The situation is even worse for the most important pieces of farming equipment: in 1986/87, only 54 out of 208 plow-loan requests were answered favorably and only 5 out of 360 loan applications for multi-purpose toolbars were honored. Finally, a blacksmith training and financing program similar to that in CMDT was suspended in 1983, after its initial beneficiaries (14 persons) showed annual loan repayment rates of 10% or less, mainly because of a lack of proper credit supervision (Ericksen 1984, 25-27; Clark 1986, 13).

These facts indicate clearly that credit institutions have a long way to go to meet the aspirations of OHV farmers to obtain formal credit that improves their productivity in agriculture. In light of the experience of CMDT, a stronger and more independent corporative status may improve OHV's eligibility for public as well as commercial bank credit to finance its agricultural credit program. As an independent agricultural company, CMDT is not only authorized to use part of the taxes imbedded in the official cotton price schedules to finance its credit operations, but also is legally eligible for direct public and private bank credit. The present legal status of the other ODRs is one of public technical enterprises with no direct access to bank credit despite their alleged financial autonomy. In fact, this financial autonomy is somewhat fictitious when one considers that, from 1979 to 1981, all major ODRs

(including OHV) obtained 30% or more of their financing from foreign sources and 5% or more of their funds from the national budget. In contrast, CMDT received only 13% of its financing from foreign sources, 87% of its funds being provided by its own resources.

Legal eligibility for bank credit remains a necessary but insufficient condition for major improvement in OHV farmers' access to agricultural credit. Above all, it appears that a clear agricultural development strategy centered on one or two cash crops, which are capable of sustaining long-term profitability of farmers' investment and their capacity to meet loan repayments, is a precondition to the potential viability and the progressiveness of credit institutions in OHV. This contention is strongly supported by the results of a 1986 study of OHV's credit program, which show that although stricter loan conditions (and a subsequent reduction in the annual number of loans) have improved overall repayment rates from 77% in 1982/83 to 92% in 1985/86, the specific rates for 1985/86 fell from 94% for cotton/maize producers and 69% for tobacco producers to 53% for rice farmers and 47% for the USAID-OHV project pilot-farmers who grow primarily millet and sorghum (Clark, 13-15).

6.4. Linkages Between Credit and Input and Output Markets

Although the institutions in charge of the distribution of formal agricultural credit and farm inputs and implements have often changed over the past 28 years, the priority has remained the same: increasing the supply of improved inputs to cash-crop producers. This priority is stated explicitly as a major condition to farmers' eligibility for loan by both CMDT, which requires the "production of a cash crop purchased by the CMDT"

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and OHV, which stipulates that "the amount of the loan should not exceed 90% of the estimated value of cash crops (cotton and/or tobacco)".

Formally, BNDA does not require cash-crop production for its loans. However, two of its general conditions point implicitly to cash-crop producers: (a) the loan "program must be of a real economic interest for the country and have a financial profitability high enough to ensure the normal repayment of the loan principal and interests" and (b) the loan applicant must have an "adequate technical level...or benefit from the technical assistance of a rural development institution" (Clark 1986). In fact, because of its general lack of technical expertise in agriculture, BNDA depends (and is expected to continue to rely) on ODRs and other services of the Ministry of Agriculture for all agricultural information required in loan documents.

Credit institutions prefer to lend to cash-crop producers for several reasons. First, formal credit was initiated to facilitate and promote the adoption of improved farming technologies developed by commodity research, which has been (and continues to be to a large extent) primarily focussed on cash crops. Second, outlets and farm-gate prices for cash (export) crops have always been guaranteed by the government, therefore minimizing price risks. This makes it easier for the lender to estimate the farm income that the loan will generate. Third, the availability of improved technologies and the guarantee of outlets and prices increase farm-level expected profitability of cash-crop production. This in turn increases farmers' demand for credit to be used to acquire such inputs. Fourth, the marketing of virtually all cash crop output through official channels (mainly the ODRs themselves) offers the most direct and effective

way for rural credit and development institutions to recover the loans.

In all subzones of our survey, only cotton can presently be considered as a cash crop, since official purchases and exports of peanuts have ceased in the 1980s, while tobacco production (still limited to fewer than 300 hectares) is mainly located in other OHV subzones (Bancoumana and Kangaba) not included in the survey. Data in Table 6-2 gives an idea of the relation among cotton production, farmers' access to formal credit and use of chemical fertilizers and animal traction equipment. In the CMDT zone, where 89.8% of the farms produced cotton in 1985, 92.2% had formal credit, 80.7% used mineral fertilizers, and animal traction equipment was used by 86.8% for plowing and 79% for weeding. In the OHV zone, in contrast, only 14.5% of the farms produced cotton, 29.2% of them had access to credit, 17.4% used chemical fertilizers, 48.8% used animal traction for plowing and 38.7% used animal power for weeding. Fertilizers deserve particular note, since they generally amount to up to 80% of the annual amount of loans made to farmers (SATEC 1982, 42). CMDT farmers who cultivated on average 0.30 hectare of cotton per active worker, used 60% more fertilizer per cotton hectare than OHV farmers, who grew only 0.04 hectare per worker. When all crops are taken into account, data from DNA show that from 1978/79 to 1983/84 OHV farmers used an average of only 13 kilograms of fertilizer per hectare as compared with 38 kilograms per hectare in CMDT, where the average fertilizer consumption rose to 56 kilograms per hectare in 1985/86 (OSCE 1986; Ministère de l'Agriculture 1987).

Table 6-2. Cash Crop Production, Farm's Access to Formal Credit, and Purchased/Rented Farm Input Use, CMDT and OHV Survey Zones, 1985

ACTIVITIES	CMDT			OHV		
	SOUTH	NORTH	TOTAL	SOUTH	NORTH	TOTAL
Percentage of farms producing cotton	92.7	87.0	89.8	30.9	0.0	14.5
Cotton area per worker (ha)	0.39	0.21	0.30	0.08	0.0	0.04
Percentage of farms with formal credit (1981-1985)	99.4	85.1	92.2	40.6	19.2	29.2
Percentage of farms using mineral fertilizers	88.5	73.1	80.7	28.2	7.9	17.4
Share of cotton in total mineral fertilizer (%)	86.4	87.7	86.8	89.8	0.0	77.1
Cotton fertilizer (kg/ha)	137	102	123	77	0	77
Percentage of Farms Using Animal Traction for:						
Plowing	80.0	93.4	86.8	43.0	53.9	48.8
Planting	54.8	6.1	30.2	4.0	21.6	13.4
Weeding	72.6	85.3	79.0	41.4	36.4	38.7

Source: CESA-MSU Food Security Project farm household surveys, 1985.

The simple correlation coefficients presented in Table 6-3 further point to significant relations between cotton production and farmers' entitlement to formal credit and purchased inputs and implements (particularly fertilizers). Despite the categorical nature of the variables used, there is relatively high positive correlations between cotton production and access to credit ($r = 0.76$), between access to credit and fertilizer use ($r = 0.69$), and between cotton production and fertilizer use ($r = 0.83$). In other words, the more farmers engage in

cotton production, the better their eligibility for seasonal credit to purchase chemical fertilizers, the largest share of which is applied to cotton fields. Similarly, there are positive significant correlations between cotton production and access to credit on the one hand and the ownership of plows and oxen on the other hand. The relatively low level of the coefficients (0.31 to 0.39) is mainly explained by the wide range of sources of income used to finance investment in animal traction, as discussed in Chapter V.

Table 6-3. Correlation Between Cotton Production and Farm's Access to Formal Credit and Purchased Inputs and Implements, 1985 (Bivariate correlation coefficients r)

VARIABLES	COTTON	CREDIT	FERTILIZER
Cotton Production (COTTON)	1.00		
Access to Credit (CREDIT)	0.76	1.00	
Fertilizer Use (FERTILIZER)	0.83	0.69	1.00
Possession of Simple Plow	0.39	0.37	0.27
Possession of Multicultivator	0.39	0.37	0.30
Possession of Oxen (OXEN)	0.36	0.31	0.23

Source: CESA-MSU Food Security Project farm household surveys, 1985.

Note: All variables are categorical, with codes 0 = NO and 1 = YES.
All correlation coefficients are significantly positive at the 1% level.

Although this discussion seems to pinpoint an institutional bias in favor of cash crops and neglect of food crops, some important interactions between sponsored and non-sponsored crops in a whole-farm perspective should not be overlooked. First, most improved cultivation techniques applied to cotton or groundnuts (e.g., mechanical plowing and weeding, planting in rows, etc.) have generally been extended to coarse grains.

Second, as discussed in Chapter IV, income from cash crops with guaranteed outlets and prices increases farmers' financial capacity to acquire hired labor, draft equipment and animals, which are used to expand both cash crop and food crop production. Third, food crops often benefit from chemical fertilizers purchased on credit for cash crops, either directly through the diversion of part of the fertilizers to cereal fields, or indirectly through the residual effect of these fertilizers on foodgrains grown in rotation with cash crops. Fourth, income from cash crops helps farmers pay their taxes and adopt optimal foodgrain transaction strategies, thereby increasing the overall farm household income and food security.

Data in Table 6-4 substantiate the point on the indirect benefit of cash crop fertilizer for food crops. On the basis of results of agronomic research, the extension services in both CMDT and OHV recommend crop rotations in which coarse grains follow cotton (Dembélé Z.V. 1988; Kagbo and Diarra 1988). The two zones differ significantly, however. In the survey villages, all field plots cultivated over more than two successive years in 1985 (91% of all field plots), 54.1% in CMDT and only 15.7% in OHV had some type of rotation between cotton and coarse grains over the six-year period 1980-1985. Alternatively, coarse grains grown on about 46% of the cereals fields in CMDT and as many as 84% of those in OHV did not benefit from any residual cotton fertilizer during these years. Moreover, 74.1% of all fields in OHV and 38.5% in CMDT were exclusively cropped with coarse grains, often mixed with cowpeas. The traditional practice of intercropping millet or sorghum with cowpeas allows nitrogen fixation and may reduce to some extent the negative effect of the lack of

crop rotation on soil fertility. Nevertheless, when one considers that maize is grown with manure/fertilizer on more than 60% of the fields without cotton rotation each year in the CMDT zone, it may be inferred that fewer than 15% of all field plots in CMDT and up to 80% of those in OHV did not receive fertilizer in any year between 1980 and 1985.

Table 6-4. Distribution (%) of 1985 Cultivated Field Plots by Crop Mix Included in Crop Rotations, CMDT and OHV Survey Zones (1980 - 1985)

CROPS IN ROTATION	CMDT			OHV		
	SOUTH	NORTH	TOTAL	SOUTH	NORTH	TOTAL
Peanut only	0.0	0.0	0.0	8.7	2.1	5.8
Coarse Grains/ Cowpeas Only	26.3	47.2	38.5	57.1	97.9	75.0
Coarse Grains/ Cowpeas-Cotton	71.4	31.5	48.3	26.2	0.0	14.8
Coarse Grains/Cowpeas- Cotton-Peanuts	2.3	8.5	5.8	1.6	0.0	0.9
Coarse Grains/ Cowpeas-Peanuts	0.0	12.8	7.4	6.4	0.0	3.5
% of Fields under Coarse Grains - Cotton Rotation	73.7	40.0	54.1	27.8	0.0	15.7
% of Coarse Grain Fields with Cotton in Rotation	73.7	40.0	54.1	30.4	0.0	16.7
Total Number of Field Plots	171	235	406	126	97	223

Source: CESA-MSU Food Security Project farm household surveys, 1986.

Within each zone, the relative importance of the different types of crop rotations between the south and the north reflects in part the

ecological adaptability of the crops. Cotton and coarse grains grown together account for 73.7% of all fields in south CMDT but only 40% in north CMDT. For OHV, the corresponding figures are 27.8% in the south and 0% in the north. Nevertheless, the impact of the strategies and policies followed historically by the two rural development institutions is even more striking than the effect of natural environment. Only coarse grains or coarse grains intercropped with cowpeas are grown on virtually all fields in north OHV. Despite a suitability for cotton comparable to that of south CMDT, the south of OHV displays a much lower percentage of field plots where coarse grains rotate with cotton (27.8%) than even the drier north CMDT (40%).

In general, the effect of cotton production on farmers' access to credit and cash crop inputs has both direct and indirect consequences for foodgrain production. Among the most important of these consequences is the direct link between relatively stable and high cash crop income (through guaranteed outlets and producer prices) and the farm capacity to finance investment in animal traction technology, which serves both cash crops and food crops. Table 6-5 shows significant differences between CMDT, where nearly 90% of the farms produced cotton in 1985, and OHV, where barely 15% of the farms grew cotton in 1985. When seeders are excluded, 56% or more of the farm households in CMDT owned each type of draft equipment and animals in 1985 as compared with fewer than 40% in OHV. More importantly, 78.4% of the CMDT farms and only 52.3% of those in OHV had at least one of the main types of cultivation equipment (the simple plow or the multi-purpose toolbar). When the ownership of the complementary draft animals (oxen) is taken into account, about two-thirds

Table 6-5. Percentage of Farm Households Owning Draft Equipment and Animals, CMDT and OHV Survey Villages, 1985

DRAFT EQUIPMENT AND ANIMALS OWNED	CMDT			OHV		
	SOUTH	NORTH	TOTAL	SOUTH	NORTH	TOTAL
Simple plow(s)	71.4	69.9	70.6	48.7	28.2	37.8
Multi-purpose toolbar(s)	62.2	66.6	64.4	28.2	33.3	30.9
Seeder(s)	38.8	5.1	21.8	5.8	12.4	9.3
Cart(s)	55.1	56.9	56.0	30.8	34.5	32.7
Oxen	54.8	78.0	66.5	42.9	28.8	35.4
Donkey(s)	54.2	58.1	56.2	29.5	32.2	30.9
Simple plow and/or Multi-purpose toolbar	73.2	83.4	78.4	55.8	49.2	52.3
Simple plow and/or Multi-purpose toolbar and Oxen	54.5	78.0	66.4	41.0	28.2	34.2
Percentage of Farms by Level of Equipment:						
Fully-equipped farms	40.3	51.8	46.1	14.7	17.5	16.2
Semi-equipped farms	32.9	31.6	32.3	41.0	31.6	36.0
Non-equipped farms	26.8	16.6	21.6	44.2	50.8	47.7
Number of farm households	325	332	657	156	177	333

Source: CESA-MSU Food Security Project farm household surveys, 1985.

Note: Fully-equipped farms own at least one multi-purpose toolbar, one cart and a pair of oxen. Semi-equipped farms own at least one piece of tillage equipment, but not the complete set of equipment and animals owned by fully-equipped farms. Non-equipped farms own no plow or multi-purpose toolbar.

of the farm households in CMDT and one-third of those in OHV could use animal traction without resorting to renting equipment or animals in 1985. This proportion is even understated for the CMDT zone (particularly the south of this zone), where an outbreak of epizootic diseases caused considerable loss of oxen just prior to our survey (see Chapter V). In sum, thanks mainly to a privileged institutional treatment linked to cotton production and income, 46.1% of the farms in CMDT owned at least a multiculteur, a seeder, a cart and a pair of oxen, in contrast with only 16.2% of OHV farms; nearly 80% of CMDT farms and only 52.2% of OHV farms had at least part of the draft equipment and/or animals needed; and only 21.6% of CMDT farms compared with 47.7% of OHV farms had no draft equipment or animals at all.

6.5. Major Constraints in the Coarse Grain Market

The empirical issues discussed in this section relate to a snapshot of the private coarse grain market as of 1986/87. Exceptionally good rainfalls in 1988 coupled with sustained research efforts to inform cereals marketing policies have induced rapid developments in the structure, conduct and performance of the private foodgrain market. More detailed analyses of these developments, and the structure and conduct of the private cereals trade, are being carried out by MSU field researchers, particularly N. Nango Dembélé, Mona Mehta and Philip Steffen, currently based in Mali. The following discussion aims primarily at bringing to light some of the major institutional constraints in the cereals market as they related to coarse grain farmers in 1986/87, i.e., by the end of the collection of the primary data used in this dissertation.

In addition to the negative effects of poor weather, bad marketing and price policies have been considered by virtually all analysts to be at the core of the slow growth of agricultural production in Mali during the late 1960s and the 1970s. All the past studies conclude that these policies explained to a large extent the shift of Mali from a position of net cereal exporter up to the early-1960s to a position of net foodgrain importer since the mid-1960s. Concerns about these policies have led major donors to fund numerous annual evaluations of Malian policies, many of them duplicating each other (CRED 1976; de Meel 1978; CILSS/Cub du Sahel 1979; Berg 1979; Linehan 1983; Dupont, Houzangbé and Vandenberghe 1984; Gagnon 1985, 1987 and 1988; Lecaillon and Morrisson 1986; Amselle, Thenevin and Yung 1986; Humphreys 1986; Bremer and Ellsworth 1986; Haykin, Roth and Wilcock, 1987; Dioné and Dembélé 1987; Dioné and Staatz 1987; Gagnon 1987; Sivini 1987; Gagnon 1988; Staatz, Dioné and Dembélé 1988). The most criticized aspects of government policies have been OPAM's legal monopoly in foodgrain marketing (and the consequent banning of private cereals trade); the setting of official producer and consumer cereal prices often below levels in the clandestine private market and neighboring countries; and the subsequent subsidization of OPAM and its privileged clientele (mainly military and civil servants in urban areas) through farmer taxation and deficit financing.

The cereals market liberalization in Mali proceeded from the implicit assumption that private traders had the willingness and the capacity to fill the gap open by the withdrawal of the public sector from cereals marketing (Dioné and Staatz; Staatz, Dioné and Dembélé). This hypothesis is examined here in the light of empirical evidence relative to some of

the major constraints that still prevailed in the private coarse grain market by 1986/87, which suggested that additional actions would be required to improve the overall performance of the cereals market.

In assessing progress made by the PRMC in liberalizing cereals marketing, it should first be noted that the liberalization of the coarse grains market (millet, sorghum and maize) in 1981/82 was more symbolic than real (Humphreys, 16). Over the eleven years preceding the liberalization OPAM's market share in coarse grains marketing exceeded 5% of total domestic production in only three years and 30% of the estimated total quantity traded in only 4 years (Dioné and Dembélé 1987, 2). Hence, despite the legal ban, the private sector had remained very active in the coarse grains market and accounted for 70% or more of total marketed surplus during the decade preceding the PRMC. In fact, 61% of the 118 coarse grain wholesalers identified in our 1985/86 surveys of four major wholesale centers were professional cereals traders before market liberalization (see Table 2-5, Chapter II). Although the cereals market reform program may have stimulated entry in private coarse grain trade, to speak of the emergence of a private grain trade sector under the PRMC would be an over-statement.

One of the most important indicators of private market performance is the extent of market integration, i.e., a test of spatial pricing efficiency through the examination of how coarse grain markets in different locations respond jointly to supply and demand forces. Several alternative measures of market integration have been proposed by economists, including Pearson correlations of prices between pairs of markets, "radial" unidirectional price correlations between peripheral

rural markets and a central urban market, and a "variance component" model of comparative seasonal movement of prices on different markets (Ravaillon 1986; Delgado 1986). The "bivariate correlation method" has been criticized for allowing coefficient bias introduced by common seasonality and inflation, for not accounting for heteroskedasticity caused by changing price variance over time, and for not isolating the effects of a "real connection" between markets from those of other factors such as public price control policies. Despite these criticisms, the simple correlation measure of pairwise market integration remains the most commonly used method, and can provide (even with short time-series) very useful insights into possible weak linkages for specific market segments, particularly when price correlations are based on, and jointly analyzed with, other relevant market information (e.g., existing product channels from rural areas to consumption centers, directions of product flows, and informal market information flows).

Preliminary analysis identified the major cereals trading channels in Mali (Dioné and Dembélé 1986a). Coarse grain market routes were then identified between the CMDT zone and Bamako via Sikasso, between CMDT and Mopti via Koutiala, and between the OHV zone and Bamako. Selection of rural markets and wholesale centers covered by this study took explicit account of this information, so that it becomes safe to assume that any significant price correlation between these markets is by no means fortuitous, but, to a large extent, the result of market information and exchange. In this respect, Table 6-6 shows that outside of northern OHV --which relates to other markets by correlation coefficients between 0.61 and 0.76--all the rural markets and wholesale centers covered by the study

Tab 1

DATE

TIME

LOCATION

WIND

WAVE

TEMP

HUMID

SEA

WIND

WAVE

TEMP

HUMID

SEA

WIND

WAVE

TEMP

HUMID

SEA

WIND

WAVE

TEMP

HUMID

SEA

WIND

**Table 6-6. Coarse Grain Price Correlations between Pairs of Markets
(Spearson R-Coefficients)**

	BUYING PRICES								SELLING PRICES			
	RURAL MARKETS				WHOLESALE MARKETS				WHOLESALE MARKETS			
	South CMDT	North CMDT	South OHV	North OHV	Koutiala	Sikasso	Bamako	Mopti	Koutiala	Sikasso	Bamako	Mopti
	—	—	—	—	—	—	—	—	—	—	—	—
BUYING PRICES												
RURAL												
South-CMDT	1.00	0.98	0.83	0.66	0.97	0.96	0.93	0.96	0.96	0.92	0.95	0.96
North-CMDT		1.00	0.81	0.73	0.98	0.94	0.90	0.96	0.94	0.91	0.91	0.95
South-OHV			1.00	0.73	0.81	0.85	0.85	0.82	0.82	0.81	0.83	0.84
North-OHV				1.00	0.68	0.67	0.61	0.75	0.67	0.73	0.59	0.76
WHOLESALE												
Koutiala					1.00	0.93	0.90	0.96	0.98	0.89	0.89	0.95
Sikasso						1.00	0.92	0.95	0.93	0.95	0.92	0.93
Bamako							1.00	0.89	0.90	0.85	0.98	0.89
Mopti								1.00	0.96	0.93	0.90	0.98
SELLING PRICES (WHOLESALE)												
Koutiala									1.00	0.89	0.90	0.96
Sikasso										1.00	0.87	0.91
Bamako											1.00	0.89
Mopti												1.00

Source: CESA-MSU Food Security Project market surveys, 1985-1987.

Note: Monthly weighted average prices for millet, sorghum and maize are used.

All correlation coefficients are significantly positive at the 1% level.

Market villages are Zangasso (south CMDT), Dougouolo (north CMDT), Quelessebougou (south OHV), and Sirakorola (north OHV). No price data were available in November 1985 for south OHV.

An outlying one-time transaction of 4,000 MT of maize bought from OPAM at CFAF 22/kg and exported at CFAF 100/kg in July 1987 was excluded from Bamako wholesale data.

are well integrated to each other as indicated by price correlation coefficients of 0.81 to 0.96. These figures are not surprising when one considers that, in the absence of legal barriers to interregional commodity movements under the PRMC, 68.3% of our sample wholesalers were informed weekly (by their own buying-agents, transporters and other traders) of cereals prices in their supply areas and 71.4% of them had weekly price information on the demand side. Through competition, wholesalers in possession of such information influence both their buying and selling agents as well as their competitors in supply areas and consumption centers. Such competitive behavior is further stimulated by the fact that all the survey markets are well connected by a network of all-season rural roads and paved highways, except for the deficit northern OHV, where roads beyond Koulikoro become much less suitable for medium to heavy trucks during the most rainy months (June through August). Finally, the high correlation between buying prices and selling prices in each wholesale center (r -coefficients of 0.95 to 0.98) seems to indicate a high degree of competition under relatively constant unit marketing costs.

Although lack of market integration seemed not to represent a major problem at least in the southern half of the country. There were several constraints to private coarse grain trading five years after the launching of the PRMC, many of which still remain to be solved. Table 6-7 summarizes findings about such constraints. First among these are liquidity constraints reported by 50% of the sample wholesalers, who complained about their limited access to formal financial institutions and high business taxes, which amounted to 50% of estimated commercial profits for companies and 30% of these profits for enterprises not set up as

Table 6-7. Wholesalers' Perceptions of Major Constraints to Private Coarse Grain Trade in 1986 (percentage of sample wholesalers)

CONSTRAINTS	KOUTIALA	SIKASSO	BAMAKO	MOPTI	TOTAL
Limited Financing	22.2	25.0	35.0	94.7	50.0
High Business Taxes	33.3	75.0	30.0	63.3	50.0
Transport Costs/Mean(a)	33.3	8.3	10.0	5.3	11.7
Supply Uncertainty	77.8	60.0	7.6	47.0	41.1
Demand Uncertainty	0.0	10.0	30.7	82.4	38.3
Licensing/Administrative Procedures	0.0	0.0	15.4	0.0	5.1
Public Inspection/Fines	44.4	16.6	25.0	15.9	23.3
Traders Reporting Fines	55.6	58.3	70.0	84.2	70.0
Average Fines (CFAF)	17,500	14,375	51,625	24,285	32,875
Traders Evading Fines	55.6	58.3	70.0	10.5	46.7
Average "Fine-evasion Fees" (CFAF)	7,500	4,125	17,375	15,000	12,370
Number of wholesalers	9	12	20	19	60

Source: CESA-MSU Food Security Project wholesaler surveys, 1986.

Note: (a) Transport Cost/Mean = high transport costs or inadequate availability of trucks. Multiple responses are allowed.

companies (Stryker et al. 1987, A.31). In fact, until 1986/87, there was no bank credit line for long-term or seasonal loans to private cereals traders. Partly as a consequence of this lack of financing, private wholesalers had no incentives to invest in seasonal storage of coarse grains, and followed very short-run business strategies: 89.1% of them did not keep coarse grain stocks for more than 2.5 weeks in 1986.

Following a second successive good harvest with no prospects for significant OPAM intervention in 1986, PRMC donors agreed to support a seasonal credit program aimed at raising producer prices by encouraging wholesalers to undertake longer-term storage of cereals³. This program called for the injection of CFAF 500 million by PRMC into the banking system, to be met by an equivalent amount from own-resources of the two private banks selected for the purpose (Banque Malienne de Crédit et de Dépôts, BMCD, and Bank of Africa-Mali, BOAM). Credit regulations of the Banque Centrale des Etats de l'Afrique de l'Ouest (BCEAO) do not provide for guaranteeing such seasonal credit through an organization such as the Chamber of Commerce (designated by the PRMC for that purpose), which is not under official state control. BMCD and BOAM could therefore add no more funds to those provided by the PRMC. Of the CFAF 500 million available, a total amount of CFAF 316.3 million (63.2%) was actually distributed to 16 traders, 10 of whom resided in Bamako, 4 in Ségou and 2 in Mopti (Dembélé and Steffen 1987; Bank of Africa-Mali 1988). This

3. Cereals production rose to record levels of 1.7 million metric tons in 1985 and 1.8 million metric tons in 1986. BCEAO denied OPAM a new seasonal loan in 1986/87, because of its 118,000 metric tons of unsold coarse grains in regulatory stocks in addition to 58,000 metric tons in security stocks on January 31, 1987.

modest effort helped finance the purchase of only 2.3% of the estimated marketable surplus of cereals by May 1987 (Dembélé and Steffen 1987, 35). In addition, two wholesalers of Bamako reported that only five of the Bamako traders who received the PRMC credit in 1987 were true cereals traders, and all of them were large import-export wholesalers (Diaby and Konaté 1988, 2). The PRMC credit program was scheduled to continue in 1987/88, with a shift of the endorsement responsibility from the Chamber of Commerce to OPAM and a total commitment of CFAF 1,500 million. This second attempt failed because funds were made available only in May (seven months after harvest) and virtually no wholesaler could provide all the accounting and other business documents required for loan application in the short time still available to the program during this campaign (Bank of Africa-Mali 1988, 4). Until 1987/88, private cereals traders' access to bank financing thus remained severely limited for seasonal credit and nonexistent for long-term investment in either transportation means or storage facilities⁴.

Given the virtual absence of formal credit, private grain traders continued to rely on informal financial sources. For example, in 1986, 61.7% of our sample wholesalers reported borrowing money from relatives (most of whom are also traders) and other traders to buy their cereals; 73.3% of them often bought grain on credit from other suppliers, and 90% of them sold cereals on credit to both consumers and retailers (Table 6-8).

4. Recent information suggests that the 1988/89 credit program is off to a good start. Improved availability of seasonal credit in November 1988 seems to have in part contributed to preventing producer prices from falling dramatically in spite of a record harvest of 2.4 million metric tons of cereals.

Table 6-8. Informal Credit Financing in Private Coarse Grain Wholesale Trade (percentage of wholesalers)

TYPE OF FINANCING	KOUTIALA	SIKASSO	BAMAKO	MOPTI	TOTAL
Money Loans	88.9	83.3	60.0	36.8	61.7
From Relatives	11.1	66.6	30.0	26.3	33.3
From Other Traders	88.9	50.0	50.0	31.5	50.0
From Banks	0.0	8.3	5.0	0.0	3.3
Credit Purchases	44.4	66.7	65.0	100.0	73.3
From Outside Traders	44.4	58.4	35.0	100.0	59.3
From In-Town Traders	0.0	8.3	30.0	84.2	38.3
Credit Sales	100.0	100.0	95.0	73.7	90.0
To Consumers	66.6	100.0	90.1	63.2	80.1
To Retailers	77.8	8.3	65.0	73.7	58.3
Number of Wholesalers	9	12	20	19	60

Source: CESA-MSU Food Security Project wholesaler surveys, 1986.

Note: Except for 6.7% of the wholesalers (all in Sikasso), the relatives who provided money loans were also professional traders. Multiple responses are allowed for the sources of money loans, the suppliers of grain at credit, and the clients for credit sales.

Although traders are usually reluctant to provide precise information about the terms of such informal credit in the Islamic and liquidity-shortage context of Mali, estimates from informal interviews with a few wholesalers in Bamako clearly indicate that interest rates on informal loans were extremely high and might reach 20% per month (Dembélé, Dioné and Staatz 1986a, 23). Thus, even with a quick turnover of stocks in 15 days, financing alone might have contributed to raising marketing costs by an equivalent of 10% of the full cost of coarse grains prior to the wholesale-storage stage.

A second category of major constraints to further development of private trade encompasses uncertainty about both coarse grain supply and demand. Data in Table 6-7 indicate that supply uncertainty affects a higher proportion of wholesalers in surplus production zones (77% in Koutiala and 60% in Sikasso), while concerns about demand uncertainty are expressed almost exclusively by wholesalers of major urban consumption centers (30.7% in Bamako and 82.4% in Mopti). Cereals wholesalers in the main urban consumption centers (particularly Mopti, where the bulk of the supply to the deficit northeastern regions transits) are continuously subjected to unstable expectations caused by unforeseen interventions of OPAM, food aid releases, and liquidity crises at the level of their clients (Dioné and Dembélé 1986b; Steffen, Dembélé and Staatz 1988; Staatz, Dioné and Dembélé 1988). For instance, in informal interviews some of our sample wholesalers gave a few examples where traders with large stocks on hand were bankrupted because of sharp drops in cowpeas or cereals prices following a sudden flooding of the markets by unexpected supply. Furthermore, the government's continuous failure to pay its urban employees on time puts additional stress on private cereals traders, who have been forced, and become more and more unwilling, to sell grain on credit to increasingly insolvent civil servants (Staatz, Dioné and Dembélé 1988, 17-18). In addition to limited access to formal financing, such instability in expectations explains to a large extent wholesalers' reluctance to undertake substantial long-term investments required for a higher degree of specialization in coarse grain trading.⁵

5. Additional analysis by Mona Mehta seems to indicate that some increase in specialization has occurred over the period 1985-1988.

Instability in demand-side expectations is further compounded by instability on the supply side, given the narrow and residual nature of the Malian coarse grain market. As mentioned in Chapter IV, at least 90% of the total demand for coarse grains is located in rural areas, so that any significant change in domestic production induces in turn a significant shift in market demand. Table 6-9 and Figures 6-1 and 6-2 illustrate the extent of price volatility under such shifting conditions of supply and demand. A combination of a modest 4.4% increase in coarse grain output with virtually no OPAM purchases and no exports in 1986/87 was accompanied by a 24.5% to 31.4% decline in coarse grain prices in both assembly and wholesale markets (except for the deficit and less integrated northern OHV) relative to 1985/86. Even during such good years, seasonal price fluctuations remain relatively high, as indicated by 1986/87 price range, which varied from 59.7% to 72% of the average annual price in rural markets and 45.6% to 75.5% of the mean-annual price in wholesale centers (Table 6-9). The estimated coefficients of variation of prices over the 24-month period of relative coarse grain abundance covered in this study (18% to 27%) may rise considerably in the advent of years of bad rainfall. As an illustration, the producer price of millet in southern CMDT quadrupled between March 1987 and July 1988, following a 15% decline in aggregate coarse grain production in 1987 relative to 1986 (Staatz, Dioné and Dembélé 1989, 3; OSCE 1988). Such large price swings reflect the high volatility of total supply of coarse grains (almost exclusively from domestic production), which in turn may constitute a strong disincentive to long-term investment in foodgrain storage and transport facilities by private traders in surplus-production zones.

Table 6-9. Coarse Grain Price Variability (November 1985 - October 1987)

MARKETS	MEAN (CFAF/KG)	RANGE (CFAF/KG)	RANGE AS % OF MEAN	STANDARD DEVIATION	COEFFIC. OF VARIATION (%)
1985/86					
Rural Markets:					
South CMDT	45.5	16.6	36.4	5.1	11.1
North CMDT	46.2	21.9	47.4	6.4	13.7
South OHV	49.9	15.1	30.4	4.4	8.9
North OHV	52.8	22.1	41.8	5.9	11.1
Wholesale Markets:					
Koutiala	49.0	22.4	45.7	6.7	13.6
Sikasso	56.0	15.5	27.7	4.7	8.4
Bamako	66.0	10.9	16.5	3.4	5.1
Mopti	63.7	23.4	36.7	6.6	10.4
1986/87					
Rural Markets:					
South CMDT	31.7	18.9	59.7	7.4	23.2
North CMDT	32.6	23.4	72.0	9.3	28.7
South OHV	37.0	25.0	67.5	10.1	27.3
North OHV	48.4	33.1	68.4	11.2	23.2
Wholesale Markets:					
Koutiala	33.6	25.4	75.5	9.5	28.2
Sikasso	41.9	19.1	45.6	7.8	18.5
Bamako	49.8	24.6	49.5	9.1	18.3
Mopti	47.3	27.2	57.5	11.3	23.9
1985/86-1986/87					
Rural Markets:					
South CMDT	38.6	28.4	73.4	9.4	24.3
North CMDT	39.4	31.1	79.1	10.5	26.6
South OHV	43.2	31.8	73.7	10.1	23.5
North OHV	50.6	33.1	65.4	9.0	17.9
Wholesale Markets:					
Koutiala	41.3	32.3	78.2	11.2	27.2
Sikasso	48.9	28.3	57.8	9.6	19.6
Bamako	57.9	29.1	50.3	10.7	18.5
Mopti	55.5	35.3	63.5	12.3	22.2

Source: MSU-CESA Food Security Project market surveys, 1985-1987.

Note: Market villages are Zangasso (south CMDT), Dougouolo (north CMDT), Ouelesseboucou (south OHV), and Sirakorola (north OHV). Monthly weighted average prices for millet, sorghum and maize are used. 1985/86 = Nov. 1985 - Oct. 1986; 1986/87 = Nov. 1986 - Oct. 1987. No price data were available in November 1985 for south OHV. The price range is the difference between the maximum price and the minimum price for a given year or period.

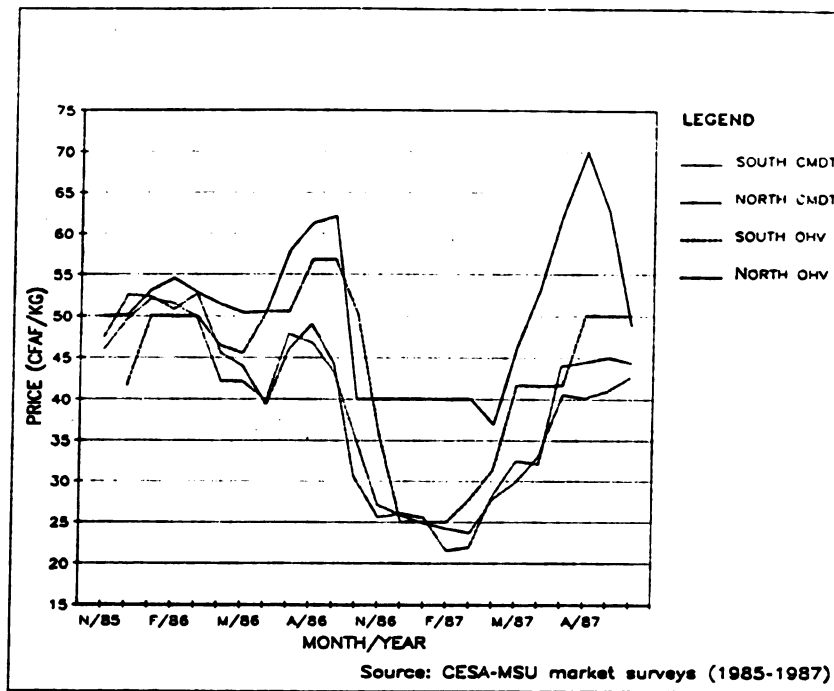


Figure 6-1. Monthly Producer Prices of Coarse Grains Rural Markets (November 1985 - October 1987)

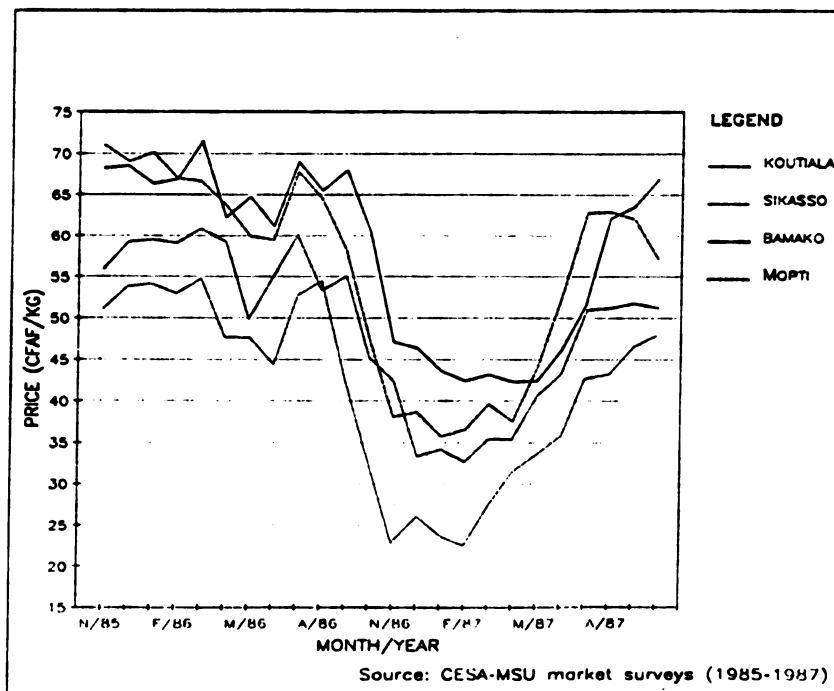


Figure 6-2. Monthly Purchase Prices of Coarse Grains Wholesale Markets (November 1985 - October 1987)

Beside very short-run transaction strategies, coarse grain wholesalers have presently very few alternative mechanisms to cope with supply and demand uncertainties. Fewer than 50% of them engaged in contract purchases and sales in 1986 (Table 6-10). Moreover, all such contracts were made for very short-term deliveries (usually one or two weeks) in response to institutional demand coming from public agencies (e.g., OPAM, the penitentiary system, etc.) or non-governmental organizations engaging in food aid operations. Contracting is more widespread among traders of the surplus south-CMDT (88.9% of wholesalers for purchase contracts and 77.9% for sales contracts in Koutiala) who sell primarily to the Mopti market, and wholesalers in Mopti (52.8% for purchase contracts and 58.8% for sales contracts) who face both the private and the institutional demands for foodgrains in the deficit northeastern regions of the country.

Oral contracts are predominant for wholesalers who reported contract transactions. Purchase contracts were exclusively in written form for only 4.8% of the sample wholesalers or 10.3% of those who buy on contract, while sales contracts were exclusively written for only 17.7% of all wholesalers or 37.9% of those who sell on contract. It is only in Bamako that a significant proportion of wholesalers (30.8%, or 89% of those who sold on contract) used exclusively written sales contracts, primarily because of the large institutional demand in the national capital, and the stronger political connections of Bamako traders relative to wholesalers of other cities and towns. In fact, besides having a privileged access to formal credit, Bamako residents have also benefitted from a disproportionate access to bids for institutional cereals-delivery contracts, most of which, depending on political connections, have

Table 6-10. Contracting and Risk-Sharing in Private Coarse Grain Wholesale Trade (percentage of wholesalers)

TYPES OF CONTRACT	KOUTIALA	SIKASSO	BAMAKO	MOPTI	TOTAL
Purchase Contracts	88.9	30.0	34.6	52.8	46.8
Form of contracts:					
Oral only	50.0	100.0	77.8	44.4	62.1
Oral or Written	37.5	0.0	22.2	33.4	27.6
Written only	12.5	0.0	0.0	22.2	10.3
Violation of terms	62.5	33.3	22.2	20.0	31.0
Sales Contracts	77.9	30.0	34.6	58.8	46.7
Form of contracts:					
Oral only	42.9	66.7	11.1	50.0	37.9
Oral or Written	42.9	0.0	0.0	40.0	24.2
Written only	14.2	33.3	88.9	10.0	37.9
Violation of terms	57.1	0.0	11.1	40.0	31.0
Agreement on Price Fixation:					
Purchase Prices	0.0	30.0	16.7	41.2	23.3
Sale Prices	0.0	30.0	12.5	41.2	21.7
Existence of Price Leaders	44.4	0.0	45.8	76.5	46.7
Number of Wholesalers	9	10	26	17	62

Source: CESA-MSU Food Security Project wholesaler surveys, 1986.

Note: The percentage of traders by form of contract and the percentage of traders reporting violation of contract terms relate to the number of wholesalers undertaking contract transactions.

historically ended up being granted to individuals who are not registered full-time cereals traders and often not traders at all⁶.

Contracts of the most common form, oral contracts, are based solely on personal confidence, which may erode quickly with the entry of relatively unknown newcomers in foodgrain trading (Staatz, Dioné and Dembélé 1988, 20). Oral contracts are traditionally backed by the "respect of the given word" among individuals with close personal and kinship relationships, and enforced through informal mechanisms without recourse to lengthy and costly court intervention. The reliability of the "given word" as a promissory note may decrease with the entry of new cereals traders, who have yet to develop strong links with other merchants and demonstrate credibility. In this respect, it is significant to note in Table 6-10 that 31% of the wholesalers who use purchase contracts or sales contracts reported violation of various contract terms (prices, quantities or time of delivery). No legal enforcement applies to oral contracts, as traders unanimously reported that all cases of violation are settled through informal "arrangements," which depend solely on the good will of the defaulting party. The general absence of longer-term contracting and the highly informal character of most existing short-term contracts provide very little long-term stability in expectations and therefore do not encourage long-term planning by either coarse grain producers or private traders.

6. For instance, of 32 persons identified in Bamako as having contracts with OPAM in 1986, only 6 were full-time cereals traders (Dioné and Dembélé, 1986b, p.12). This situation may also be changing because of recent developments. As of November 1988, OPAM has moved to a bid a tender system for contracts, which has apparently reduced the level of political influence in the awarding of contracts.

A final category of market constraints deals with administrative issues. Although only 5.1% of the sample wholesalers complained about licensing and administrative procedures and only 23.3% of them complained about frequent public inspection and fines, 70% of them reported having had to face payment of fines (Table 6-7). One of the main reasons for this apparent paradox is that, given the lengthy and costly administrative procedures required for licensing and regular trade practice, most traders prefer not to comply with official rules and therefore face inevitable fines that they avoid paying by simply "buying out" control agents of the Direction Nationale des Affaires Economiques (DNAE). To substantiate this point, data in Table 6-7 show that, except for Mopti, all wholesalers who reported fines also admitted making "arrangements" with DNAE agents in order not to pay the full amount of the fines. The exception for Mopti may be explained by traders' hesitation to report information on such a sensitive issue as corruption in a regional capital where 84.2% of coarse grain wholesalers did not comply with official regulations, and also by the fact that the cost of fine evasion is much closer to the actual average amount of the fines in Mopti (61.8%) relative to the other three cities (42.9% in Koutiala, 28.7% in Sikasso, and 33.7% in Bamako).

Private traders' concerns about the administrative regulations and controls of cereals trade were eloquently voiced at the October 1988 National Workshop on Cereals Marketing by a major Bamako import-export wholesaler, who suggested that (1) "private sector participants be informed of all regulation texts and their annual amendments," (2) "DNAE agents stop concentrating their efforts on suspicious controls," and (3)

"the government set the rules of the game once for all"⁷. These suggestions are particularly important in the search for increased participation, competition and long-term investment in private grain trade through the PRMC process. Merchants may often be suspected of being willing and attempting to collude to fix prices, and data in Table 6-10 show that about 20% of the sample wholesalers admitted agreeing on purchase and sale prices and 46.7% of them reported the existence of price leaders. Yet most of the alleged irregular practices for which traders are blamed find their deepest roots in the very lack of clarity, realism and stability of the official "rules of the game" (Newman, Sow and NDoye). While official regulations may change each year or often during the same year in the context of evolving general economic reforms, private sector participants are seldom consulted prior to, or thoroughly informed of, continuous changes in laws and administrative procedures, some of which are simply unrealistic. For instance, a proposed decree in 1988 required that (1) all foodgrain wholesalers hold a licence, (2) each licensed wholesaler keep at all times a minimum stock of 250 metric tons of grains and each semi-wholesaler a minimum of 25 tons, and (3) all these traders report to DNAE the level of their stocks and the list of their main suppliers and clients by the fifth working day of each month⁸. As Gagnon (1988) notes, such restrictive conditions create an atmosphere of confusion, suspicion, arbitrariness and uncertainty in private cereals marketing. In addition, they explicitly ignore prevailing liquidity constraints by requiring each

7. Communication of Gérard Achkar to the National Workshop on Cereals Marketing, Bamako, 18-20 October 1988.

8. This proposal was withdrawn following strong donor opposition.

wholesaler to immobilize in permanent grain stocks an investment of CFAF 25 million (which may exceed the value of total monthly sales of most small wholesalers). Under such circumstances, the best alternative available to private traders is very likely the strategy they have always adopted, i.e., to simply ignore official rules and subsequently strike personal "arrangements" with DNAE agents in order to avoid paying costly fines. In so doing, overt competition is likely reduced by traders' propensity to protect themselves by making their operations much less transparent.

6.6. Human Capital Constraints and Limited Farmer Organization and Participation in Rural Development Management

To paraphrase Professor Eicher, there is a significant difference between "investment in agriculture" (the extent of public expenditure on agriculture) and "investment for agriculture" (investment in the production of improved technologies, inputs, infrastructure and human capital). One of the universal prime movers of agricultural development remains "investment in people" (Eicher 1988, 14 and 21). Over the first three decades of "African independence," billions of dollars of "agricultural development funds" have been invested to promote growth in rainfed agriculture, irrigated agriculture, plantation agriculture, etc. Notwithstanding these efforts, the 1980s can be characterized as the decade of structural crisis-management reforms throughout the continent. If most of these reforms have tackled the problem from a policy and institutional standpoint, constraints regarding the human capital required at all levels in order to implement the recommended reforms successfully remain essentially unsolved. As a result, the main party that ultimately

determines rural development, farmers, remain the least represented at national debates on agricultural development planning.

Starting with the colonial era, Malian farmers have continuously been cut out of policy decisions that affect them. The basic assumption seems to have been that illiterate villagers cannot organize themselves and have therefore to be "organized" by more knowledgeable people. Accordingly, several forms of farmer organization and participation have been designed and implemented in a top-down approach by experts working for the central administration of rural development in Mali. Retrospectively, these organizations include the Greniers Villageois of 1910, the Société Indigène de Prévoyance (SIP) of 1919, the Associations Agricoles Indigènes (AAI) of 1932 in the Office du Niger, the Sociétés Mutuelles de Développement Rural (SMDR) of 1953 in the Mali-Sud region, the Groupements Ruraux de Production et de Secours Mutuels (GRPSM) and the Groupements Ruraux Associés (GRA) of 1960, and finally the Groupements Ruraux (GR) and Fédérations de Groupements Ruraux (FGR) of 1968 (Ministère de l'Agriculture 1987, 113-24).

All these pseudo-cooperative farmer organizations had the official objective of stimulating farmers' capacity to collectively defend their interests, and the above list may convey an impression of systematic efforts to help farmers achieve this goal. Nevertheless, none of these associations emerged from farmer initiative, and membership was compulsory. They were all designed by, and imposed from, the top, and have continuously been subjected to strong political interference regarding the choice of their leaders as well as how they should operate. Not surprisingly, these farmer organizations have served mainly as the most

effective instruments available to the central and the rural development administrations for tax collection, compulsory cultivation of collective fields by villagers and forced marketing of foodgrains at official prices. For instance, during 1966 and 1967, the FGRs owed CFAF 40 million in equipment loans to SCAER, whereas their contribution of CFAF 78 million to SCAER's capital was frozen (Ibid., 118). Moreover, farmer-cooperative "subscriptions" continue to be collected to feed budgets of regional administration. Finally, the FGRs supplied between 86% and 96% of the total quantity of coarse grains bought annually at official prices by OPAM from 1974/75 to 1977/78 (Ibid., 122).

It is only in the mid-1970s that more autonomous and active forms of farmer organization began to emerge in the CMDT zone. Frustrated by their lack of control over some critical cotton marketing operations (particularly weighing and valuing of output) arbitrarily performed by CMDT buying agents, farmers of a few villages required that these functions be entrusted to literate villagers (mainly school dropouts residing in the village). This proposal was well-received by the CMDT administration, which perceived this new strategy as an effective way of ensuring payment of delinquent loans contracted by farmers during the drought period of the early 1970s, through a shift of credit responsibility from individuals to farmers' associations. Thus, in agreeing to assume primary cotton assembly for CMDT, village associations also agreed to collect on behalf of CMDT individual loans due, therefore sparing CMDT the prospect of having to tarnish its image through coercive intervention for loan recovery.

Regardless of CMDT's acceptance motives, the form of farmer organization that emerged from this sharing of functions and responsibilities offers the considerable advantages of (1) accounting for farmer initiatives, (2) building on the tradition of village-level associations (particularly the ton), and (3) allowing increased direct participation of farmers in the design and the management of rural development activities. The success of these informal village associations (AV) was such that, prior to the political designation of the Ton Villageois (traditional name for village association) as the "the engine of grassroots development" in 1982, their number had grown in the CMDT zone from one in 1973/74 to 404 in 1980/81 (Ibid., 127). CMDT village associations (950 in 1986/87) have developed to become the most-preferred agricultural credit intermediaries for BNDA as well as the major final distributors of farm inputs and implements and primary assemblers of marketed output for CMDT.

In 1987, seven of our eight survey villages in CMDT had a village association officially approved for credit and input distribution, and output assembly, compared with only one of the eight villages selected in OHV, where the total number of officially approved associations has increased from 3 in 1983 to 52 in 1988 (Kagbo and Diarra 1988). It should be noted that the nationwide generalization of the Ton Villageois concept has proceeded so fast under political impetus that one may safely assume that most village associations created outside of the CMDT zone have not had time to grow autonomously around strong interests felt collectively by farmers. The danger is that farmers in the other rural development

zones may continue to perceive these organizations not as their own and to politely accept them with the greatest passivity.

Insights from the short experience of CMDT village associations already point to potentially significant development achievements through increased participation of genuine farmer organizations. First, once in charge of expressing whole-village demand for, and distribution of, farm inputs, equipment and credit, village associations may use their collective guarantee to extend access to formal credit and inputs to some small-farm households that would otherwise be excluded on an individual eligibility basis. Informal discussions with members of the village associations in our CMDT sample confirm such improvements in poorer farmers' entitlement to rural development resources.

Second, farmer associations are paid by rural development and credit agencies for the functions they perform in input and output marketing and credit management. Estimates of the Ministry of Agriculture show that in 1986/87, cash income generated from cotton marketing amounted to an average of half a million CFAF per village association in CMDT (Ibid., 128). With these funds, generally supplemented by autonomous village-level tax revenues, most CMDT village associations have been able to invest in collective actions aiming at improving overall living conditions in the rural area. Such actions include the acquisition and management of threshers, foodgrain mills and small irrigation pumps, the construction of functional literacy centers, schools, primary health care facilities, child-delivery centers, farm input warehouses, foodgrain silos, livestock vaccination parks, and sometimes even the private hiring of school instructors, veterinary agents, and primary health care personnel, etc.

(Coulibaly 1985; Kéita 1987). Some dynamic villages in CMDT have even moved forward to associate themselves and create mutual funds (e.g., the Caisse Mutuelle des Associations Villageoises, CMAV, of Kaniko) for collective savings and investment purposes.

Third, viable associations of farmers have gained direct access to BNDA seasonal credit for hunger relief (prêts de soudure, avances sur récoltes), cereals marketing and the constitution of cereals banks (prêts commercialisation-stockage villageois) in CMDT. These activities have not only a direct positive effect on farmers' food security, but also a beneficial impact on farm household incomes through the collective management of village marketed surplus of cereals. In 1986/87, for instance, a total amount of CFAF 668.9 million was contributed by PRMC (CFAF 500 million) and FED (CFAF 168.9 million) and mobilized through BNDA in loans to village associations for cereals marketing (BNDA 1988). Official records of BNDA show that, when rice producers of the Office du Niger (who received 65.4% of the total funds) are excluded, 52.2% of the total amount of loans went to CMDT village associations. This credit program enabled farmers to collectively manage the marketing of 6,021 metric tons of coarse grains bought during the early post-harvest period, stored at the village level and loaned to needy households or sold later when market prices rose. The cereals-bank component of such surplus foodgrain management offers one of the most viable solutions to seasonal household food insecurity in surplus production zones. In 1985, for example, the seven villages associated with the C.M.A.V. of Kaniko were able to assist 85 deficit households with a total of 7.3 metric tons of coarse grains loaned from cereals banks, and paid back with a 25% interest

in grains at harvest (Coulibaly 1985). Such positive initiatives are presently confined almost exclusively to CMDT, where the number of villages with cereals banks has risen from 6 in 1985 to 60 in 1988 (Dembélé 1988, 8).

Finally, through an aggressive demand for functional-literacy training, which was met by a positive response of the CMDT administration, village associations are in the process of inducing a major reform in agricultural extension strategy in CMDT. From 1981/82 to 1986/87, between 8,000 and 13,000 farmers have been registered each year in CMDT functional literacy centers (Ministère de l'Agriculture 1987, 128-29). Training programs include a broad variety of technical topics such as field measurement, equipment use and maintenance, elaboration of group and individual-farm records, improved crop and livestock production techniques, anti-erosion techniques, and farm management counselling. Starting in 1983/84, villages with a satisfactory level of progress in the functional literacy program and the management of credit and input distribution and output marketing are associated in Zones d'Animation et d'Expansion Rurale (ZAER). Each ZAER comprises six to eight villages. Each village association has technical teams of farmers specializing in such areas as field measurement, yield estimation, output marketing, veterinary care, primary human health care and hygiene, construction of improved mud-stoves, use and maintenance of cereals threshers and mills and irrigation pumps, functional-literacy training, extension of technical packages recommended by CMDT for crop and livestock production, etc. (IER 1985). In 1987, the CMDT zone had 18 ZAERs, which covered a total of 123 village associations. The CMDT administration is gradually transferring

field-level extension activities to these farmer organizations, while converting its own extension agents into technical instructors and advisors to the technical teams of the ZAERs. As may be expected, this recent innovation in increased farmer participation in the design and management of rural development may contribute to further widen the gap in growth between the CMDT zone and other rural areas of Mali.

6.7. Summary and Policy Implications

This chapter has identified some major institutional constraints on the coarse grain production and distribution system. Despite very similar endowments in natural resources (land, soils, water) and labor, there are significant institutional differences between the CMDT zone and the OHV zone, which explain to a large extent the superior agricultural performance of CMDT over OHV. First, as a rural development zone, CMDT has benefited from a continuity and a gradual evolution of its goals, priorities and strategies since the early 1950s. Its development strategy has been continuously centered on cotton, a strong export crop capable of generating sustained and substantial incomes, which subsequently served as the main support to further diversification through the gradual development of additional production activities (cereals, livestock, non-farm, etc.). The success of CMDT relative to other rural development zones results from a cautious and sustained cumulative growth process. In contrast, OHV has suffered frequent shifts in its official development goals, priorities and strategies since 1964. As a result, OHV has not been able to systematically build on its past efforts in order to move one step higher at each of its rural development planning stages.

Second, cotton income, affiliation with the French CFDT and a relatively strong research/technical base have allowed CMDT to gain a strong financial status. This financial strength has enabled CMDT not only to sustain most of its credit and input distribution efforts with its own resources, but also to enjoy a privileged access to funds of formal financial institutions for the benefit of its farmers. Consequently, unlike their peers in OHV, CMDT farmers have not been penalized by frequent and major disruptions in formal credit and farm input and implement distribution caused by the erratic evolution of the agricultural credit and input distribution systems at the national level.

Third, the operational linkages between cash-crop production and agricultural credit and input distribution have always provided CMDT farmers an effective entitlement to rural development resources. This access and the autonomous financial capacity that cotton income confers to farms mainly explain why, in 1985, about two-thirds of our sample farm households in CMDT owned at least a plow and a pair of oxen as compared with only one third of the farms in OHV. In addition, during the same year, as many as 81% of the survey farms in CMDT and only 17% of those in OHV used chemical fertilizers. Such differences in effective access to formal credit and input markets largely explain the significant gaps in labor productivity and yields between CMDT and OHV farmers, as discussed in Chapter IV.

Fourth, in spite of the official liberalization of the cereals market, several constraints have limited the potential effects of market incentives on coarse grain production. Limited own-working capital and poor access to bank credit have reduced private merchant specialization

in large-scale cereals trading and long-term investment in storage facilities and transportation means. Other factors contribute to destabilize private traders' expectations and to induce them to adopt very short-run planning and strategies. These include domestic supply uncertainties caused by fluctuating rainfall, and demand uncertainties resulting from the combination of unforeseen interventions of the public marketing system (OPAM) and food aid distributors, and from government's failure to meet its payroll on time. Sub-optimal planning under unstable expectations also results from additional uncertainties about official cereals marketing policies and regulations, which change constantly without prior consultation with, or notification to, private traders.

Finally, severe human capital constraints prevail at all levels, especially for farmers who, because of illiteracy, are seldom associated with the design and management of rural development activities, and continue to be perceived as passive recipients of, and participants in, these activities. The pioneering efforts made by the CMDT administration for increased farmer literacy and direct participation in rural development management point to potentially significant effects of genuine farmer organizations on growth and improvement of overall living conditions in the rural area.

Three broad lessons emerge from the above facts. First, for rural development projects to induce significant economic growth, planning should be undertaken so as to ensure a cumulative growth process, which may be sustained over the long term by a selective use of the natural and human resource endowments of each region. As far as areas with the highest potential for agricultural production are concerned, the CMDT

example shows that priority should be given to the identification of, and continuous investment in, a major cash crop, which may generate substantial income in order to finance additional development activities. In this sense, economic output expansion priorities should be defined for viable cash crops and nonfarm activities, and sustained over the long term. Rural development administration and institutions (credit system, input and output markets, research, extension, etc.) should be tailored to fit these priorities. Investment in cash crops does not mean ignoring research on coarse grains, however, since there is a clear synergy between cash crops and food crops. Indeed, farmers may be reluctant to expand into cash crops until their own foodgrain production is sufficiently assured.

Second, rural development should aim more at investing for agriculture than investing in agriculture. For farmers to become the true engine of agricultural development, substantial direct investment should be made to train them in order to facilitate and promote the emergence of their own organizations, which should be allowed to participate increasingly in the design and the management of rural development activities. Because of potential benefits of collective bargaining, an explicit financial-assistance effort to help farmers manage collectively their marketed surplus grains might have a positive effect on producer prices.

Farmers (not OPAM or private wholesalers) have always been the main holders of seasonal and inter-annual stocks of cereals in Mali. This suggests that storage at the village level is cost effective. In fact, given the short distances between supply sources and consumption centers, wholesalers in cities and towns located within surplus production zones

need not be pushed into costly investment in large-scale and relatively longer-term storage of domestic cereals if they could have continuous access to bulk village-level stocks virtually on a daily basis. Such access requires investment in roads, in order to adequately link cereals-surplus villages to the consumption centers, especially during the rainy season. It also requires good information on demand in the system.

Increased reliance on farmer organizations offers the additional advantage of incorporating farmers' own initiatives in the identification of priorities and the design and the implementation of rural development activities. Such initiatives may prove superior to those coming from top levels of rural development planning and administration, as illustrated by the potential improvement in poorer farmers' access to credit, inputs and seasonal foodgrain loans (from cereals banks) resulting from collective actions of village associations. For these reasons, the potential contribution to food security from investment in, and increased participation of, farmers' organizations should not be overlooked.

Third, our analysis clearly shows that market liberalization alone is not sufficient to overcome imperfections in cereals marketing. Private traders' uncertainties about the continuity of policies and regulations should be reduced through clear and stable political choices, of which all private sector participants should be thoroughly informed. These policies and regulations should be defined so as to allow the maximum flexibility (easy conditions of entry, realistic taxation, less cumbersome and costly administrative procedures and economic controls, less rigid management conditions, etc.) required for the daily adjustments that traders must make just to keep their business viable.

Likewise, supply and demand uncertainties should be reduced to the extent possible through the implementation of a market information system capable of generating, organizing, processing and diffusing nationwide data on supply and demand conditions as well as information on policy and regulations on a timely basis. The CESA/MSU research project is already collaborating in the implementation of such a system. This initiative requires, however, a strong political commitment to devote significant investment to the building and the maintenance of domestic institutional capacity. There is also a need to go beyond market liberalization and market information and search for feasible measures to help stabilize the coarse grain market. Given the residual nature of this market, such measures could include freeing regional and international trade, developing a grain-fed livestock industry, and developing easier-to-prepare forms of coarse grains that could substitute for rice.

Finally, the severe liquidity constraints that inhibit the overall performance of the private cereals market should be tackled not only with donor financing, but more in structural terms through the systematic search for alternative mechanisms conducive to increased cereals trader eligibility for bank credit in compliance with BCEAO regulations. Given the disqualification of the Chamber of Commerce and Industry as a guarantor for wholesalers' loans, OPAM may continue to play this role (as approved in 1988) as long as it does not intervene as a public sector competitor to these same traders in buying and selling operations. After all, as a public-sector agency, the role of OPAM should evolve toward supplying public goods (information, public guarantees, elaboration of standard grading systems and contract mechanisms, generation of improved

marketing technologies and facilitating services, etc.) to private cereals market participants.

CHAPTER VII

SUMMARY AND IMPLICATIONS FOR POLICY MAKERS AND FURTHER RESEARCH

This study was carried out in the broader context of a major research effort on food security in Africa. The African continent has been stricken by a severe food crisis characterized by a decline in per capita food production at the annual rate of 0.3% in the 1960s and 1.2% in the 1970s. The Sahelian countries (of which Mali is one) have been among the areas most affected by this crisis. Although the prolonged drought of the early 1970s contributed to making the food production gap more visible, Africa's food crisis did not result from bad weather alone. The food problem stemmed mainly from a complex set of political technical and structural constraints. In most countries, agriculture has been given a low priority in development plans and budgets. These plans have historically been designed without adequate information on the agricultural and food systems. Moreover, in the absence of improved technologies, negative pricing and taxation policies have reduced farmers' capacity and distorted their incentives to increase food and agricultural production.

This study was based on research carried out explicitly to inform food security policy in Mali. It used mainly primary data collected in 1985-1987 at the level of four rural markets, four wholesale markets, and a panel of 190 farm households and 118 wholesalers, to investigate the

major constraints on farmers' and private traders' capacity and willingness to invest in new activities so as to improve the overall performance of the foodgrain production and distribution system. The analyses were carried out at three different but complementary levels. First, both tabular analysis and econometric techniques were used to examine the effects of agroclimatic factors, institutional environment and farm equipment on farmers' coarse grain production, transactions and net foodgrain availability, within the general framework of the farm household as a production and consumption unit. Second, within a general framework of entitlements, major institutional and policy constraints on farmers' investment in improved production technologies were examined, with an emphasis on the process of investment and disinvestment in animal traction. Finally, institutional constraints to the vertical coordination of the rainfed foodgrain subsector were examined, taking into account the priorities and strategies of the rural development agencies, agricultural credit and input distribution systems, output markets, and the extent of farmer organization and participation in agricultural development management. This analysis focussed on comparisons of the institutional settings in two of the best agroclimatic zones in Mali: the CMDT cotton-production zone and OHV.

Several lessons emerge from these analyses in relation to both current food and agricultural policies, and areas of focus for further research on food security in Mali.

7.1. Summary of Findings and Related Policy Implications

Mali is currently reforming its economic system. From a radical socialist orientation during the first eight years of independence, and after two decades of heavy state control the Malian economy is moving gradually toward more reliance on the free market in the 1980s. Foodgrain market liberalization through the Cereals Market Restructuring Program (PRMC) still remains the single most important economic reform implemented to a certain level of satisfaction to date. However, in the absence of strong empirical information on the structure and the conduct of the domestic cereals production and marketing system, the PRMC was initially designed and launched on the basis of several preconceptions of both donors and the Malian government. This study has shed some light on these assumptions and additional policy actions needed as complements to product market liberalization in promoting increased production and improved distribution of cereals.

7.1.1. Price policies

The PRMC was launched with the two major price policy objectives of "getting prices right" under legal private trade and supporting producer prices via public sector purchases at increased official prices. The goal was to raise farmers' income and incentive to produce more cereals for the market. These objectives were formulated on the basis of the implicit assumptions that official prices were a significant determinant of actual cereals prices received by farmers. Most of the farmers were also perceived to be net sellers of foodgrains and to have the willingness and

capacity to respond to higher prices by increasing cereals surplus production for the market.

Yet neither "getting prices right" nor supporting producer prices are simple solutions to food insecurity problems. This study has shown that increased foodgrain prices are clearly not beneficial to a significant group of farmers in the short run. Even during two good rainfall campaigns such as 1985/86 and 1986/87, about 43% of the farm households of two of the best agricultural zones of Mali (CMDT and OHV) were net coarse grain buyers. The proportion of net cereals buyers among farm households was even higher in low rainfall northern subzones (54%), in zones with a weak rural development institutional framework such as OHV (72%), and for farms with a low level of animal traction equipment (52% for semi-equipped farms and 62% for non-equipped farms). Moreover, net coarse grain sales were highly concentrated at the level of few farm households. Of the total quantities of net sales during the two years, 90% came from 28.4% of the farms, 77% from farms in the more humid southern subzones (49% of the farms of the sample villages), 94% from farm households of the institutionally privileged CMDT zone (66% of the farms of the sample villages), and 71% from farms owning a complete set of draft equipment and animals (36% of the farms of the sample villages). In addition, market prices applied directly to only 61% of farmers' coarse grain outflows, 39% of these transactions being made in the form of gifts.

As indicated by the above findings, what Timmer, Falcon and Pearson (1983) have termed "the food price dilemma" clearly applies in this case. In the short term, higher coarse grain prices benefit mainly fewer than one third of the farm households, while depressing the real income of 43%

of them who are net cereals buyers. The equity implications of official support of producer prices are even more important when one considers that the bulk of the benefits accrue to the wealthiest farmers of subzones which enjoy the best rainfall and soil conditions, the highest level of farm equipment and the best institutional supporting services. In the absence of reliable estimates of coarse grain supply responsiveness to prices for these privileged farms, it is difficult to say much about the long-term effects of these short-run benefits on future consumer prices of cereals and employment opportunities and wage levels for the rural poor. However, it is safe to assume that, given the generally low price elasticity of agricultural supply in developing countries and the context of relative low-level stagnation of agricultural technology in Mali, higher producer prices will need a long gestation period and strong complementary investment in research, extension and other supporting services before they induce any significant effects on foodgrain availability and the incomes of the rural poor.

Beside such equity concerns, the feasibility of raising producer prices through schemes of public buffer-stocks in the Malian context of general poverty, great production variability due to weather and thin cereals market is highly questionable. The example of the 1985/86 cereals marketing campaign is quite instructive in this respect. There was no indication that private market prices were held below market clearing levels. Despite record official purchases enabled by an unprecedented financial support from PRMC donors, OPAM failed to maintain actual producer prices of coarse grains close to the official price-target beyond the four months (December 1985 - March 1986) covered by its buying

operations. Moreover, because of a second good harvest in 1986 and in spite of a limited donor-sponsored seasonal credit program for private traders and farmer associations to support producer prices, not only did OPAM fail to rotate its previous year's buffer stock, but also average actual producer prices of coarse grains fell by 25.8% in 1986/87 relative to 1985/86.

The above arguments have two major policy implications. First, ambitious producer price support and stabilization policies through direct public sector involvement in surplus production management are financially and technically unsustainable policy options for Mali presently. Alternative measures such as the elimination of export bans or costly licensing procedures for cereals exports even in years of good harvests are likely more feasible ways of preventing producer prices from falling drastically. Similarly, the promotion of new outlets for coarse grains (e.g., developing a grain-fed livestock industry and easier-to-prepare forms of coarse grains that could substitute for rice) may also be an effective way of increasing the demand for coarse grains and help support producer prices, while providing the population of some rural areas an additional source of income. Second, producer price support efforts should not overlook policies that enable farmers to collectively manage the supply of their marketable surplus foodgrains themselves. As discussed in Chapter IV and Chapter VI, a greater financial support to, and participation of, farmers associations in cereals marketing would not only improve the efficiency of private traders' operations by raising the scale of assembly transactions from their current atomistic levels to bulk village-level deliveries, but also give farmers a greater collective

bargaining power. In addition, such collective supply management would promote the constitution of village-level cereals banks, which may improve deficit rural households' access to seasonal foodgrain loans at below rural market-level prices charged by private traders.

7.1.2. Fiscal policies

In dealing with cereals market restructuring, the PRMC has overlooked important interactions between agricultural product marketing and price policies on the one hand, and fiscal policies on the other hand. Our analysis has shown that fiscal policies have important effects on both farmers' capacity to take advantage of product price incentives and farmers' capacity to invest and preserve their investment in agricultural production. In zones with marginal or no cash (export) crop production such as OHV, farm households' foodgrain sales do not necessarily reflect a real marketable surplus. For instance, of all farm households that sold coarse grains in OHV, 74% in 1985/86 and 72% in 1986/87 had per capita production below 188 kilograms. In other words, 37% of OHV farmers in 1985/86 and 25% of them in 1986/87 sold cereals without producing any real surplus beyond home consumption requirements. These compulsory sales were mainly caused by head tax liabilities, as 51% of coarse grain sellers in south OHV and 92% in north OHV reported the payment of head taxes as the most important reason for their sales in 1985/86.

Both the level and the timing of the collection of head taxes have negative effects on farm households' food security. In 1985/86, these taxes amounted to a proportion of the value of total households' coarse grain production of about 12% in south CMDT, 14% in north CMDT, 18% in

south OHV, and 23% in north OHV. In addition, head tax collection during the immediate post-harvest months (December-April) forces most deficit farmers (especially those without substantial income from cash-crop production or non-farm activities) to sell their grains at low market prices, and to subsequently buy or borrow cereals during the lean months of the hungry season (May-August) when prices increase. Hence, most of the poorest farm households are unable to take advantage of price incentives in the liberalized cereals market simply because fiscal policies prevent them from adopting optimal transaction strategies, i.e., buying during the harvest period and/or selling later when prices rise as the rainy season approaches. The sub-optimal transaction strategies of these farmers are in part attributable to the absence of well-functioning financial markets in rural areas. If farmers could borrow enough money to meet their cash needs in a timely way, they would be able to plan their foodgrain sales and purchases so as to draw maximum advantage from the private cereals market. Lacking adequate access to cash financing, poor farmers have little freedom in timing their grain transactions and must often engage in informal loans in kind to feed their households.

In addition to this negative effect on farm households' food security, direct head taxation also constrains farmers' capacity to invest in more productive technologies. Weak self-financing capacity and limited access to credit were reported as the most important constraints to investment in animal traction by 44% of the sample farm households in south CMDT, 60% in north CMDT, 96% in south OHV and 98% in north OHV. This financial constraint is compounded not only by indirect farmer taxation through official cash-crop price schedules (24% to 61% for cotton

and 48% to 65% for groundnuts, relative to world market prices), but also by head tax collection during years of low farm income following crop failures caused by drought. Thus, about two-thirds of the OHV sample farmers who have historically invested in animal traction have also disinvested because of cash needs to face both household food shortages and head tax payment in years of bad harvests.

Fiscal policies directed toward the rural sector clearly conflict with other policies aiming at promoting more investment in agricultural production. Head tax rates exceed the real agricultural surplus that can be extracted without endangering long-term productive capacity in most zones lacking a strong cash-crop production. The rough proxies (e.g., soil characteristics, rainfall regime, dominant crops, presence of rural development agencies' activities, etc.) used as indicators of potential income for tax purposes do not properly reflect actual levels of taxable income, and need to be progressively complemented by empirical budget information for different categories of households in the present tax administration districts. Outright annual tax exemptions should also be considered for the entire population of zones which are stricken by substantial income shortfalls during periods of drought, in order to avoid such hardships as heads of households having to flee their villages to avoid severe sanctions for being unable to pay their taxes. Moreover, the determination of tax rates should take direct account of farm investment needs, and allow farmers who acquire expensive implements such as animal traction equipment to benefit from the same types of tax exemptions currently granted to investors of the industrial sector over the first few years of their investment. It should be emphasized that short-term tax

incentives are critical for future investments in agricultural equipment, and therefore for the long-term capacity of the agricultural sector to generate greater taxable income and tax revenue on a sustainable basis.

Heavy taxation was also reported by coarse grain wholesalers as one of the most important constraints to private cereals marketing in Mali. They argued that tax rates of up to 55% of net trade revenues estimated on the basis of rough indicators of their business volume, inhibit the propensity to invest in visible marketing assets (e.g., warehouses, heavy trucks, etc.). In addition, such high tax rates likely induce traders to avoid a greater transparency in their operations--that is to limit or bias market information flows--by corrupting economic control agents in order not to comply with administrative regulations requiring them to report accurate information about their transactions. These negative effects on both traders' willingness to invest and government budget revenues should be avoided by the fixing of more realistic tax rates that traders would be willing to pay legally.

7.1.3. Agricultural research institutions and policies

Major weaknesses in commodity research are strongly associated with the slow growth rate of agricultural production in Mali. Since 1960, there have only been significant improvements in yields for cotton (5.5% per year) and maize (3.1% per year), two crops grown predominantly in the cotton production (CMDT) zone. The relative success in cotton and maize is essentially attributable to the progressive development and use of improved inputs (particularly fertilizers, selected seeds, better tillage techniques), which were effectively adapted and extended by CMDT, thanks

to its connections with the French commodity research networks of IRCT (on cotton) and IRAT (on cereals).

In contrast, millet and sorghum (the two principal foodgrains) continue to be cultivated under traditional low-input techniques, mainly because of the lack of improved technologies on the shelf. There will likely not be significant long-term increases in the production of these coarse grains without considerable commodity-research efforts to develop and extend more productive technical packages (especially seeds, fertilizers), which are more adapted to the weak financial capacity of the various categories of farms and the low and fluctuating rainfall conditions of most of the ecological zones of the country. Such long-term efforts require an intelligent technology-borrowing strategy, and strong political commitment to building the capacity of the network of agricultural research institutions, which are currently characterized by overstaffing with undertrained and underfunded junior researchers and the absence of an incentive system of rewards.

7.1.4. Priorities and policies of the rural development agencies (ODRs)

Our comparative analysis of farm household coarse grain production and transactions in CMDT and OHV has shed some light on how the synergy between cash crops and food crops and differences in the performance of the institutions in charge of the management of rural development may lead to considerable productivity gaps between regions with similar agro-climatic resource endowments. In addition to being the largest producers of cotton in Mali, CMDT farmers also produced 2.5 to 3 times as much coarse grains per capita as OHV farmers in 1985 and 1986. After net

transaction outflows amounting to 10.3% of their total production, CMDT farm households had enough coarse grains to meet their home consumption needs (at 188 kg per capita per year) and constitute security stocks equivalent to 15 months of home consumption during the two good crop years of 1985/86 and 1986/87. In contrast, despite net purchases amounting to almost 16% of their own production, the net quantity of coarse grains available per capita fell short of 188 kg per year for OHV farm households in both years.

These differences in foodgrain production and transactions were significantly associated with differences in cash-crop production strategies and opportunities (and therefore farm income) between CMDT and OHV. For instance, of the sample farm households in CMDT, 90% produced cotton, 92% had access to formal agricultural credit, 87% used ox-plows, and 81% used mineral fertilizers. In OHV, only 15% of the sample farms cultivated cotton, 29% of had access to formal credit, 49% used plows, and 17% used mineral fertilizers. For the sample farm households and the two crop years covered by our study, each 10% increase in the area cultivated under cotton was associated with a 5.5% increase in coarse grain production. The main factor underlying this complementarity between cash crop and food crops in a global agricultural growth process is capital formation through improved technology and increases of farmers' income. Cotton income gives farmers a better access to agricultural credit, improved farm inputs and extension services, all of which have direct or indirect beneficial effects on coarse grain production. In addition, cash income from cotton allows cotton producers to meet most of their fixed cash liabilities and adopt coarse grain transaction strategies which

enable them to take advantage of price incentives in the liberalized cereals market. Such opportunities are seldom open to farmers with marginal or no cash crop production.

Hence, relative to OHV, the success of CMDT in promoting foodgrain production was achieved through a strategy centered on a vertically coordinated set of activities (research, extension, input and credit distribution, and output processing and marketing) for the long-term growth of cotton production and income. This income served as an engine to support gradually the development of food crop production and non-crop activities. In contrast, the OHV zone has not been able to build long-term cumulative growth, mainly because of the lack of a dynamic combination of activities that are conducive to capital formation.

The main lesson that emerges from these comparisons is that agricultural development policies should aim primarily at increasing farm households' total income instead of self-sufficiency in cereals in a narrow sense. The weak capacity of OHV farmers to profitably absorb and repay formal agricultural credit suggests that coarse grains alone cannot support sustained investments in farming, given the thinness of the market for these staple foodgrains. As a consequence, a better growth policy for the relatively high rainfall zones would require the identification and the long-term prioritization of a limited number of high-value crops, which can generate an increasing stream of income to support progressive investment in other rural activities, including food-crop production. Cotton and tobacco are examples of such crops suited for the southern part of the OHV zone. The prioritization of these two cash crops in OHV development planning should not be overlooked as a cost-effective strategy

to increase farmers' overall income and their capacity to produce more foodgrains for their own consumption and the market.

In the more arid agricultural areas, farm household food security may be better achieved not only through the development of drought-adapted technologies for crop production (especially drought-resistant varieties), but also importantly through the promotion of non-crop activities (particularly livestock production and handicrafts), which constituted the major sources of income used by grain-deficit farm households in north OHV to buy the complement of cereals needed for their consumption.

Such a strategic approach to rural development significantly diverges from the integrated rural development approach followed in most ODRs and the traditional food crop - cash crop dichotomy, which is almost irrelevant in the CMDT case where there was growth in cereals production mainly because of the growth in farmers' income from cotton production. In this sense, to achieve long-term food security, the search for a sustainable and cumulative income growth and strategic reinvestment process becomes more relevant than direct self-sufficiency in foodgrains at any cost.

7.1.5. Formal credit and input distribution policies

Financing appeared to be the single most important constraint to investment in animal traction (the most successful new agricultural technology in Mali to date). For instance, the gross value of the total 1985 coarse grain and cotton production of the non-equipped farm households in our sample could merely cover 30% to 50% of the acquisition

costs of a simple plow and a pair of oxen in north CMDT, and in both the south and the north of OHV.

On the other hand, analysis of the institutional factors underlying farmers' capacity to produce and sell foodgrains indicates a clear focus of the formal credit and farm input distribution systems on cash crops. This trend is justified to the extent that the viability of credit and input distribution institutions requires dealing with solvent farmers, i.e., farmers who are involved significantly in the production of crops with a strong and reliable effective demand. Given current institutions and the strong synergy between cash crops and food crops, the promotion of the production of high-value commodities such as cotton is a precondition to the improvement of farmers' access to formal credit, which in turn constitutes a necessary condition for farmers' investment in most purchased improved agricultural inputs.

Besides this issue of general access, small farmers' individual access to agricultural credit and inputs may be improved through a greater participation of autonomous farmer associations in deciding who is eligible for seasonal or long-term agricultural loans. Through their collective guarantee, farmers' associations can extend credit and input distribution to some small households, which would otherwise be excluded from such services under individual eligibility conditions based on farmers' current cash production capabilities. In addition, the collective management of agricultural loans by village associations would facilitate an eventual participation of the private sector in financing farmers' investment, if other barriers such as subsidized interest rates and input ceiling prices were removed. Farmers' associations should

therefore be encouraged and trained to manage farm credit and input distribution collectively at the village level.

Financing was also perceived as one the most binding constraints to the development of cereals marketing by half of our sample coarse grain wholesalers. Lacking adequate investment and working capital, domestic foodgrain wholesalers were seen to follow very short-term transaction strategies with a rapid (one to three weeks) turnover of their stocks of grain. Although some efforts are being made with strong donor support to improve traders' access to seasonal credit for cereals marketing, more institutional and policy reforms are needed to solve the financing problem of the foodgrain market in a long-term perspective. A structural solution to cereals traders' poor access to formal loans would require the systematic search for alternative mechanisms conducive to increased trader eligibility for bank credit in compliance with the regulations of the central bank of the West African countries (BCEAO). In addition, such eligibility should not be limited to seasonal credit; it should also include long-term credit for investment in marketing facilities, especially the construction of warehouses and the acquisition of adequate transportation means for wholesalers who supply chronically deficit regions in remote locations from the major surplus zones.

7.1.6. Private foodgrain marketing and trade regulations

The analysis of the institutional constraints to increasing coarse grain production and marketing has also shown that market liberalization is not sufficient by itself to build a well-functioning cereals market. Private traders of coarse grains face at least two broad types of

uncertainties. First, these traders must cope with an uncertain supply of grain due to the vagaries of the climate, and demand uncertainty resulting from sporadic liquidity crises at the level of their clients and unforeseen distribution of imported foodgrains (mainly food aid) at below-market price levels. Second, private traders have to deal with uncertainties about the continuity of policies and regulations (entry conditions, licensing, credit conditions, stock-holding, taxation, etc.), which change constantly without traders being consulted beforehand or thoroughly informed afterwards.

Not surprisingly, most coarse grain wholesalers in our sample showed a propensity not to comply with official policies and regulations (which are often unrealistic or too rigid), with the obvious consequence of having to face costly fines, which they tended to evade by paying off state control agents. The negative effects of such an uncertain policy environment on traders' expectations and behavior should be reduced through the definition of clear regulations that allow the maximum flexibility required for the daily adjustments necessary to keep private coarse grain trading viable. The role of the public sector in foodgrain marketing should evolve toward supplying public goods (e.g., information, public guarantees, standard grading systems and contract mechanisms, improved marketing technologies and facilitating services) to private cereals market participants. In this respect, a major political commitment should be made to sustain and further develop the initial efforts (currently made collaboratively by OPAM and the MSU Food Security Project) in building domestic institutional capacity to generate, analyze

and disseminate to all market participants in a timely way critical information about market supply, demand and regulations.

7.1.7. Evolutionary nature of policy reforms

This study has presented a snapshot of the coarse grain market as of 1985/87. The numerous references to on-going food-security research efforts clearly indicate, however, that the economic reforms undertaken by the government of Mali are not static. In light of research findings, policies continue to be improved with strong donor support in several domains such as the financing of private marketing, market information, and private trade regulation. Such progress needs to be sustained, since a well-functioning cereals market helps improve rural food availability. More reliable food markets induces adoption of cash crops and new technologies. Hence, there is also a clear synergy between policy reforms, technology adoption and capital formation. This dynamic should be taken into account to foster more reforms of the foodgrain production and distribution system.

7.2. Implications for Further Research

This study has identified some of the determinants of farmers' and traders' behavior in the rainfed foodgrain subsector in Mali. However, the type of data collected and used in the preceding analyses, as well as the conclusions reached, remain limited to the extent that the information gaps--which primarily motivated the study--could not all be filled given the limited human, financial and time resources of a single study. As a consequence, follow-up research is needed at several levels to refine and

complement the findings of this study. From a methodological standpoint, we learned that reliance on farmers' and traders' responses could be a viable and cost-effective way of collecting relevant information to inform on-going policy reforms in the poor data and information context of African countries such as Mali. Although such investigation methods may lead to a certain degree of imprecision during the initial stage of their implementation, it appears that the overall quality of the information collected increases through an iterative process, whereby the respondents learn to trust the researchers and the enumerators and to remember and report more accurately requested information. In this sense, the cost of imprecision during the experimental stage of these survey methods could be more than offset by longer-term gains in information efficiency.

Chief among these gains is the timeliness of the analysis and dissemination of data to monitor and inform on-going policy reforms. For research to be useful for both short-term and long-term policy decisions of policy-makers, research results should be extended on a timely basis to policy-makers, whose feedback should be taken into account to shape the next round of research activities. This iterative process obviously requires a certain tradeoff between the degree of precision and refinement used, and the timeliness of the release of the empirical information. Eventually, a critical mass of data becomes available. In the meantime, it is appropriate to experiment with alternative streamlined methods of data collection, while testing their degree of precision relative to more costly and time-consuming direct observation techniques. For instance, the precision of the production data estimated from farmers' responses

according to their own units of measurement should be tested against production estimates from direct field-level measurement techniques.

Our study has relied heavily on categorical proxies for most of the variables at stake. As a result, the bulk of our conclusions relate to major trends and not the precise level of association between the factors investigated. Such a level of precision for forecasting requires additional research for more detailed (and continuous) information on several of our main variables.

Although clear interactions were found between foodgrain production, transactions and net availability on the one hand, and cash-crop production and non-crop activities on the other hand, these relations could be estimated with some degree of detail only for cotton, for which estimates of the actual area cultivated could be directly obtained from the sample farmers. To fully understand the linkages between food production and security, and non-food activities, more detailed research is needed on the level of income that farm households earn from cash crops and non-crop activities, and on the effect of this income on foodgrain production, transactions and farmers' food security. Special attention should be paid to understanding the dynamics of nonfarm enterprises, and the synergy between these activities and farm production and food security. A detailed study should specify the types of non-farm activities performed by different categories of farm households (e.g., farm households of different sizes, different equipment levels, and different agroclimatic subzones) and household members (men, women, children, etc.), the interactions between agriculture and these activities, and strategies to promote their growth. The relationships among

alternative enterprises and farm household total income need to be investigated and documented in more detail to allow policy-makers to define priority growth strategies that take explicitly into account the synergies between food crops, cash crops and nonfarm activities.

Similarly, our proxies for the production technology used by farmers (a limited number of levels of animal traction equipment) could not provide a full understanding of the effects of different technical packages on foodgrain production. In-depth farm production studies are required in order to disentangle the effects of various techniques of tillage, the use of mineral fertilizers, and the overall management skills of farmers on farm production and income. Such studies are also needed to determine different technical packages suitable for farm households of different sizes and different levels of income.

Our study also fell short of tackling the food security problem from a nutritional standpoint. Although coarse grains constitute the main source of calories for the farm population of the survey zones, other important food items (cowpeas, chick peas, sweet potatoes, yams, fruits and vegetables, fish, meat, etc.) are also consumed. Moreover, our analysis of net foodgrain availability was carried out at the aggregate farm household level and did not take into account intra-household and seasonal distribution of the net stocks available. These stocks were not directly observed, but estimated indirectly using production and transaction data without any precise information about the level of carryover stocks at the beginning of the 1985/86 crop year. More detailed research on farm-level storage and consumption/nutrition (such as the nutrition survey being carried out by Sundberg in conjunction with the

CESA-MSU research project) is required in order to further substantiate the findings of this study.

In a broader sense, a detailed work on intra-household economics is necessary to shed light on the roles of men and women within the household, the impact on household food security of intra-household distribution of roles and income, and the effects of various food and agricultural policies on the contribution of different categories of household members (men, women, children, migrants, etc.) to household food security and general welfare. Some of these aspects are already being examined through CESA-MSU investigations by D'Agostino and Sundberg on farm household strategies for coping with food insecurity. These efforts need be complemented with more detailed intra-household economic studies.

Non-market cereals transactions deserve special attention. The importance of coarse grain gifts relative to market transactions has been emphasized throughout this study. However, most of our explanations of the phenomenon of gifts remain tentative to the extent that additional information was not available to support our conclusions empirically. An important research effort could evolve around the hypotheses that the substantial gifts observed either result from market imperfections--i.e., the existence of a "gift market" parallel to the cash market--or reflect the mechanisms of a rural-rural and rural-urban insurance market. In both cases, an in-depth understanding of why farmers give away a significant proportion of their cereals production may have important implications for foodgrain marketing and food security policies.

Related to the above is the need for a better understanding of the structure, conduct and performance of formal and informal rural financial

markets in Mali. As argued previously, farmers' investment, foodgrain market-transaction strategies (particularly the timing of sales and purchases) and non-market transactions (substitution of in-kind "gifts" for cash) are influenced by their access to financing. A study of rural financial markets would therefore enable researchers to inform policy-makers on the effects of poor access to cash loans on household productivity and food security in rural areas, and policy alternatives for the improvement of rural financial markets in complementarity with cereals market reforms.

Research is also needed on alternative institutional forms or arrangements of farmer participation in managing some of the traditional functions of the rural development agencies, including village-level credit and input distribution and coarse grain assembly and storage. It has been argued in this study that one of the future strengths of the CMDT development approach may reside in the promotion of active farmer associations, which may improve farmers' access to credit, inputs, extension services and foodgrain loans through village-level cereals banks. The extension of the CMDT experiment to other zones requires careful study of the conditions for success of such collective organizations.

This study also covered only the case of good rainfall years in the most favorable agricultural zones in Mali. There is need to include more years of data analysis to permit insights on the changes in farmers' and traders' strategies in years of poor harvest. Likewise, our comparisons of the southern and northern subzones of two favorable zones do not shed enough light on food crisis in the least favorable rural areas. Case-

studies of truly unfavorable zones (300 millimeters of annual rainfall or less) are needed in order to broaden knowledge on food insecurity in rural Mali.

Finally, as time-series market data build up, attention should be paid to cereals supply and demand studies, which would enable researchers to inform policy-makers more precisely on expected farmers' and consumers' responses to various policies. Such studies would be very instrumental in investigating the major macro-micro linkages of the foodgrain subsector in Mali. Very little is presently known on how macroeconomic policies (e.g., exchange rates, taxes and subsidies, tariff and non-tariff trade barriers) affect the domestic foodgrain production and distribution system. A priority study of fiscal policies aimed at the rural population is indispensable in order to ensure consistency between the the fiscal burden of head and product taxes--which affect negatively both farm household food security in the short-run and farmers' long-term investment and productive capacity--and on-going policy reforms in other spheres (particularly market liberalization) aimed at raising farmers' incentives to produce more for the market. In sum, substantial research investment is needed in order to understand the major macro-micro linkages of the agricultural and food sector, and to take these linkages into account in formulating and implementing a comprehensive and consistent package of policies to improve both food production and food access in Mali.

APPENDIX I
AGROECOLOGICAL CHARACTERISTICS OF CMDT AND OHV

APPENDIX I

AGROECOLOGICAL CHARACTERISTICS OF CMDT AND OHV

1. Ecological Setting of the CMDT and the OHV Zones

Prior to the redefinition of the boundaries of the rural development operations (ODRs) in 1982, the Malian Company for the Development of Textiles (CMDT) intervened in all the main agricultural regions of Mali, i.e., the regions of Kayes, Koulikoro, Sikasso, Ségou and Mopti. Since 1982, CMDT has covered an area of about 96,000 square kilometers, which includes all the seven cercles of the region of Sikasso, the cercle of Dioila in the region of Koulikoro, and the cercles of Barouéli, Bla, San and Tominian in the region of Ségou. This zone is occupied by some 100,000 farm households and had an estimated population of 1,234,000 inhabitants in 1986 (World Bank 1983; Dembélé 1988).

Created in 1964, the geographic boundaries of OHV were modified in 1979/80 and 1981/82 to now cover a total area of 31,000 square kilometers. In 1986, this zone had about 40,000 farm households and an estimated population of 610,000 inhabitants, living in the cercles of Kangaba, Koulikoro, Bamako and Kati, all included in the region of Koulikoro (Club du Sahel 1983; Kagbo and Diarra 1988).

CMDT has thus about 3.1 times the area, 2.5 times the number of farm households and twice the population of OHV. Except for these differences

in size and population, the two zones are very similar with respect to virtually all ecological factors. The climate in both zones is characterized by a distinct rainy season (from May to October), during which average temperatures vary between 17 and 38 degrees centigrade. According to the results of the most recent land resource inventory, both zones stretch from the Guinean zone (1150 to 1450 mm of rainfall per year) in the south to the Sudano-Guinean zone (750 to 1150 mm of rainfall) and the Sudano-Sahelian zone (550 to 750 mm of rainfall) in the north (PIRT 1986). Similarly, soil types in the two zones vary from loamy clays (and hydromorphic clays in lowlands) in the south to light sandy loams and loamy sands in the north (USAID 1978; World Bank 1983). Finally, the climatic and soil conditions of the two zones are appropriate for the same set of rainfed food and cash crops, including millet, sorghum, maize, cowpeas, cotton and groundnuts. It may be argued that the OHV is even more privileged than the CMDT, because of the Niger River which runs through all subzones of the OHV and provides a great potential for rice production under flood recession and irrigation.

2. Land Endowment and Tenure

The basic principle of the Malian legislation is that land belongs to the national collectivity. Accordingly, the state, in compliance with customary rights, is responsible for land management, its distribution according to the demands of the collectivity and the issuance of property titles when necessary (Dème and Coulibaly 1987, 6). In practice, all agricultural land (except for irrigated land) is managed according to customary rights whereby "the concept of ownership extends to the produce

of the land but not to the land itself" (CRED 1976, 23). Traditionally, each village has its own collective lands called the "village bush." Assisted by a council of elders, the village chief, in his role as official "holder" of the village lands, distributes land between the heads of extended families, settles land problems between families, and serves as intermediary between administrative authorities and the villagers. All heads of families, regardless of caste or ethnic origin, can claim and obtain land for free. Upon a request to the village chief, new settlers in the village are granted land for a symbolic payment (usually of cola nuts, which have progressively been replaced by small amounts of cash).

It may be argued that this land tenure system is arbitrary to some extent, and results in the best parcels from the point of view of location and fertility belonging to the most influential families and earliest settlers of the village. However, the system does not prevent significant investment in long-term land improvement by individual families. One of the most common forms of such improvements is the planting of fruit or shade trees in farm fields. This seeming paradox is explained partly by the relative abundance of land and the fact that the village community automatically grants a strong user right comparable to a quasi-ownership right over a piece of land to the man who first clears it. Land assigned to heads of families can be reassigned by them to their descendants, and this inheritance system underlies the ancestral quasi-ownership pattern of village lands.

Agricultural land is still not a scarce resource in Mali in the two zones covered in our surveys. The most restrictive estimates of the PIRT show that in 1985, at most 60% of total arable land was under cultivation

in all the three ecological zones covered by CMDT and OHV (Ministère de l'Agriculture 1987, 7).

It seems therefore safe to conclude that in both CMDT and OHV, increasing agricultural production is not constrained by the lack of cultivable land or by severe imperfections in land tenure. This conclusion is supported by the data presented in Table A.1-1, which show that, in both zones, 52% of the survey farm households increased their cultivated area between 1981 and 1985. Furthermore, virtually all these farm households still practice a system of fallow which allows the restoration of soil fertility after a few years of cultivation. The average duration of fallow (5 years in CMDT and 8 years in OHV) seems to indicate a greater extent of intensification in the CMDT zone. In fact, land may be relatively more scarce in CMDT (particularly in the north of this zone), where the average area cultivated per farm household (6.4 hectares) was almost double that in the OHV in 1986/87. From the relative abundance of land and the flexibility in land tenure, it appears that what limits the capacity of a farm household to extend its cultivated area may be labor and/or capital (equipment) inputs.

3. Labor Availability

The structure, conduct and performance of the rural labor market are very poorly documented in Mali. However, the little empirical evidence available suggests that the share of hired labor in total farm labor is small. For instance, Whitney (1981, 112-13) notes that:

Since land is still in relatively plentiful supply, there has not developed a landless class, which earns its living working on the fields

Table A.1-1. Indicators of Farm Land Resource Availability, CMDT and OHV

INDICATORS	CMDT			OHV		
	SOUTH	NORTH	TOTAL	SOUTH	NORTH	TOTAL
Total farm households (a)	--	--	100,000	--	--	40,000
Cultivated Land:						
Total ('000 ha) (b)	--	--	643	--	--	138
Hectares per Farm	--	--	6.4	--	--	3.5
% of arable land (c)	--	--	60	--	--	60
FARM SURVEY DATA: (d)						
Sample size (households)	325	332	657	156	177	333
Percentage of sample farms having extended cultivated land from 1981 to 1985	70.5	34.7	52.4	69.5	41.2	54.5
Duration of Land Cultivation before Fallow:						
Average (years)	10	6	8	9	8	8
Percentage of farms:						
1 to 4 years	2.4	29.4	16.0	15.7	29.7	23.1
5 to 10 years	68.9	64.7	66.8	65.3	55.7	60.2
More than 10 years	28.7	5.9	17.2	19.0	14.6	16.7
Duration of Fallow:						
Average (years)	6	4	5	10	6	8
Percentage of farms:						
No fallow	0.4	0.0	0.2	0.0	0.0	0.0
1 to 4 years	11.6	70.6	41.4	17.0	41.3	29.9
5 to 10 years	84.7	23.5	53.8	51.0	51.0	51.0
More than 10 years	3.3	5.9	4.6	32.0	7.7	19.1

Sources: (a) World Bank 1983 (for CMDT); OHV 1984 (for OHV)
 (b) Office Statistique des Communautés Europeennes (OSCE) 1988
 (c) PIRT, cited in Ministère de l'Agriculture 1987
 (d) CESA-MSU Food Security Project farm household surveys, 1985

of others. Therefore, the amount of outside help any one household can employ is constrained by the time other people must spend on their own farms. Periods of peak demand for outside labor are also peaks of demand for family labor, thus limiting the availability to those who have expanded the area cultivated.

Whitney found that about 20% of total farm labor in southeastern Mali (CMDT zone) was supplied by workers outside of the farm household during the rainy season of 1979. A more recent survey by IER shows that the share of outside labor in total farm labor supply was 16.8% in OHV and 9% in CMDT in 1984/85 (Doumbia, Mariko and Touya). It may be inferred from these observations that the bulk (80% or more) of total farm labor comes from members of the farm household itself.

Table A.1-2 shows the results of a detailed demographic survey of our sample farm households. No significant difference exists between the CMDT and the OHV zones in terms of average farm household size. At the subzone level, the largest household sizes are found in north CMDT (14.2 persons) and south OHV (13.1 persons). The average number of workers per farm household is higher in CMDT than OHV by only 0.7 person. However, a higher percentage of the total household population is reported as active workers in CMDT, particularly in the south of this zone where household member participation in both farm and non-farm activities may be higher because of the impacts of cotton income on the global economy of the subzone.

Even when young workers of less than 15 years of age are attributed a weight of 0.5 relative to adults, the farm households in CMDT, with an average equivalent of 7.3 adult workers, hold an advantage of only 0.6

**Table A.1-2. Farm Household Population and Available Family Labor
CMDT and OHV, 1986 (averages per farm household)**

DEMOGRAPHIC CHARACTERISTICS	CMDT			OHV		
	SOUTH	NORTH	TOTAL	SOUTH	NORTH	TOTAL
Total on-farm population	11.4	14.2	12.8	13.1	12.1	12.6
Available household labor						
Number of workers	8.2	8.1	8.1	7.4	7.4	7.4
Percent. of population	72.1	56.9	63.5	56.5	61.2	58.9
Adult active units	7.2	7.4	7.3	6.6	6.7	6.7
DEPENDENCY RATIOS:						
Persons/worker	1.4	1.8	1.6	1.8	1.6	1.7
Persons/adult active unit	1.6	1.9	1.8	2.0	1.8	1.9

Source: CESA-MSU Food Security Project farm household surveys, 1986.

Note: Working children below age 14 are given a weight of 0.5 in estimating the number of adult-equivalent workers.

adult worker over their peers in OHV. Virtually no difference emerges between the two subzones of each zone as far as farm household labor availability is concerned.

The above facts indicate that, in addition to their very similar ecological conditions and land endowment, CMDT and OHV show no major differences with respect to total household labor supply. The wage labor market is very narrow in both zones, and most of the outside labor used by farm households is likely supplied through participation in traditional labor exchange groups of young men or women, which exist in each village covered by our surveys. Given these similarities in terms of natural resource and labor endowments, the difference between CMDT and OHV with respect to the overall productivity of their farm households should be attributed to other institutional factors such as their credit systems, their input and output markets and the extent of farmer participation in

managing some of the crucial activities of rural development. All these aspects closely relate to the overall rural development strategies and policies pursued by the two rural development agencies.

4. Major Crop Production

Despite very similar family size and amount of available family labor in the two zones, the average total area cultivated per farm was 79% larger in CMDT than OHV during the two good rainfall seasons of 1985 and 1986 (Table A.1-3). Except for rice and groundnuts, the average cultivated area per farm for any crop was at least 50% larger in CMDT relative to OHV. Likewise, average yields were at least 20% higher in CMDT than OHV for every crop, except millet/sorghum (same yield in both zones) and groundnuts.

The most significant differences in performance between the two zones apply to the two crops that have been the subject of most intensification efforts in the CMDT zone, i.e., maize and cotton. Relative to OHV, farm households in CMDT cultivated on average 63% more maize area with a 48% higher yield, and almost 800% more cotton area with a 21% higher yield. As a result, the average production of cereals per farm household was 65% higher in CMDT than OHV, while the average quantity of cotton produced per farm in the CMDT zone amounted to almost 11 times that in the OHV zone.

As far as the group of coarse grains (millet, sorghum and maize) is concerned, the average cultivated area per farm was 52% larger in CMDT than OHV, while average yields also tended to be higher in CMDT (mainly because of its yield advantage in maize). An important fact with respect

**Table A.1-3. Area, Yield and Production of Major Crops, CMDT and OHV
(averages for 1985/86 and 1986/87)**

CROPS	Area per Farm (Hectares)		Production per Farm (kg)		Yield (kg/ha)		Percentage Variation (CMDT/OHV)		
	OHV	CMDT	OHV	CMDT	OHV	CMDT	Area	Product	Yield
Millet/ Sorghum	2.7	4.1	2435	3676	906	904	51	51	0
Maize	0.3	0.5	437	1055	1387	2053	63	142	48
All coarse Grains	3.0	4.6	2871	4732	956	1033	52	65	8
Rice	0.1	0.1	80	151	952	1510	19	88	59
All Cereals	3.1	4.7	2951	4882	956	1044	52	65	9
Groundnut	0.3	0.2	237	128	903	704	-31	-46	-22
Coton	0.2	1.4	169	1822	1058	1278	792	978	21
All Crops	3.5	6.3	--	--	--	--	79	--	--

Sources: Baseline data from OSCE 1988; World Bank 1983 and OHV 1984 for the number of farms.

Note: Average harvested area and average production per farm are computed using an estimated number of 100,000 farms for CMDT and 40,000 farms for OHV.

to these crops is that CMDT was able to progressively expand the realm of intervention of its extension service from about 20,000 farms cultivating some 25,000 hectares of millet and sorghum in 1974/75 to more than 75,000 farms and 198,000 hectares in 1986/87 (Dembélé Z. V. 1988, 4). The very lack of data on such indicators for the OHV zone may reflect a much poorer organization and performance of the extension system of this zone.

Because of the lack of comparable market price data for each crop and each individual rural development zone, we have estimated the average

gross crop income for all crops valued at their 1985-1986 official prices. This estimation showed that the gross crop income per farm household was 128% higher in CMDT relative to OHV. The contribution of cash crops (cotton and groundnuts) to the estimated gross crop income was 37.8% in the CMDT zone and only 13.8% in OHV. Cotton alone accounted for 35.8% of the gross crop income in CMDT as compared with only 7.6% in OHV. At about CFAF 15,000 per capita, the estimated gross crop income was clearly too low to cover the bulk of the needs of OHV farmers, particularly when purchased input costs are accounted for. This extreme weakness of farm income from crop production (particularly cash crops) justifies enough OHV farmers' propensity for non-crop and non-farm activities as well as rural out-migration.

APPENDIX II
RESEARCH PLANNING TOOLS

A.2-1. Mali Research Planning Matrix

Questionnaires

Component	Research Questions	Hypotheses	Key Variables	Key Indicators
Village/Market	1. Estimate the agricultural resources available in the village (land, labor, and capital) 2. Identify the constraints faced by the village producers and the prospects for their utilization of additional resources for foodgrain production 3. Establish a basis for further sampling of production units	A. Villages with poor market access have a larger amount of unused agricultural resources and a smaller marketable cereals surplus B. Villages with a significant marketable cereals surplus are those with better access to input implement and credit provision systems, high percentages of animal traction-equipped farm households, and a relatively higher involvement in cash crop (cotton) production C. Marketable cereals surplus production at village level decreases with the availability of income from off-farm activities		
Producer/Investment	1. First, an attempt will be made to quantify their production activities--the amounts of inputs used, level of output attained, storage and sales of output, level of non-monetary as well as monetary exchanges involved 2. Second, their overall profitability will be assessed 3. Third, their decision-making behavior and management strategies will be studied, particularly as it bears on food security--for their families and for the nation	A. The lack of reliable and profitable fertilizer formulas and improved seeds for coarse grains prevents farmers to invest in cereals yield-increasing techniques B. Deficiencies in input/implement and credit provision systems constitute major constraints which inhibit farmers' willingness to invest in animal traction which can lead to a significant increase in coarse grain production through an extension of cultivated area C. Because of the deficiencies they perceive in input and output markets, farmers find it profitable to produce coarse grains only for the needs of the farm household and invest in other more reliable/profitable activities (e.g., cash crop and livestock production, off-farm activities, etc.)		

A.2-1. continued

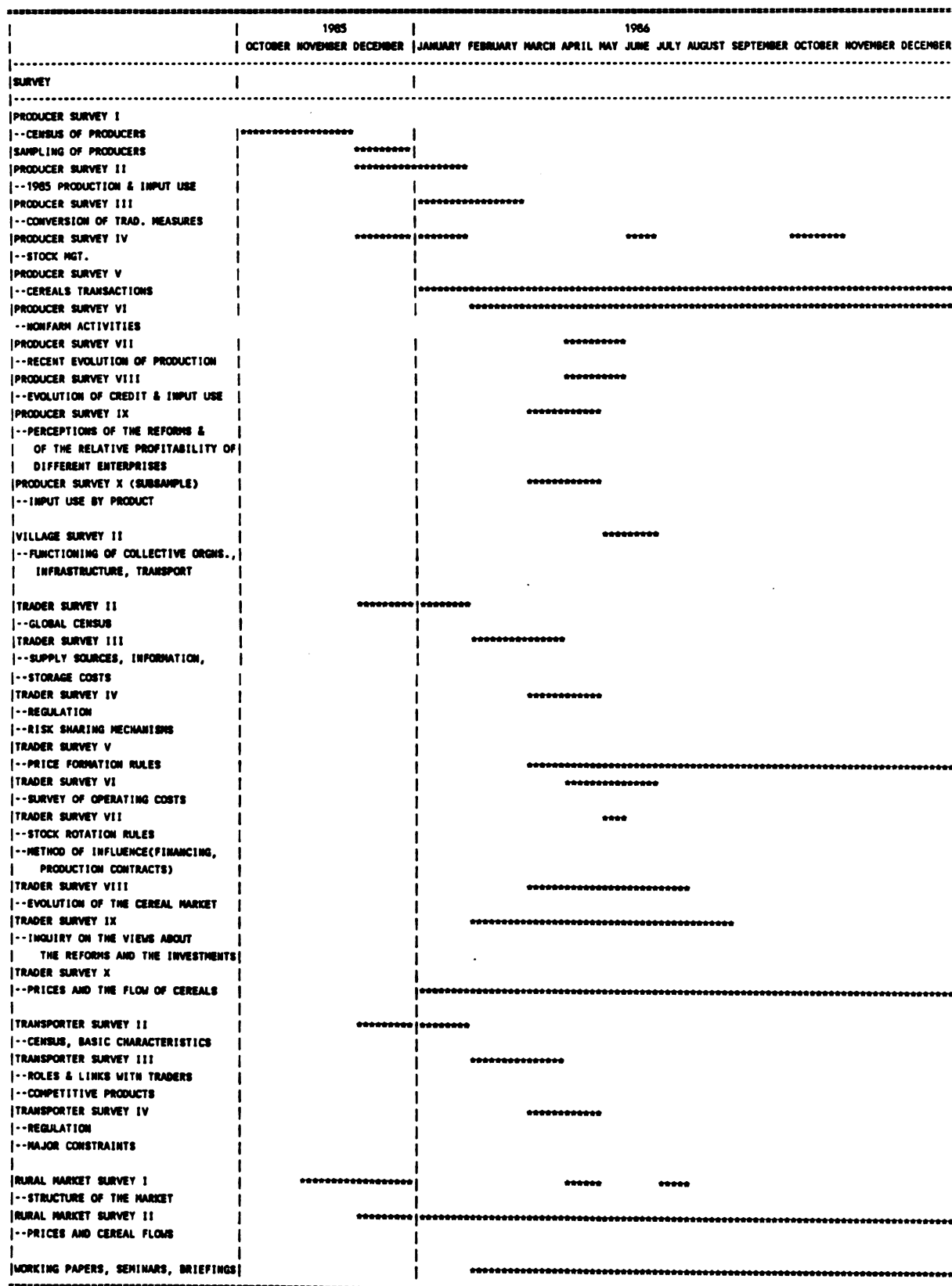
Questionnaires			
Component	Research Questions	Hypotheses	Key Variables Key Indicators
Price	1. Determine the actual level of prices received/paid by the different participants of the coarse grains subsector	E. The relatively high degree of risk involved in grain trade prevents traders to specialize and to keep large stocks of cereals over relative long periods of time.	
	2. Identify the major factors underlying price variations over time and space	F. Poor access to formal bank credit lines limits the scale of private grain trade and prevents traders to take advantage of potential economies of scale.	
	3. Measure price margins on the different segments of the marketing chain	A. Within market price differences are insignificant for the same quality of the same commodity at any given point in time, i.e., instantaneous market information and competition are nearly perfect	
	4. Measure the extent of market integration and the distributive efficiency of the liberalized coarse grain market	B. Prices received/paid by farmers at the village level vary significantly within and between villagers, with those villages having poor market access receiving lower prices (because of transportation costs and imperfect market information)	
	5. Measure the degree of seasonal coarse grain price fluctuations and the timeliness of cereals imports (including food aid)	C. Prices paid at the village level vary significantly with the type of purchasing agent (village merchant, visiting trader, relatives, etc.) and the mix of services that go along with cereals transactions (especially informal credit)	
		D. Rural markets and urban markets are weakly integrated because of the availability of imported cereals (food aid and commercial imports) in urban centers	
		E. The degree of seasonal price fluctuations is lower in urban (wholesale) centers where the bulk of cereals imports (food aid and commercial imports) is absorbed	

A.2-1. continued

Questionnaires

Component	Research Questions	Hypotheses	Key Variables	Key Indicators
Trader/Transporter	1. Ascertain current business arrangements in coarse grain trade and transportation	D. Except for maize in the CMDT zone, marketable coarse grain production is accidental, unplanned		
	2. Measure the main costs and identify the major constraints faced by private coarse grain traders and transporters	E. Recent policy reforms (e.g., market liberalization) have not affected significantly farmers' perceptions and expectations with respect to the relative payoff of investment in coarse grain production		
	3. Trace the evolution of the activities of grain traders and transporters since the liberalization of coarse grains marketing (changes in official policies and business arrangements, and subsequent adjustments)	F. The perceived unreliability of coarse grain supplies from private and official (commercial or food aid) sources makes farmers adopt a self-insurance (or autarkic food-security) strategy whereby they build up their own security stocks of which they sell out significant quantities only when there is enough evidence that the level of the forthcoming harvest will allow the complete renewal of the stocks		
		A. Marketing liberalization has reduced the real costs of private trade of coarse grains, particularly because of the elimination of the risk associated with the illegality of the former parallel cereals marketing network		
		B. The licensing system constitutes a barrier to free entry in private grain trade, thus limiting the degree of private competition and depressing producer prices		
		C. The restriction of the number of private grain wholesalers/importers resulting from the licensing system opens the door for tacit coalition and monopolistic practices		
		D. Market power resulting from informal credit ties and better market information alters the distribution of bargaining power in favor of traders as opposed to farmers.		

A.2.2. CESA-MSU Food Security Study: Excerpt of Condensed PERT Chart



APPENDIX III
SIMPLE LINEAR FUNCTIONAL FORM OF THE ESTIMATED EQUATIONS
OF COARSE GRAIN PRODUCTION PER FARM HOUSEHOLD

APPENDIX III

SIMPLE LINEAR FUNCTIONAL FORM OF THE ESTIMATED EQUATIONS OF COARSE GRAIN PRODUCTION PER FARM HOUSEHOLD

Table A.3-1. 1985 Total Coarse Grain Production per Household

Adjusted R Square	.54	F = 29.24	Signif F = .0000		
Independent Variables	B	SE B	Beta	T	Sig T
Constant	-992.9	459.6		-2.16	.03
Family Labor (WS)	216.8	43.2	.306	5.02	.00
Dependency Ratio (CPW)	209.5	91.8	.122	2.28	.02
Zone (Z)	847.8	288.3	.184	2.94	.00
Subzone (SZ)	547.3	249.2	.119	2.20	.03
Semi-Equipped (SEQ)	387.7	286.8	.084	1.35	.18
Equipped (EQP)	1376.7	380.7	.261	3.62	.00
Cotton Area (ACOT)	535.4	130.1	.296	4.12	.00
Non-Crop Activities (NCA)	345.6	246.3	.073	1.40	.16

Table A.3-2. 1986 Total Coarse Grain Production per Household

Adjusted R Square = 0.55	F = 29.19	Signif F = .00			
INDEPENDENT VARIABLES	B	SE B	Beta	T	Sig T
Constant	-582.5	653.5		-.89	.37
Family Labor (WS)	258.9	61.4	.259	4.22	.00
Dependency Ratio (CPW)	208.2	130.2	.086	1.60	.11
Zone (Z)	1453.6	391.3	.222	3.71	.00
Subzone (SZ)	-283.1	349.6	-.043	-.81	.42
Semi-Equipped (SEQ)	130.0	409.2	.020	.32	.75
Equipped (EQP)	1639.7	546.1	.220	3.00	.00
Cotton Area (ACOT)	1035.7	191.1	.377	5.42	.00
Non-Crop Activities (NCA)	179.8	352.9	.027	.51	.61

Table A.3-3. 1985 and 1986 Total Coarse Grain Production per Household

Adjusted R Square = 0.54

F = 49.11

Signif F = 0.00

INDEPENDENT VARIABLES	B	SE B	Beta	T	Sig T
(Constant)	-1206.8	415.6		-2.90	.00
Family Labor (WS)	239.9	38.2	.275	6.29	.00
Dependency Ratio (CPW)	211.0	81.1	.100	2.60	.01
Zone (Z)	1148.9	248.9	.202	4.62	.00
Subzone (SZ)	141.5	218.8	.025	.65	.52
Semi-Equipped (SEQ)	245.5	254.0	.043	.97	.33
Equipped (EQP)	1523.0	338.0	.234	4.51	.00
Cotton Area (ACOT)	756.6	116.5	.328	6.50	.00
Non-Crop Activities (NCA)	281.7	218.5	.048	1.29	.20
Year (YEAR)	815.9	201.0	.143	4.06	.00

APPENDIX IV
CONCENTRATION OF COARSE GRAIN GROSS SALES AND NET SALES
AMONG THE FARM HOUSEHOLDS OF THE SAMPLE VILLAGES

APPENDIX IV

CONCENTRATION OF COARSE GRAIN GROSS SALES AND NET SALES AMONG THE FARM HOUSEHOLDS OF THE SAMPLE VILLAGES

Table A.4-1. Distribution of Coarse Grain Sales among Farm Households Ranked by Decreasing Order of Total Quantity Sold

1985/86		1986/87	
PERCENTAGE OF FARMS	PERCENTAGE OF SALES	PERCENTAGE OF FARMS	PERCENTAGE OF SALES
4.7	36.1	4.6	45.2
10.0	50.1	6.3	50.2
15.4	60.8	9.5	59.4
20.2	69.5	15.0	70.2
24.0	75.2	17.1	74.5
25.0	76.1	19.8	78.4
30.3	84.1	24.5	83.2
34.8	89.1	29.9	87.6
36.4	90.0	32.4	89.9
39.7	92.7	34.7	92.3
44.4	95.1	40.1	95.3
45.1	95.3	44.8	97.2
50.0	97.6	50.0	99.0
55.1	99.0	55.0	99.8
60.2	99.9	58.0	100.0
63.3	100.0		

Table A.4-2. Distribution of Net Coarse Grain Sales among Farm Households Ranked by Decreasing Order of Total Quantity Sold

1985/86		1986/87		1985/86 AND 1986/87	
PERCENTAGE OF FARMS	PERCENTAGE OF NET SALES	PERCENTAGE OF FARMS	PERCENTAGE OF NET SALES	PERCENTAGE OF FARMS	PERCENTAGE OF NET SALES
1.0	18.2	1.0	19.5	1.0	20.5
2.1	26.1	2.0	27.7	2.1	28.8
4.7	41.0	4.7	44.6	4.7	45.0
7.9	51.1	6.4	49.6	5.7	49.2
10.0	55.7	9.7	58.6	9.6	59.5
15.4	67.7	14.8	69.9	15.2	73.0
19.8	76.0	17.0	74.5	15.8	74.5
24.8	84.5	20.1	81.2	19.7	80.0
28.2	90.0	25.0	86.3	24.8	86.7
30.2	91.8	29.7	89.8	28.4	89.9
35.0	95.8	36.0	94.8	30.1	91.9
40.0	98.5	40.2	97.0	34.9	95.3
45.0	99.7	45.0	98.9	40.0	98.2
47.7	100.0	49.7	99.8	45.2	99.2
--	--	52.2	100.0	49.9	99.9
--	--	--	--	53.0	100.0

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