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A FOOD SECURITY STUDY IN MALI:
TOWARD HARMONIZED FOOD POLICY FOR RURAL FARM HOUSEHOLDS

BY

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ABSTRACT

A FOOD SECURITY STUDY IN MALI: TOWARD HARMONIZED FOOD POLICY FOR RURAL FARM HOUSEHOLDS

By

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The purpose of this research was to study the major constraints affecting different farm households in the production and consumption of grain foods (mainly coarse cereal crops) and their estimated income situations in Mali. The study utilized farm household level data selected as part of a research program of Michigan State University and USAID from 1985 to 1989.

The research methods used in this study consist of descriptive and quantitative statistics (basic statistical tests, multiple linear regression methods). Data utilized are based on the main food production and transaction, household characteristics, taxation, census of 190 farm households from October 1985 to October 1986 in Mali.

The research showed that there were two major different kinds of rural farm households which have very different socio-economic characteristics, and some differences in household income and food strategies. Many interrelated factors affect this difference, though no single dominant factor can distinguish one kind of household from another. Due to the differences, the serious equity issue has been raised. The present fiscal policy has a negative impact on changes in rural equality, hence reform is needed. This study recommends that different food policies need to be made concerning food security and income distribution problems of different rural households.

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INTRODUCTION

Problem Statement

1. General food security problems in African countries

While the world's food situation is improving because of increased grain production, improved marketing, decreased grain production costs and a high level of food consumption per capita, the food situation in African nations has deteriorated. Both the growth rate in food production and food consumption per capita have decreased in the last two decades.

It was widely believed that the food crisis --a situation of food shortages, famine and malnutrition--is caused by not easily controlled factors, especially lack of rainfall and rapid population growth. Many people are also suggesting that poor domestic economic policies were major contributions to the African food crisis (World Bank 1981).

Statistically, the population growth rate in Africa was 2.1% in 1950's, 2.7% in late 1970's and it is estimated the rate will be approximately 3.0% by 1990's. From 1960 to 1980 the annual food production growth rate in Africa was only 1.8%. Sub-Saharan Africa is the only region of the world where food production per capita declined in the 1960-78 period (Eicher). Malthus' theorem and Ricardo's food bottleneck are appropriate concepts when addressing the food security issue in Africa.

(1). Past attempts to analyze and identify the food problems in Africa

The food crisis has lasted more than two decades in many African nations. The Sub-Saharan Africa problem has diverted world attention regarding developing nations' food problems away from Asia to Africa.

In the 1970s, many scholars and development scientists believed that the same development strategies that had been used to address Asian food problems would also be effective in combating Africa's food crisis. Despite ten years of activities, the food crisis did not diminish. Although the food aid that the developed world has given to Africa is two or three times greater than that deployed in major Asian countries (Eicher 1989), Africa's food problem remains and in some areas has gotten worse. More and more people in Africa, especially in sub-Saharan nations, are suffering starvation and malnutrition. Even without considering the short-term impact of hunger and famine on Africans, it is believed that about 15-20% of the population in Africa suffers from malnutrition (Eicher, 1989).

The reasons for the failure of the efforts related to combat the African food crisis had been a concern of many people. Dione (1989) argues that this related to the fact that "... 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".

With the African food problem worsening, many scholars have attempted to identify reasons for failures of the various efforts. Some of the studies were carried out in terms of international comparisons studies between Asia and Africa. These studies relied heavily on the aggregated national (macro level) data. The comparisons analyzed such

factors as natural conditions (rainfall, soil), agricultural technology, food production and consumption variability, demographic factors (population density), investment-disinvestment in agriculture, capital accumulation (saving), functioning of markets, institutional conditions (such as the efficiency of the government bureaucracy), and rural-urban income disparities, as well as other factors (see, Lele 1981, Eicher 1982, Siamwalla and Valdes 1980, World Bank 1981).

Some of the previous studies have been subsequently criticized by many social scientists and researchers. The criticisms tend to focus on the use of inappropriate research methodology, analytical tools and implicit assumptions. As Dr. Eicher mentioned in 1982:

> "First, they assumed that one discipline- economics could provide answers on how to slay the dragons of poverty, inequality, and malnutrition. Second, the cities were unable to provide jobs for the rural exodus because of trade unions pressure that elevated minimum wages in government and in industry and capital-intensive techniques in the industrial sector. Third, the neoclassical growth models were unable to provide convincing micro understanding of the complexity of the agricultural sector- the sector that employs 50-95 percent of the labor force in African states."

Lack of detailed micro-level data to carry out food security studies in Africa makes it extremely difficult to draw useful policy implications or even correctly identify the problems at the micro levels. Dr. Eicher (1988) argues that data and information voids inhibit our ability to identify the appropriate role of agricultural research, scientists and institutions in addressing the food crisis in Africa. Also, the cross-country comparisons are not only limited by the lack of micro level data, but by the implicit assumption that inside a country different regions are homogenous. As Siamwalia and Valdes point out, the "discussions of potential remedies have overlooked the enormous

difference in the nature and magnitude of food-security problems in Asia, Africa, and Latin America. In these discussions only a limited number of policy instruments have been considered relevant to the problem of food security." (1984, p.189).

Because of the limitations of country-to-country comparative studies, additional studies have been conducted on the national, regional and household level. More emphasis is given to micro-macro considerations in confronting these problems. This approach makes it possible for us to understand the explicit performance of different groups, especially rural household behavior. However, the previous micro-level studies also had weakness. These studies usually treated different households within a region equally, that is, assuming homogeneity of the households within a region, even though it was realized households across regions were different. The lack of explicit studies of households with different food situations and the inability to observe the heterogeneity of rural households within a region cause these analysis to fall short in providing workable policy recommendations for dealing with food security problems at the rural household level.

(2). Recognition of the food security issue in Africa

The reasons behind Africa's prolonged food crisis according to Eicher (1984, 1989) are: First, Africa's food crisis is rooted in its historical background, that is, the long history in colonization. Most African nations received their independence only a few decades ago. Hence, they are in the early stage of economic development.

Second, associated with this history, the institutional setting

may not be appropriate. Institutional failure had played an important role in making the food security situation worse. The food crisis may not be only the result of the failure of food production but also the dysfunction of the institutional setting.

Third, political instability and internal conflict (civil war) has caused food problems (especially famine) in Africa. Finally, neglecting the role of agriculture during economic development and the net flow of resources and capital out of the agricultural sector also have had a negative impact on food security in Africa (Eicher 1984, Dioné 1989). Therefore, weather is not the only reason for the food crisis in Africa.

With this recognition, food security studies and debates are influenced by the "hunger equation" (or food security equation). The hunger equation states that food problems can be sub-divided into problems of food availability (food supply side or production side) and the problem of food access (demand side or food entitlement). Viewing hunger in these terms is an important contribution and a major breakthrough in the understanding of food problems in less developed countries. Using this equation, food security needs to be studied in a more systematic way. As Eicher (1989) notes:

> "Over the past decade, there has been growing empirical support for two fundamental premises about the linkages between food availability, poverty and access to food. These premises can be described as the two sides of the hunger equation. The first premise is that increasing food production, storage and trade can ensure national food availability, but food availability will not automatically end hunger and ensure that all people have enough to eat. The second premise is that because poverty is a central cause of hunger and malnutrition, special public and private efforts are needed to help the poor and the landless increase their access to food through home production, off employment, new income streams and targeted food transfer programs".

Using the concept of the hunger equation, scholars in food

security study can be classified into supply side and demand side, or food production side and food entitlement side. Amartya Sen is believed to be one of the most influential scholars on the food entitlement side. Many studies have been carried out which emphasize the problems of food access. Currently, the heavily reliance on the entitlement approach has been questioned by some scholars. As Eicher states further, given the "priority to food access/entitlement programs, the long run food production problem is being inadequately addressed..." He notes that the future challenge is to develop a balanced strategy that tackles both the food availability and food access issues.

At the micro-level for most Africa countries, separation of food supply and food access are not relevant. As D'Agostino (1988) notes in her thesis, "... the distinction between the supply and demand side of the food security equation becomes less clear because farmers allocate their own production not only to home consumption and storage but also to monetary and non-monetary transactions...".

In the recognition of this fact, this study will treat the two sides of the equation in an integrated way, that is, use the net food availability per capita as the dependent variable of the hunger equation to reflect the impact of both the supply side and demand side on the rural household food situation.

(3) Food situation problems in the context of Mali

Mali, located in west sub-Sahara Africa, is regarded as one of the poorest countries in the world (GNP per capita was estimated at approximately equivalent to US $150 in 1987). Prior to independence in 1960, Mali was a French colony. About 70 to 80% of the total population

lives in rural areas. Generally, the natural conditions are not favorable for agriculture; about 65% of the area is within the Sahara desert. With the exception of the area along Niger river, much of this area lacks irrigation. Agriculture mainly relies on the natural rainfall. The production of grain, livestock and cotton is the main agricultural activity. The export of cotton and livestock products is the main source of foreign exchange. Cereals (mainly millet, maize and sorghum) are the most important crops meeting the food needs of the country. Seventy percent of the total food calories are provided with these coarse grain crops. Rural people heavily rely on the coarse grains, while urban people have more rice in their diet (Dioné 1989).

Until the late 1960s, Mali was a net food exporter. Since then, because of rapid population growth, severe drought and the failure of the government policies related to agriculture, Mali has become a net food importer. Faced with a growing financial deficit and related lack of foreign exchange for food importation, Mali has asked for assistance from donor agencies in addressing its serious food deficit situation.

Staatz and Dioné (1988) argue that previous food-related policy (mainly the price policy) was detrimental to the rural people, as government fixed both consumer and producer prices, similar to the policies employed by other less developed nations. It was assumed that the policy would achieve three conflicting objectives: 1) Increase the income of the rural people, 2) Provide lower retail food prices to urban people and 3) Make the net benefit or surplus generated by agricultural available for investments in non-agricultural sectors. As argued previously, it is almost impossible to achieve these three goals

simultaneously. Actually, only the second and the third goals were achieved (Staatz, Dioné, and Dembélé 1989). The implication of the policy can be summarized as "even without being fed, the horse is expected to run faster and further".

As a result of the policy, farmers had no incentive to sell the cereals to the government grain marketing agency (The Office des Produits Agricoles de Mali, or OPAM, which was granted legal monopoly power for the grain trade). Private food marketing activities were significantly suppressed. This policy has been diagnosed as the main reason behind the dysfunction of food marketing, hence affecting the food supply. With the pressures from donors, the government chose to raise the official producer and consumer prices for grain disproportionately. Consequently, the government was facing a divergence of food prices. The government food trade agency OPAM had to absorb a cumulative food trade budget deficit equivalent to US $80 million annually in 1976 (Dioné 1989, p.20).

With the commitment of the donor agencies, Mali addressed the problem by implementing of the Cereals Market Restructuring Project (PRMC) in 1981. The objectives of reform problem were aimed at further increasing both the producer and consumer prices. The PRMC also aimed at liberalizing the grain market and improving the efficiency of government food marketing agency, OPAM. The logic behind the reform package is fairly clear and simple: by cutting the government subsidies in the food trade, and improving OPAM management, and liberalizing the food trade market, the government would reduce its financial burden related to the food trade. Food transaction costs would be

substantially reduced, hence both producers and traders would be better off. It was assumed that the reform would help reduce the risks of the food trade and would encourage farmers and traders to increase the market supply of cereals. Eventually, the reform would provide more incentives to food producers to produce more food (increase supply), causing food production and marketing to be improved further.

With the implementation of this reform, it was assumed that equity issues would not be a major consideration, because most of the food producers were assumed to be the net producers. This proved to be incorrect. In their study "Cereals Market Liberalization In Mali," Staatz, Dioné and Dembélé have explicitly analyzed the impact of the market liberalization on different groups of people, such as rural producers and consumers (in terms of food purchases and food sales for different region) and among urban consumers. Their study showed that the rural consumers and farms producing surpluses benefitted most from the reform. Due to the lack of reliable time-series data on farm-level prices and quantities produced and marketed, and perhaps more important, the irregular weather, identifying the overall impact of the policy on the performance and the distribution of benefits among different group can be extremely difficult. Nevertheless, using the appropriate micro data and other relevant information, one can infer that farmers producing surpluses benefit most from the reform. By classifying rural households into food deficit and food surplus groups, a number of issues can be studied. If the timing of the trade is important because of seasonal food price fluctuations, why do some farmers have the capacity to respond to the new opportunities whereas others have been severely

limited? The fundamental question then becomes why are the households different?

How can the government stabilize the grain markets and encourage marketing investment given its "limited financial resource and the thinness of the markets?" What is the role of the farmers in achieving food market stabilization? Is the financial problem the main reason why food marketing reform has been partially unsuccessful? This thesis addresses three questions and also tries to identify what other policy constraints affect the food situation at rural household level.

ii). Study Objectives

The study objectives of this thesis can be listed as:

(1). To identify the main factors affecting grain[1] production and self-sufficiency for rural households in Mali.

(2). To use the agricultural household decision model to identify the factors affecting household production behavior with regard to grain production and problems with regard to income equality for different rural households.

(3). To create a policy simulation analysis (budgeting analysis) to examine alternatives and make recommendations for the policy reform and to observe the impact of the relevant policy reform regarding equity issues among different rural food situation households.

(4). To provide suggestions and evidences that a better institutional environment can play a positive role in letting farm

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[1] Grain is defined as the cereal crops (including maize, sorghum and millet) and other grain and non-grain food crops (rice, cowpea and groundnut). This food concept will be used throughout this thesis.

households achieve better food security and income distribution.

(5). To identify problems for further research.

3>. Organization of the thesis

Chapter two will put forth the research methods employed for data collection and analysis and the main hypotheses to be investigated. Chapter three will address the appropriate theoretical tools and approaches that will be used to guide the analysis of this research report. Chapter four will identify the main characteristics of studied areas, characteristics of different households from the different regions, and factors affecting the household food self-sufficiency and self-reliance. Chapter Five will present the results of an econometric analysis related to grain self-sufficiency and self-reliance. Chapter Six will provide a discriminant analysis of different households' food situation. Finally, in Chapter Seven, a summary of the findings of this research will be provided, and areas of further needed research will be identified.

Chapter Two

Research Methodology

The data used in this research project were collected as part of food security in Mali by the CESA-MSU food security research project. This project itself is part of a larger USAID-funded Food Security in Africa Cooperative Agreement Project with MSU. The study in Mali focused on food security aspects in Mali and on the Cereal Market Restructuring Program. For details on the CESA-MSU study, see Dioné (1989). The reasons for the specific data collection efforts undertaken by the CESA-MSU study are outlined in figure 2-1.

(1) Selection of commodities for study

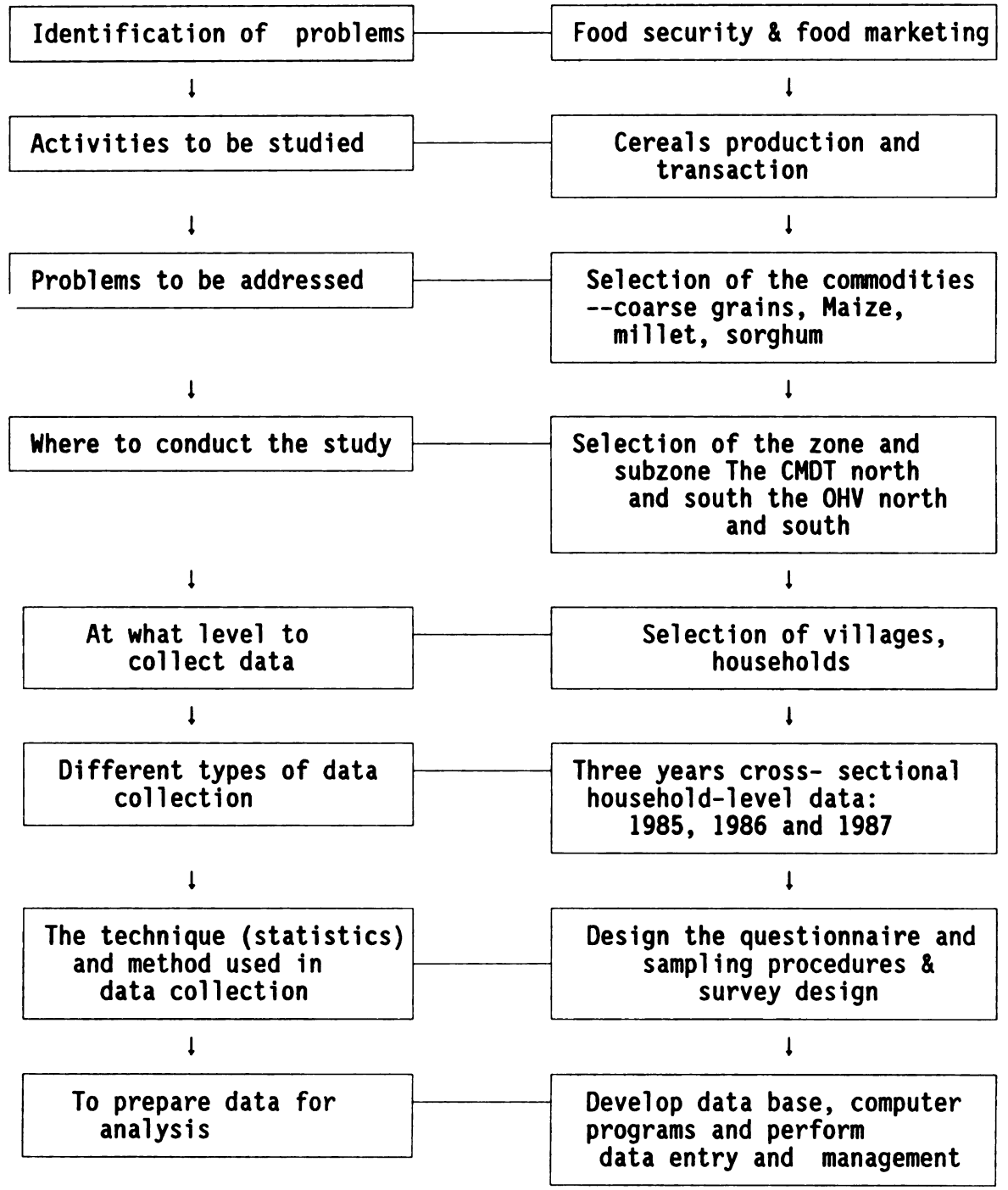
Three main coarse grains, millet, maize and sorghum were selected for the study. There were two main reasons for selecting these crops. First, these three crops are the dominant food crops in Mali (about 92% of the grain acreage, 91% of the cereal production and 82% of the total food grain availability). The second reason is because the relevant price and market reform policies were only implemented for coarse grains initially (Dioné).

(2) Selection of studied zone and sub-zone

The basic factor for the selection of the zone relates to the underlying assumption that the farmers or households within the better agricultural production areas will have higher potential for expending their marketable food production and transactions. Hence they have a

greater incentive to respond to the changing price and market

Figure 2-1 The Design of Data Collection of the Survey area



policies. Consequently, the studied area selected was the southern zones of Mali (the CMDT and the OHV[2]). This zone has the best natural and socio-economic conditions in the country.

The factors taken into consideration in selecting this zone and subzones (north and south) within the area include the natural conditions, (e.g., rainfall and soil type), the institutional conditions, (e.g., access to credit and extension advisors) and socio-economic characteristics. Since both the CMDT and the OHV zones have similar average annual rainfall in their southern subzones and in their northern subzone, and there are observed differences in food production, marketing and diversification of the households activities between the CMDT and OHV zones and between the northern and southern sub-zones, these zones were selected for the research study. The CMDT north, CMDT south, OHV north and OHV south formed the four studied subzones.

The two zone CMDT and OHV are showed in the figure 2-2. Each of the four subzones contain a "base sector" (a township), and each sector contains several villages, and has a major coarse grain market. The CMDT South is defined as in the area of Zangasso within the sector of Koutiala. The CMDT North is centered in the area of Dougoulo, within the sector of Bla. The OHV South is in the areas of Ouelessebougou and Sougoula, within the sector of Ouelessebougou. And the OHV North includes the areas of Sirakorola and Tougouni within the sector of Koulikoro. (D'Agostino 1988).

(3) Selection of villages and the households

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[2] When referred to the institutional zones, CMDT stands for Malian Company for the Development of Textiles. OHV means Niger River upper-valley development agency (Dioné 1989).

Several factors were taken into consideration in selection of the survey villages. According to Dioné, distance to market, the type of extension services available and village-level associations were the three most important factors used in selecting the villages. Four villages were chosen in each of the four subzones for a total of 16 villages.

Generally, among the four selected villages in each subzone, one village was the major market place for the grain trade within its subzone. Two villages were close to the market (within a radius of 12 kilometers). Of these two villages, one had a permanently based extension agent and the other did not. Finally, the remaining village was more distant from the market (at least 15 kilometers) and had an extension agent (Dioné).

When the project was implemented, it was determined that there were inadequate data on the basic features of the survey households in the studied area (Dioné). Faced with this problem, a census of all farm units was implemented.

As Dioné noted "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." The farm census provided information on characteristics of the households studied. These include: a) social status, 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, based on the village ranking (small, medium or large), c) the number of active

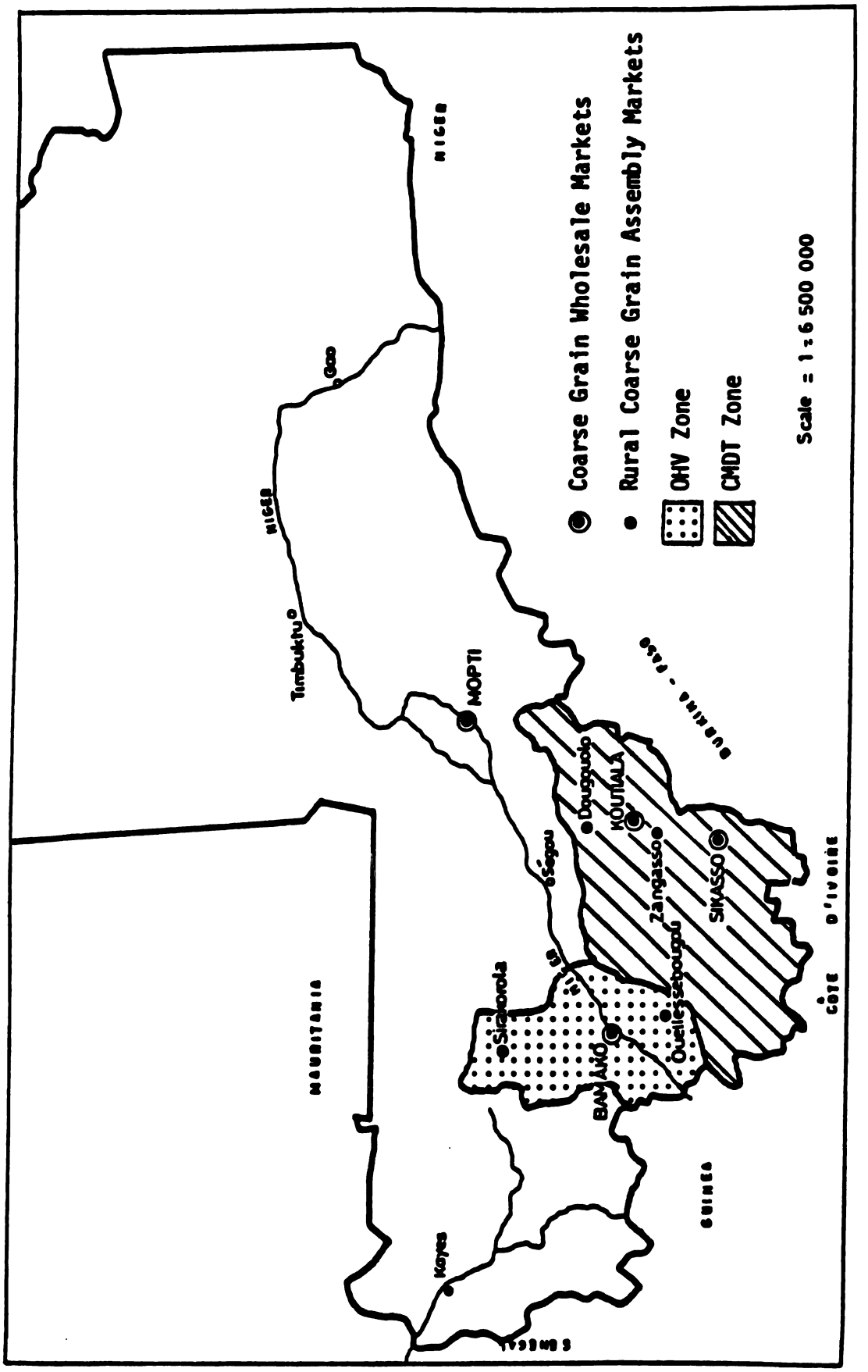

Figure 2-2. Republic of Mali: CESA-MSU Survey Sites

agricultural workers and size of household during the 1985 cropping season; d) off-farm activities (migration); e) household equipment level, draft animal renting and possession, particularly with respect to animal traction; f) household access to formal credit over the past five years; g) the mix of crops grown in 1984; h) estimate of the proportion of agricultural production sold (zero, less than half, half, more than half) in 1984/85; i) the household's access to land in the past five years (whether or not a household had the chance to enlarge the land utilization and the reasons change) and j) the farm household food situation;

Because of their knowledge of local conditions, the farm census was conducted by the field-level extension personnel of the rural development agencies. Selection of the final 190 sample households to survey over the following three years was achieved by using a stratified random sample from the 1,300 rural households covered by the census in 18 villages, of which only 16 villages were finally used for the ongoing survey work.

The procedure for sampling households utilized the information contained in the census data. Using these data, farms were identified as to their level of animal traction equipment: fully equipped, semi-equipped and non equipped. "Fully equipped" are those households that had draft oxen, a multi-purpose plow, a seeder,and a cart. Semi-equipped are those households that had either draft animals but no multi-purpose plow, or a general-purpose plow or seeder but no draft animals. The "non-equipped" households did not have equipment other than a short-handled hoe, or had unusable animal traction equipment. The equipment

status was combined with the household's food situation (surplus, self-sufficient and deficit) to form four types of households. The four types of households are showed in the table 2-1.

The analysis of the census data showed that the households that are fully equipped were almost all assumed be food self-sufficient or better. The households with the semi-equipped status either were in a food self-sufficiency or a food deficit status. And households with a poor equipment status were largely in a food deficit situation. Households that fell into other parts of the classification matrix were not studied.

Table 2-1 The Matrix of Household Classification in terms of Grain and Equipment Status

Euipment Status	Grain Surplus Household	Grain Self-Sufficient Household[3]	Grain Deficit Household
Fully Equipped	Type I	Type I	N.A.
Semi- Equipped	N.A.*	Type II	Type III
Poor- Equipped	N.A.	N.A.	Type IV

* N.A.= Not applicable

Using this classification for the type of farms and considering the sample size for the study, three households for each of the four household types were randomly selected in each of the sixteen villages (D'Agostino, Dioné). Thus, 192 sample households were selected. The sample should have 48 equipped households with a self-sufficient (or

[3] In the census, food self-sufficiency was defined in terms of a household's ability to feed its members adequately from all sources, including the market (not defined just in terms of own-farm production.

surplus) food situation, 48 semi-equipped households with a self-sufficient food situation, 48 semi-equipped households with the food deficit situation and 48 non-equipped households with a food deficit situation. Due to the complexity of the survey process and other complications, the proportions of different types of surveyed households are only approximately as described (see table 2-2). Only 190 households were included in the first year survey and 186 for the later two years' surveys.

Table 2-2 Classification of the Different Types of Survey Households

	CMDT			OHV			TOTAL		
	OUTH	NORTH	TOTAL	SOUTH	NORTH	TOTAL	SOUTH	NORTH	TOTAL
Fully Equipped & food self-sufficient	13	16	29	11	9	20	24	25	49
% of the sample	6.8	8.4	15.3	5.8	4.7	10.5	12.6	13.2	25.8
Semi-equipped & food self-sufficient	12	11	23	10	10	20	22	21	43
% of The Sample	6.3	5.8	12.1	5.3	5.3	10.5	11.6	11	22.6
Semi-Equipped & Food Deficit	11	11	22	13	10	23	24	21	45
% of The Sample	5.8	5.8	11.6	6.8	5.3	12.1	12.6	11	23.7
Non-Equipped & Food Deficit	12	10	22	14	17	31	26	27	53
% of The Sample	6.3	5.8	11.6	7.4	8.9	16.3	13.7	14.2	27.9
The Whole Sample	48	48	96	48	46	94	96	94	190
% of The Sample	25.2	25.2	50.5	25.3	24.2	49.5	50.5	49.5	100

Source: Calculation based on the data set.

The data for the study were obtained from a general farm survey and monthly field surveys for the years 1985 through 1987. The surveys

were conducted by personnel worked on the CESA-MSU research project.

The data were originally collected to meet the research needs of a project directed by Dioné. The data collection process was directed towards testing the hypotheses of that project. Thus, for this research project, it was necessary to utilize data collected for another purpose. While the previous research focused on Mali's food security and food market reforms, this research addresses issues related to the factors influencing the household food situation.

2>. Identification of the Research Hypotheses

The research hypotheses of possible interest relate to household production efficiency, equity issues, risk and uncertainty, labor mobility, and factors affecting the rural household food situation. However, based upon the discussions regarding the original study and re-examination of the original data, the data are not adequate for testing certain hypotheses. The data do allow for the possible testing of the following hypotheses.

H1: Natural conditions, adoption of new technology, family size, family labor, institutional setting and diversification of household activities are the most important factors affecting a rural household's food situation and income generation.

The diversification of the household activities means that a household not only has grain production but also cash crop (cotton) production and non-farm activities. The household grain situation is measured by two methods. The first method is the household grain self-sufficiency level per consumption unit. This is defined as the

household's grain supply that comes from its own food production activities.

The second measure of the household food situation is the net grain availability per consumption unit in a household. The values of the net food availability of each consumption unit of a household are obtained by combining total household grain production and net food inflow through market and non-market transactions (grain purchased, grain gifts received and food barter-in), minus food outflow through the market and non-market transactions(food sales, food gifts made and food barter-out). Using grain net availability to measure the food situation of each household is an important step in order to analyze grain supply and demand of rural households simultaneously. Furthermore, because of the lack of the data on household income, the net grain availability per consumption unit of each household is used as a proxy of the household income. This assumption seems appropriate considering the agricultural nature of these households and their very low level of income.

H2: A rural household's food situation is affected by the redistribution of the household income through taxation policies.

Redistribution of the income of the farm households is accomplished when rural households pay the government tax. The assumption behind this hypothesis is that the government extracts income from the agricultural sector through low producer prices and rural taxation system. Food problems should not be considered only as problems of poor market competition and inadequate incentives for food production, but also the problems of bad government policies.

H3: The zones with better institutional arrangements have a more equable income distribution and higher homogeneity among households regarding the grain situation.

As mentioned above, since household income data is not available, grain availability per household consumption unit will be used as a proxy for purchasing power of the households. Comparing two zones, it is expected that households in the better institutional zone (e.g., those with a good extension service and farmer associations) are more similar than those in the poor institutional zone. The basic assumption underlying this hypothesis is that the policy implementation may be more easily implemented in better institutional zones than in the poor ones.

H4: Increasing grain production alone may not play a major role in increasing the purchasing power or income generation of the households.

It is assumed that a household with higher labor productivity in grain production tends to shrink the grain crop acreage and utilize the land and labor inputs for other activities such as growing cash crops and non-farm activities in order to achieve the maximization of the household income. This hypothesis will indicate that the households with the highest productivity in grain may not have incentives to increase their grain production. Furthermore, grain market reform may have little impact on increasing the total grain supply. Farmers may already have the capability to increase the grain supply, but because of better alternative for these resources, they choose not to expand.

H5: No single factor can distinguish a good food situation household from a poor situation household--but rather the food situation of a rural household is affected by several factors simultaneously.

By testing this hypothesis, important policy implications can be drawn. To deal with the rural food problem, the importance of a single policy reform program may be quite limited. A well-designed package reforms is needed to address the food problems in Mali.

3>. Statistical and econometric methods to test of the hypotheses.

To test the hypotheses, three methods will be used. These three methods include: econometric analysis, discriminant analysis and basic statistical tools (mainly frequency analysis).

The first hypothesis will be tested using a multiple linear regression model (OLS model). Equations will be created to estimate grain yields, grain acreage, food self-sufficiency and food self-reliance.

Hypotheses two and three will be tested with employing the discriminant analysis. Hypothesis five will be tested with frequency and descriptive analysis. Hypothesis four will be tested with the joint use of econometric, discriminant and frequency analysis.

4>. Data processing and analysis

For the purpose of testing the hypotheses, transformations and conversions had to be made to the original data. First, since the econometric and discriminant analyses are sensitive to missing variables (unless we improperly treat the missing variable as "zero"), it was necessary to find missing values for certain variables. Otherwise, too many sample cases would be excluded from the econometric and discriminant analysis. Because of this problem, special data handling was done. For example, many households did not report information regarding crop acreage. Since the total crop production and unit yield

is available for other households, missing values of household crop acreage are calculated by dividing the total production by the group mean yield. Other missing values were handled in similar ways (see Appendix II). Secondly, when using the original data, many new variables can be created based on logical computations and other principles. For instance, the variable "number of household consumption units" is a transformation the "total household members" using FAO standards for calorie needs of different ages and sexes. Two other variables, "total food production per household consumption unit" and "net food availability per consumption unit" are computed by adding all the possible grain together, weighted by their calorie conversion factors. Thus, the food calories are transformed to kilograms of coarse cereal crop equivalent (weight maize, millet and sorghum equally).

In order to do the discriminant analysis, a household classification has to be made. Two or three different food situation groups are made according to the classification criteria. The households with different levels of net food availability per consumption unit hadto be classified into different food situation groups. Chapter Six explain these classification procedures.

5>. Data Utilization and Limitations

In order to test the hypotheses effectively, some of data have been converted based upon the study's purpose. For instance, family size is not measured in terms of the total number of the household members, but the total number of consumption units (active adult men) in each household, as indicated in table 2-3. The conversion of the family

members in consumption units is in terms of nutritional needs, that is, the calorie requirements.

Table 2-3 Conversion Factors to Calculate Consumer Equivalents

Household Member	Recommended Daily Energy Intake	Consumption Unit
Active Adult Man	2970 Calories	1.0
Woman	2760 Calories	.929
Boys:		
10-12 Year Old	2600 Calories	.875
13-15 Year Old	2450 Calories	.825
16-19 Year Old	2580 Calories	.869
Girls:		
10-12 Year Old	2350 Calories	.791
13-15 Year Old	2120 Calories	.714
16-19 Year Old	1970 Calories	.663
Children:		
Less than a Year Old	820 Calories	.276
1-3 Year Old	1360 Calories	.458
4-6 Year Old	1830 Calories	.616
7-9 Year Old	2190 Calories	.737

Source: FAO, 1974 in Latham, 1979.

Because of costs and time constraints and other considerations, the data collected do not totally fit the research requirements. There are inadequate time series data regarding the different kinds of household activities (incomes, prices, etc.). Second, much of the data is in the

form of categorical rather than continuous values. Categorical values can be only used to create the dummy variables (usually one and zero). Too many dummy variables will affect the accuracy of the estimated model parameters. Also, the categorical variables in some cases were not precise enough. For instance, both poor and rich households had access to credit. However, it is not known if they had equal access to the same level of credit. Access to credit as a categorical variable only indicates whether a farmer had access to credit or not, and not the level. Household equipment level as a category variable had a similar problem. There may have been some complementary effect in utilizing the different equipment or tools. If a farmer had animal traction but lacked other tools such as plow, the animal traction could be of limited value. Due to this complexity, the category variables may not truly represent the different equipment levels for each household. Finally, due to the irregular weather conditions, the data collection period may have been too short. In other words, the unusual weather may overshadow the impact of other factors in a more typical weather year.

Chapter Three

Conceptual Framework of the Study

This chapter presents the conceptual framework regarding factors influencing farm household decisions. The household decision process involves making choices given the objectives and goals of the overall household. These decisions may be narrowly focused on the household food situation or more broadly on household income and general welfare.

Using this framework and given the internal and external environment, farm households will make choices and implement their decisions. The interaction of the environment and farm household behavior will influence the outcomes. In a dynamic sense, the results of the decision will in turn affect the environment and farm household economic behavior. With new environmental conditions and changing farmers' behavior new results are achieved. The interactive process is a continuous activity. The conceptual diagrams that reflect this process can be seen in figure 3-1.

Complexity of the real world Oftentimes, economists find that it is difficult to use models to explain, describe and predict situations studied because of limited knowledge. Using models to describe reality, researchers are forced to make simplifying assumptions. According to Coppedge (1977), there are two kinds of assumptions, specified and unspecified. "Specified assumptions are those

relationships and conditions that have been stated as constituting a portion of the applicable body of knowledge or model of current concern... Unspecified assumptions are those conditions and relationships that are unrecognized in the case at hand..." (pp. 4). It tends to be true that when using economic models to reflect the reality, economists usually use the factors which are recognizable and significant when building the model.

The first conceptual step of modeling is to interpret human behavior. Generally, human behaviors can be classified into two types, economic behavior and non-economic behavior. Non-economic behavior (i.e., psychological behavior) may be treated as unrecognized factor in economic analysis. For instance, people traits, such as jealousy and honesty are usually not considered as independent variables in most economic models. For this study, the same assumption will be used. This implicitly assumes that non-economic behavior will not be used in the modeling process to predict the outcome of economic activities. Based upon empirical study in Africa, this assumption does not cause major problems. When analyzing the factors affecting rural poverty, Jones (1960) holds that factors (local custom, suspicions, jealousies, ignorance, and fatalism and other uncountable cultural factors) which may affect behavior of rural people and their household situation, do not seem to influence rural poverty (Eicher 1984). Likewise, economists tend not to use in their analyses all the factors that affect human economic behavior. According to Shaffer, there are three kinds of human economic behavior, opportunistic behavior (self-interest seeking with "guile"), maximizing behavior and the loyalty behavior (Shaffer

1980). In earlier times, economic analysts tended focus on maximizing behavior when constructing economic models. Given the nature of data collected for this study, maximizing behavior is considered the major factor influencing farm household behavior.

Farm households have production and consumption functions. Their economic behaviors are structured in order to maximize the household production and consumption activities given the certain natural, social, political and economic conditions. Farmers as both producers and consumers are assumed to have various goals and objectives. The common goals of farmer as a producer is often assumed to be maximizing household production or income generation. As a consumer, farmers may try to maximize food security or achieve a higher standard of living. When allocating resources, farmers may face a trade-off between achieving production and consumption goals. For instance, if the farmer spends money for current consumption, he may have lower production because he is unable the purchase needed production inputs. Also, a rural household may choose to have current lower per capita consumption today if higher productive goals can be achieved in the future, (i.e., they may choose to have a large family size today with the hope that when the children mature they will add to the labor resources). Hence, the modelling farm household behavior is difficult because of nature of household activities and goals.

The farm household's choice options becomes more difficult when production and consumption activities also include leisure time considerations. These choices are made even more difficult when factors such as input-output prices, household labor supply and demand, and

household income level fluctuates. In their systematic study of agricultural household models, Singh, Squire, and Strauss (1986) note that many of the models make explicit assumptions regarding how farm household's decisions in production, consumption and leisure are interrelated. According to these authors, the models often assume market conditions for trade is perfect and that farmers are price-takers. Given these conditions, production and consumption decisions can be treated as if they were sequential or independent. The production decision would be made first, even though they may be made simultaneously with consumption decision (pp.89).

In many less developed countries, the assumption that the farmer's production and consumptions are made independently may be incorrect. Markets are not perfect and households are not price -takers with respect to both the inputs and outputs. In a developing country such as Mali, a large part of agriculture is composed of semi-commercial farms in which certain inputs are purchased and only a proportion of output is sold. Consequently, production, consumption and labor supply decisions are not made by farm households simultaneously (Singh, Squire, and Strauss p.6). The analysis of these farms relatively more complicated under this assumption. In a true subsistence household, these decisions are made simultaneously.

According to Singh, Squire, and Strauss, when farmers are price-takers, profit influences the household decision making regarding production and consumption. That is, "production decisions determine farm profit, which are a component of household income, which in turn influences consumption and labor supply decisions. This one-way relation

between production on the one hand and consumption and labor supply on the other hand" (Ibid., p.7) gives farm household decision making process a recursive character.[4]

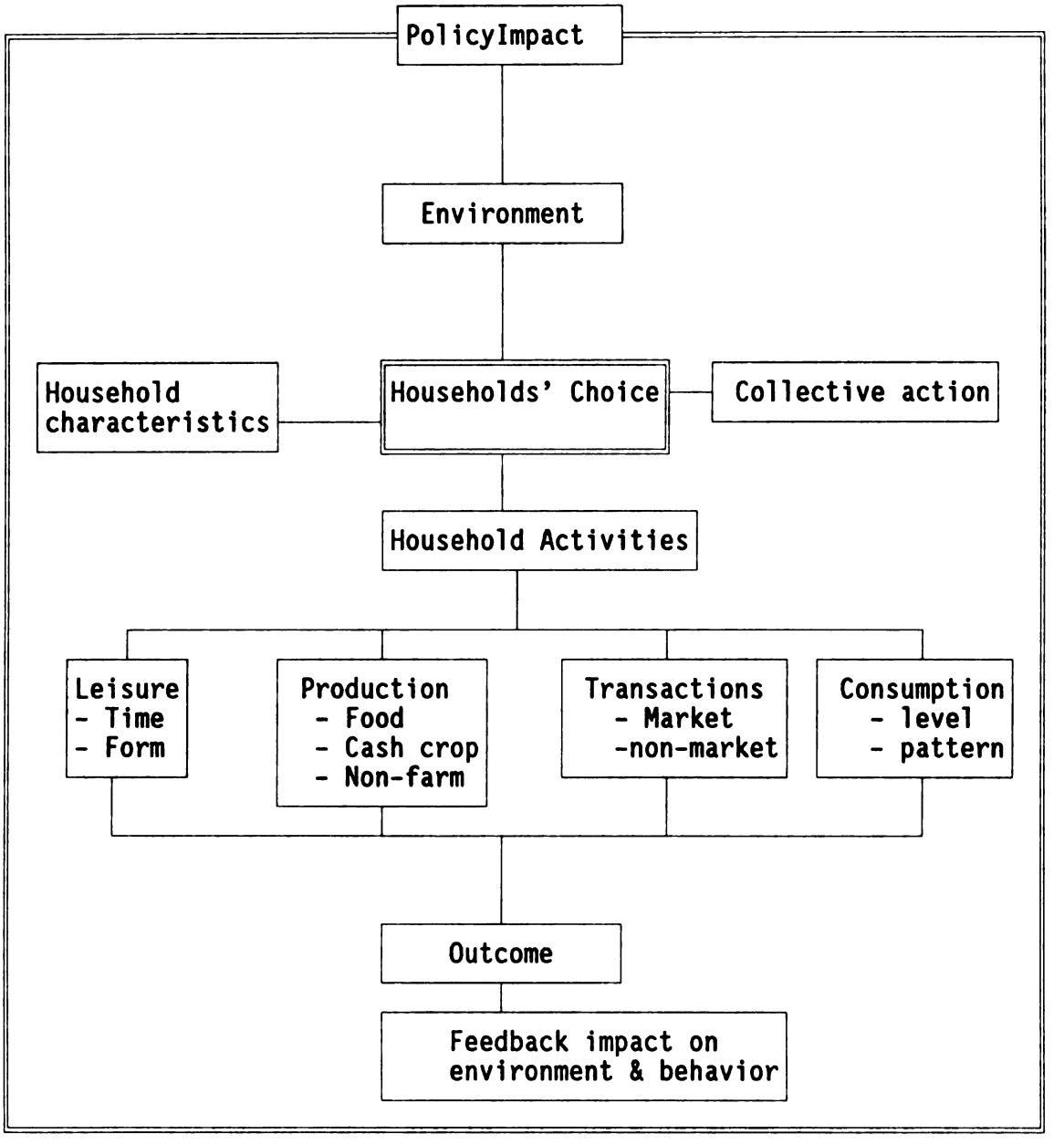

Figure 3-1 Conceptual diagram interactions of various of factors affect farm household choice in household activities--dynamic process

[4] Recursive character is one in which there is unidirectional dependency among the endogenous variables (Kennedy 1979, p.118).

With regard to household time allocation, household workers can choose to work or to rest. There is trade-off between time allocation to work and to leisure. The profit level may be affected by this trade-off. Higher producer prices will increase the household profit, which will in turn affect the value of labor and hence the household labor supply. Some current theories suggest that as profit increases, farmer households may increase their leisure consumption rather than allocating additional labor to production activities In general, the factors affecting household behavior in production, consumption and leisure can be described with the conceptual diagram in figure 3-1.

In certain socio-economic and political environments, farmer household decision making is determined by the external and internal conditions. Within a given environment, farm households make their own decisions regarding household activities (the household food and income related activities). Farmers choose different strategies to fulfill their goals. As actions are taken to meet these the goals, both policy makers and farmers evaluate the outcomes. Based upon the evaluation process, policies change and household decisions adjust to the changing policies.

Modeling the interaction of environment and household decision on the relevant outcome--the short run static analysis.

In Mali study, there are not adequate data and information regarding multi-year production, consumption, prices and labor supply and demand to observe the long run dynamic effects shown in figure 3-1. Only a short-run analysis of the interaction of the environment and

economic behavior of the rural people can be considered. Furthermore, the studied farm households are heterogenous rather than homogenous in commercial production (D'Agostino, Dioné and Staatz, 1989). Some farm households (substance) are not price takers for some commodity, whereas other households (semi-commercial and commercial farm households) are price-takers for commodities sold, and inputs purchased. Thus, it is impossible to model all households as a homogenous group regarding household decision making. Because of this limitation, the analytical model has to somewhat simple in operational terms (e.g., a multiple linear regression of household food with different levels of food self sufficiency.

In rural Mali, because the natural conditions make agricultural production risky, food production is given a higher priority in farm household decision making. The household production and consumption decision is made relative to maximization of household food security. This is mainly achieved through maximizing the household food self-sufficiency or the households net food production. If the markets function well, rural household may also choose to maximize total household income through alternating production activities. If there is a high risk in acquiring food by trading methods --as historically has been true in Mali-- farmers may choose to maximize food production in certain years and store excess food production for less favorable years.

Based on the analysis of agricultural household models, it is difficult to model factors affecting household behavior. It is reasonable to assume that farm households in rural Mali desire to maximize household income per capita given that the other prime

objective of the household, food self-sufficiency, is achieved. Households have to balance food production and total income generation. Whether a farmer can achieve these goals depends upon several factors and conditions. These factors can be classified into, 1) farmers' short run production decisions; 2) collective action; 3) the natural, technological and resource environment; 4) household characteristics and 5) policy and institutional setting.

To achieve its production objectives, farm households have to make choices regarding the allocation of resources including household laborers, to different production and marketing activities. Possible activities include on-farm grain and cash crop production, market and non-market transactions, non-farm activities and other production activities.

The choices made by farmers in rural Mali may reflect the level of risk they are willing to assume in their production and other activities. Lacking perfect information, individuals often have a risk aversion attitude. Rural farmers in Mali are assumed to have a similar risk avoidance attitude (Dioné 1989, pp.93-96). Because of this attitude, "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..."(Ibid.,96). Facing a risky situation, the farm household may choose a high level of diversification of household activities and utilize relevant risk reducing technologies such as intensive grain cultivation.

Farmers' collective action may also affect household behavior. Through collective action, a better credit program may be implemented.

Consequently, better credit cash crop production might be enhanced. Better collective action of farmers can also lead to sounder institutional arrangements at village level, such as a more equitable implementation of taxation policy. Better collective action may also reduce the self-interest behavior of the individuals. Better collective action can be enhanced with stronger farm associations and other local organizations, good local rural social services, and a better institutional environment.

The measurement of collective action remains a problem when modeling the household's behavior. Often this done with non-continuous variables. In the modelling done in this study, two variables are used as proxies to reflect the effectiveness of collective action. These two factors are the zone variable which reflects a different mix of institutions and services and household's access to credit.

In achieving household objectives, farmers is constrained by the natural environment. For instance, rain-fed agriculture may be heavily influenced by precipitation levels. Higher rainfall generally causes higher yields. The characteristics of the soil also influence the crop grown and yields achieved. Better soils (high level of natural fertility of land) can lead to higher crop yields. Natural and resource conditions, such as the amount of land and water, and population distribution may be closely interrelated. In a better natural conditions zone, the amount of land available to a household may be more constrained because of a higher population density. Rational farmers tend to select a relatively better natural condition region for settlement. Therefore, the amount of better quality land per capita may

be lower in the better zone. Households in the region with better natural conditions are more likely to achieve higher household food and other crop production through intensive cultivation. In less favorable zones increased production might be accomplished by expanding the area cropped.

The availability of new technologies, such as improved varieties, mineral fertilizer, modern production equipment and tools, and pest control measures will influence the farm household strategies employed in crop production. Technology adoption is usually related to the level of investment to support production activities by the households. The level of investment, especially capital investment, is related to the household's income and welfare situation. Thus, a household with a better food and income situation would be expected make a higher level of use of new technologies. Due to data problems, only two factors which represent the household technological level are employed in this study. The two factors are the household equipment status and level of fertilizer use.

Policy factors have an important influence on household decision. Policies, such as food pricing policies, taxation rules, land tenure regulations and income distribution policies, can have a major impact on the real income of rural households. Due to data and measurement problems, no policy factors were directly incorporated into the quantitative model in the study. Finally, household characteristics are important in the household decision making process. For instance, family ties and social relations will affect household food production and transaction decisions. Household workers with non-farm skills might

be able to earn more income by working off the farm. Only two variables in this study are used to represent the household characteristics. One variable is the number of adult equivalent consumption units, and the other variable is the number of household members.

Modeling the process of factors affecting the outcomes of household production and marketing activities is complex. There are measurement difficulties for certain types of factors and a lack of understanding regarding the interaction of different factors. Factors such as technologies and institutional conditions are not handled easily as continuous variables. Also in the long run, the factors are interrelated and mutually influenced by one anther. Thus, categorical variables are often used. However, for other factors, categorical variables are not appropriate (i.e., some policy factors and household characteristics). To address this problem, economists generally simplify the analytical process by making of explicit assumptions. These assumptions make it possible to use a static model to study a dynamic situation. However, these simplifying assumptions cause the model to not accurately reflect reality.

In the factors-behavior-outcome conceptual model, in the short-run static situation it is necessary to assume that household production and consumption are independent (even though it is not entirely a realistic assumption). It is also assumed that the most relevant factors exogenously determine the household decisions making and the relevant outcomes. these assumptions are necessary because the data problem does not allow us for consideration of the endogenous factors in the modelling analysis. Farmers' production decision are only influenced by

technologies, quantities and qualities of production inputs and input-output price ratios. In the short run, it is assumed that the household production decision and the relevant outcome are determined only by different factors exogenously. Based on these assumptions, household food production per capita may be determined by the combinations of factors utilized (e.g., land, on-farm labor technology, household characteristics, natural condition, institutional factors). Because crop yield multiplied by crop acreage results in household food production, a better understanding of households' food strategies can be obtained by studying the factors affecting yields and acreage.

When the risk of food insecurity is reduced to a certain level, farmers might pursue the goal of higher household income, or further pursue the enhancement of household food security. When data regarding household income is not available, household net food availability per capita can be used as a proxy to represent the income level of the households. Net food availability not only reflects the household food production, but also household market and non-market transactions. The household food transaction activities are influenced by cash crop production, and non-farm activities, The diagram of factors affecting net household food availability are showed in figure 3-2.

The policy environment, resource availability, technology options, and institutional and natural conditions are considered the external environment affecting household decision making. The household characteristics and village collective action can be regarded as the

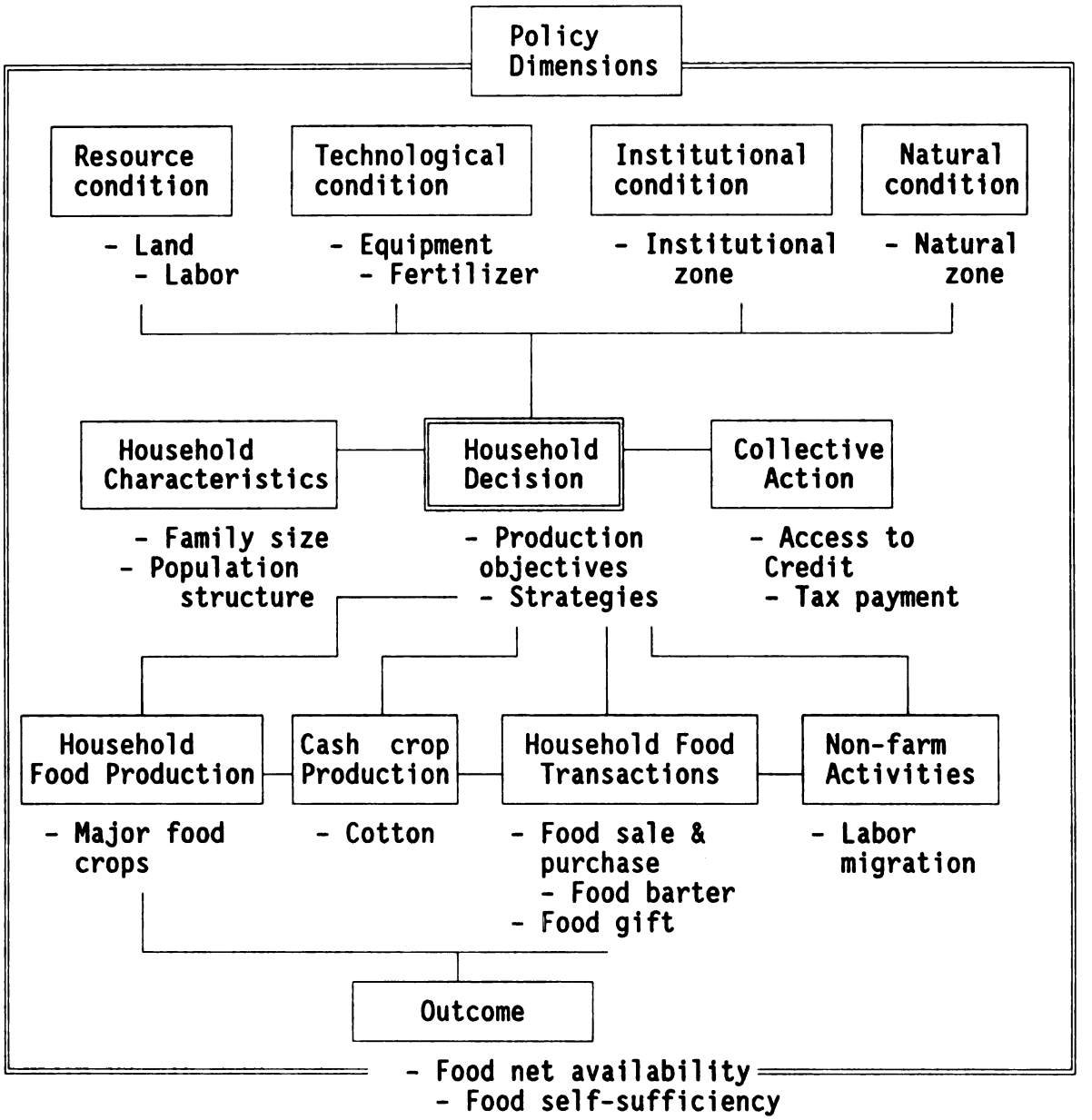

Figure 3-2
Conceptual diagram of factors affecting household food net availability in the short run

internal environment affecting household decision making. The choice of different household activities as influenced by the external and internal environment can be thought of as farmers' strategies in achieving their objectives. Food availability is the major goal that farm households attempt to achieve.

Prediction of the Outcome

The interaction of environmental conditions and farm household behavior generates the outcomes. The outcomes from the farm households decisions and strategies can be evaluated in terms of efficiency and equity issues in general and rural poverty and food security issues in particular. In the case of rural Mali, the outcomes of household production decisions and the strategies are indicated by the household food and income situations. As stated earlier, because income information is not directly available, the net food availability is used as a proxy for household income. It is also used to represent the household food security situation.

In the study of food security in rural Mali, particular attention must be given to addressing the food problems of households with food deficit. To improve the food security situation of the rural poor, it is necessary to have an understanding of why food-deficit households are different from food-surplus households.

According to Lipton (1977), there are several reasons why poor people remain poor. One reason is the size of the family. Since a poor family tends to have "too many" children, the output per family member is at a subsistence
level. Lipton implies this tendency may not hold true in the long run (pp. 84). The second reason suggested as to why the poor stay poor is based on the assumption that they have high preference for leisure (unwillingness to work). A third stated reason is that policies tend to hinder the poor relative to other groups. According to Lipton, unwillingness to work is

"neither chosen nor genetically determined, but is the result of inegalitarian policy in general and urban bias in particular." (Ibid.,pp.83). Lipton believes that urban bias can be simply explained as policy makers ignoring opportunities that would make it possible to increase total economic efficiency and at the same time to achieve higher equity. Under this condition, policies are systematically shifted, away from some 'better' or 'best' policy which is unbiased with respect to urban and rural areas (pp. 44). According to Lipton, the poor (especially the rural poor) stay poor because the rural people are treated unequally in resource allocation, investment and income distribution compared to their urban counterparts.

To identify empirically if there exists an urban bias in Mali is beyond the scope of this study. However, by examining different factors such as household characteristics, natural and economic conditions, technology and the policy programs in relationship to different rural household food and income situations, it may be possible to gain an understanding of rural poverty.

To predict the food and income situation of different farm households, the relevant factors and conditions can be used as the independent variables. By using an estimated household food situation function, it is possible to evaluate the importance of different factors affecting household food security, insecurity and household income. This evaluation process may provide implications for policy adjustments to improve the food situation of the rural poor.

The framework of this study may help us understand how different factors affect household production decisions and outcomes of these

decision related to the household food and income situation. The study maintains that in the short run, household production behavior can be described and predicted given the internal and external environment conditions. A better understanding of farmers' behavior regarding production and marketing may suggest needed policy changes that will lead to improving the efficiency and equity of the society in general and improving the food security situation of the rural poor in particular.

CHAPTER FOUR

MAIN CHARACTERISTICS OF DIFFERENT FOOD SITUATION HOUSEHOLDS IN THE SURVEY AREA

In order to understand the food problems of different rural households, especially those of the rural poor households (usually the food deficit households) in the survey area, a study of the characteristics of the different food situation households is necessary. The basic natural, physical and socio-economic features and the main characteristics of the households in whole study areas (across the zones and subzones) and within zones (or subzones) have been studied in detail by D'Agostino (1988) and Dioné (1989). This study focuses on the major characteristics of the different food situation households in the study areas with respect to family size, food production and transactions, cotton production, non-farm activities, household equipment status, labor, land, access to credit and food net availability.

Before presenting the analysis on the characteristics of different food situation households, the definitions of the different food situation households needs to be given.

A food-deficit household is a household where the net food availability for each household member in a year is less than 188 kilograms (Dioné). Net food availability means the household obtained its food from its own food production plus (or minus) the food net inflow (or outflow) through the market or non-market transactions, such as sales and purchases, gifts made and gift received, and food barter-in and out.

An equivocal food situation household is a household where the net food availability of each household member in a year is more than 188 kg but less than 216 kilograms. the 216 kilograms figure is obtained through a calculation that the post-harvest food loses are 15% of the total food production (Dioné). Based on some studies, the grain losses were around 10-30 % or more in many African countries (Lele and Candler, 1984, pp.207) Therefore, by adding the 15% food security coefficient, a household can be regarded as having enough food if its net food availability is 15% higher than 188 kg per capita in a year. If the amount of food a household member had is in the range between 188 and 216 kilograms, the household is regarded as in an equivocal food situation.

A food-surplus household is a household where the net food availability of each household member is equal or greater than 216 kilograms/year.

Now that the definitions of the different food situations of households have been set, the basic characteristics and profiles of the sample farm households in different areas (across different zones) and in the same area (within a zone or subzone) can be introduced.

Sample households in the study areas

Referring to table 4.1, among the 190[5] sampling households 95 of them were from the CMDT zone and 91 from the OHV zone in the final sample. There was also 1 missing case from the CMDT North and 3 missing cases from the OHV North for the original sample of 190 households. Within a zone,

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[5] Only 186 households have provided adequate data for the entire 3-year survey study.

48 came from the CMDT south, 47 from the CMDT north; 47 from the OHV South, and 44 from the OHV north. Among the sample households, the CMDT South had 25.8% of the total sample farm households, the CMDT North had 25.3%, the OHV South had 25.3% and OHV North had 23.7%. Because there were missing cases for the OHV North, the sample size of the OHV was slightly smaller than that of the CMDT.

Table 4-1 Sample farm households of different food situations in the studied areas (1984-1986, Mali)

	CMDT		OHV		TOTAL	
	No.	%[6]	No.	%[7]	No.	%[8]
SOUTH	48	50.5	47	51.6	95	51.1
Food deficit household	6	6.3	32	35.2	38	20.4
Equivocal food situation household	1	1	3	3.3	4	2.2
Food surplus household	41	43.2	12	13.2	53	28.5
NORTH	47	49.4	44	48.4	91	48.9
Food deficit household	9	9.5	30	33	39	21
Equivocal food situation household	3	3.2	4	4.4	7	3.8
Food surplus household	35	36.8	10	11	45	24.2
TOTAL	95	100	91	100	186	100
Food deficit household	15	15.8	62	68.1	79	42.5
Equivocal food situation household	4	4.2	7	7.7	11	5.9
Food surplus household	76	80	22	24.2	98	52.7

Among different food situation households, there were 15 grain deficit households in CMDT which account for 8.1% of the total 186 sample households, or 15.8% of the surveyed households in the CMDT zone). In

[6] Percentage of households in the CMDT zone.

[7] Percentage of households in the OHV zone

[8] Percentage of all surveyed households.

CMDT, there were also 4 equivocal food situation households and 76 grain-surplus households. There were 62 grain-deficit households, 7 equivocal grain-situation households and 22 grain-surplus households in the OHV zone. Within zones, CMDT South had 6 food-deficit households, 1 equivocal food situation household and 41 food surplus households. The CMDT North had 9 food deficit households, 3 equivocal food situation households and 35 food surplus households. There were 32 food deficit households, 3 equivocal food situation households and 12 food surplus households in OHV South. And 30 food deficit households, 4 equivocal food situation households and 10 food surplus households were from the OHV North.

Generally, the food situation of the sample households deteriorated from the CMDT zone to OHV zone and from the south to north. The CMDT had 77.6% of the food surplus and 19.5% of the food deficit households in the sample. The OHV had 80.5% of the food deficit and 22.4% of the food surplus households. In the CMDT South, 85.4% of the households had a food surplus households and 12.5% were the food deficit households. The figures in the CMDT North were 74.5% food surplus and 19.1% food deficit. The food deficit households accounted for 68.1%, food surplus accounted for 25.5% of the survey households in OHV South. In the OHV North the figures was 22.7% food-surplus and 68.2% food deficit households These facts indicated that differences exists in the food situations of households in the different zones and subzones.

Since the range for classifying households as equivocal food situation is so narrow, these households accounted for only a small proportion (5.9 percent) in the total sample cases. Hence this becomes insignificant when doing this analysis by food group. Therefore, in

analysis, these households will be excluded.

Population and family size of the study households

The total number of people in study 190 households was approximately 2,600. This is equivalent to 2,431 consumption units (Dioné) and 2,090 active adult men. Of the total people in the study, 1,217 were taxable people (i.e., household members that had to pay head tax to the government) accounted for about 46.8% of the total. Approximately 49.5% of the people belonged to food deficit households, and 4.6% belonged to the equivocal food situation households and 44.9% were in the food surplus households.

As shown in Table 4-2, a farm household in the survey had the equivalent to 12.8 household consumers (defined by Dioné as the ordinary household members in food consumption). A food deficit household had the equivalent to 15.6 consumers, while a food surplus household only had 11 consumers. In the CMDT zone, an average household had 11.8 consumers. A food deficit household had 13.3 consumers, while a food surplus household had 11.5 consumers. In the OHV zone, a household had 14.4 consumers. A food deficit household had 16 consumers, and food surplus household had

Table 4-2 Family size of the sample farm households

(1985, Mali)

	CMDT	OHV	TOTAL
No.of consumers in sample	1121	1310	2431
% of the total	46	54	100
% of food deficit	16.6	83.4	100
% of food surplus	80	20	100
Household size (No. of consumers)	11.8	14.4	12.8
Food deficit household	13.3	16.5	15.6
Food surplus household	11.5	10.5	11.1

10.5 consumers. Of the total food deficit, 16.6% were from the CMDT zone,

and 83.4% from the OHV zone. Approximately 80% of food surplus people were from CMDT zone, and 20% were from the OHV zone.

Based on the above information, it seems that household size were negatively related to the farm household food situation. The greater the number of family consumers in a household, the worse the food situation of the household.

Farm Household Labor

Since farm household in the survey differed with respected to family size (household members), the size of the labor force of each household also tended to be different. On the average, a household in survey area had the equivalent of 4.78 adult workers. For a food deficit household, the average was 5.14 adult workers, while for the food surplus household the number was 4.69. In the CMDT zone, a household have 5 adult workers, and the average OHV zone household 4.55 adult workers.

A survey area household had an labor to consumption unit ratio of .46 (SD=.15). The dependency ratio (the inverse of the labor to consumption unit ratio) was equal to 2.17. For a food deficit household, the labor to consumption unit ratio is .41(SD=.14). The dependency ratio was equal to 2.43. A food surplus household had a labor to consumption unit ratio of .50 (SD=.15) and the dependency ratio was equal to 2.0. In the CMDT zone, the labor to consumption unit ratio is equal to .5 (SD=.14) and the dependency ratio is equal to 2.0. In the OHV zone, the labor to consumption unit ratio is .41. Within the CMDT zone, the labor to consumption unit ratio is .477 (SD=.11) for a food deficit household, and .504 for a food surplus household. Inside the OHV zone, the labor to consumption unit ratios are .388 (SD=.138) and .487 (SD = .178)

respectively, the dependent ratio is equal to 2.58 and 2.05 respectively.

Farm Household Food Production

Household included in the study grew one or more of the main food crops. These include coarse grains (maize, millet and sorghum), rice, groundnut and cowpea. Total food production is measured in coarse grain equivalent, this production figure is calculated through calorie conversion. According to Latham (1979), 1 kg. of the coarse grains (mixed maize, millet and sorghum) can yield of proximately 3490 calories. For a more accurate measurement of the food situation of the different households, rice, groundnut and cowpea were "converted" to coarse grains based on the appropriate calorie conversion ratio. Based on these conversions, the yearly food production was calculated for each household.

Total food production of the survey households

On the average, the survey household produced the equivalent of 2,818 kilograms coarse grains per year during the period from 1985 to 1986. For a food surplus and food deficit household the figures were 3,712 and 1,793 kilograms respectively. In the CMDT zone, a household produced 3,614 kilograms coarse grains. In the OHV zone, the figure is 2,152 kilograms. The average food production of the food deficit households was 2,051 kg in the CMDT zone and 1,784 in the OHV zone. The average food production of food surplus households was 3,993 kg in the CMDT zone and 3,080 in the OHV zone. These results are shown in table 4-3.

As the table 4-3 indicates, the differences in household's food production between the zones and between food deficit and surplus households were sizeable. An average household in the OHV produced only

Table 4-3 Average Annual Food Production of Different Food Situation Households 1985-1986, Mali

	CMDT (kg)	OHV (kg)	TOTAL (kg)
All household food production			
Mean value	3614	2152	2819
Standard Deviation	2561	1752	2288
Deficit household food production			
Group mean	2051	1784	1793
Standard Deviation	1957	1374	1480
Surplus household food production			
Group mean	3993	3080	3711
Standard Deviation	2591	2369	2541
Food production index A (CMDT=100)			
1.Household food production	100	59.5	78
2.Food deficit household	100	87	87.4
3.Food surplus household	100	77.1	92.9
Food production index B *			
1.Food deficit household	51.3	57.9	48.3
2.Food surplus household	100	100	100
Food production index C **			
1.Food deficit household	51.3	44.7	44.9
2.Food surplus household	100	77.1	92.9

* The food surplus household food production be equal to 100.
** The food production of food surplus household in the CMDT zone be equal to 100.

60% of the food of a CMDT household. A food deficit household produced 48% of a food surplus. In the CMDT zone, a food deficit household produced 51.4% of a food surplus household. For the OHV zone, the figure is 57.8%.

Intensification of crop growing and on-farm labor grain productivity

(1). **Household main crop acreage** The household crop acreage includes the growing of food crops, cotton and other crops in 1985. The average crop acreage under cultivation for a surveyed household was 5.92

hectares. Farmers in the CMDT cultivated an average of 7.5 hectares per household. In the OHV zone, the average crop acreage cultivated per household was 3.6 hectares. It is believed that the crop acreage cultivated varies widely in different locations within Mali (D'Agostino 1988). Within different food situation households, the crop acreage cultivated also tended to vary significantly. Farmers in a food deficit household cultivate an average of 4.5 hectares per household. While a food surplus household cultivated 7.4 hectares. This is 64 % more acreage than that of a food deficit household. Considering the variations within household size (household consumers) in the surveyed area, the average crop acreage or per consumption unit (active adult man) in a household is calculated.

On the average each consumption unit of a household had .61 ha. of crop land. In the CMDT the average crop acreage per consumption unit was .79 ha. and .42 hectare in the OHV zone.

(2) Grain crop acreage per consumption unit The surveyed household grew the average of .52 ha. of grain crops per consumption unit in each household. This accounted for 85% of all crop acreage. In the CMDT, the grain crop acreage per consumption unit in a household is an average of .63 hectares, 80% of the all crop acreage. And in the OHV, each consumption unit had .40 hectares of grain crop acreage, 94.5% of total crop acreage. This is only 63% of that of a consumption unit in the CMDT zone.

(3) Intensification of grain crop cultivation. This refers to the grain acreage cultivated by each on-farm adult worker of a household. As we can see in table 4-4, each on-farm adult worker cultivated an average

of .78 hectares of grain crops. However, each on-farm adult worker in a food-deficit household

Table 4-4 The average grain crop cultivated by each adult on-farm worker

	CMDT	OHV	TOTAL
All surveyed households			
Mean Value	.94	.63	.78
Standard deviation	.85	.75	.80
Food deficit households			
Group mean	.73	.55	.59
Standard Deviation	.41	.59	.55
Food surplus households			
Group mean	1.0	.91	.96
Standard Deviation	.92	1.07	.93

cultivated .59 hectares of grain crops, while in a food deficit household the figure is .96 hectares. This is 63% higher than that of a food deficit household. In the two zones, each on-farm laborer in the OHV zone cultivated an average of .63 ha. of grain crops. Meanwhile, each on-farm laborer in the CMDT zone cultivated .94 ha of grain crops, 49% higher than in the OHV. In the OHV zone, each on-farm laborer of a food surplus household cultivated an average of .91 ha.of grain crops, 60% higher than that of the labor productivity of a food-deficit household in the OHV. In the CMDT zone, each on-farm laborer of a food surplus household cultivated 1 ha. of grain crops, 37% higher than in the CMDT.

The standard deviations values tended to be high. This indicate that the levels of grain crop cultivated by each on-farm adult worker varied greatly between two different zones, the two different food situation households, and between similar households. It is therefore desireable to study the households within a zone and with the same kind of household food situation to determine why these differences exists.

(4) Household grain crop labor productivity The household grain crop

labor productivity refers to the total amount of grain each on-farm worker of a household produced. This is calculated by dividing the total household food production by the total number of on-farm laborers of a household.

productivity of a food surplus household averaged 666 kg, which is 120% higher than that of a food deficit household.

The standard deviations of different households within a zone and with the same kind of households also tended to be high, this indicates that the productivity varied significantly from household to household.

Diversification of farm household activities.

Diversification of household activities related to how a that a household allocates its labor not only for grain production, but also to cash crop production (mainly cotton) and the non-farm activities.

Cotton acreage ratio and Cotton production

Table 4-5 The average grain productivity of on-farm labor of different households 1985-1986, Mali

	CMDT	OHV	TOTAL
All surveyed households			
Mean value	590	303	443
Standard Deviation	513	337	453
Food deficit households			
Group mean	303	255	256
Standard Deviation	313	251	255
Food surplus households			
Group mean	666	465	611
Standard Deviation	530	491	519

As table 4-5 indicates, the grain crop labor productivity for the all surveyed households was 443 kg. For the food- deficit households, each on-farm laborer produced 256 kg grain products. For food-surplus household, the figure is 611.2 kg, 138% greater than that of a food

deficit household. In the OHV and CMDT zone the grain labor productivity was 303 kg and 590 kg respectively. In the OHV zone, the productivity was 255 kg for food deficit household and 465 kg for a food surplus household. A food surplus household had 82% higher grain crop labor productivity than that of a food deficit household. In the CMDT zone, the grain labor productivity of a food deficit household averaged 303 kg. The Cotton acreage ratio is the cotton area cultivated divided by total household crop acreage. The mean value of the cotton acreage ratio and cotton

Table 4-6 The average cotton acreage ratio and production in survey area 1985-1986, Mali

	Cotton Acreage Ratio(%)			Cotton Production(kg)		
	CMDT	OHV	TOTAL	CMDT	OHV	TOTAL
All survey households						
Mean value	19.7	6	12.7	1274	237	741
Standard Deviation	11.8	12.5	14	1508	634	1265
Food deficit households						
Group mean	15.4	5.4	6.7	924	229	323
Standard Deviation	12.4	11.5	11.9	1446	646	852
Food surplus households						
Group mean	20.5	9.3	18.3	1363	327	1147
Standard Deviation	11.6	15.8	13.5	1553	694	1474

production of each household in different zones and different food situations can be seen in table 4-6.

An average a household had 12.7% of the total crop acreage in cotton, a total cotton production of 1,274 kg. For individual households within the different zones with different food situations, the level of household cotton production was quite different. In the whole surveyed area, a food deficit household used on average 6.7% of the total crop land for growing cotton and produced 323 kg cotton. For a food surplus household, the figures are 18.3% and 1,147 kg. respectively. In the CMDT zone, a household used an average of 19.7% of its total crop land for

growing cotton and produced 1,274 kg cotton. In the OHV zone, the figures are 6% and 237 kg respectively. Comparing the households of different food situations in different zones, the cotton production differences were even larger. On the other hand, comparing the same food situation households in the same zone, it can be observed that the cotton production of each individual household varied widely, This is indicated by the high standard deviations, especially in the OHV zone. The high standard deviations values reflect a concentration of cotton growing. In other words, a few large farms or households probably accounted for a major proportion of total cotton production in the study area. Actually, as the frequency counts indicated, 25% of the survey households (48 of the 190 survey households) accounted for about 81% of total cotton production, and 25% of the cotton growing households (among the cotton growing households) accounted for 61.5% of the total cotton production.

Non-farm activities of the survey households

According to the survey data, only 37.7 % of the total survey households were engaged in non-farm activities. Sixty two percent of the households did not have non-farm activities. Among 77 food-deficit households in the survey, 43% of them had non-farm activities. On the contrary, about 34% of the food surplus households had non-farm activities. The results are showed in table 4-7.

As table 4-7 indicates, in the CMDT zone, about 29% of the households had non-farm activities. The CMDT zone had 20% of the food deficit households and 30% of the food surplus households doing non-farm activities.

Table 4-7 Non-farm activities of the surveyed households

	Households doing non-farm activities			Households without doing non-farm activities		
	No.	%	% of group	No.	%	% of group
The surveyed households*	66	37.7	100	109	62.3	100
--Food deficit households	33	42.9	50	44	57.1	40.4
--Food surplus households	33	33.7	50	65	66.3	59.6
The CMDT zone	26	28.6		65	71.4	100
--Food deficit households	3	20	11.5	12	80	18.5
--Food surplus households	23	30.3	88.5	53	69.7	81.5
The OHV zone	40	47.6		44	52.4	100
--Food deficit households	30	48.4	75	32	51.6	72.7
--Food surplus households	10	45.5	25	12	54.5	27.3

* The 11 equivocal food situation households are not included in computation of the non-farm activities of different food situation households.

In the OHV zone, the rates were 48% and 46% for food deficit households and food surplus households respectively.

An interesting and important question related to rural labor doing non-farm activities is: whether such non-farm activities have a positive effect on the household food situation. Usually, more non-farm activities may lead to an increase of the total income of the household, and consequently, the household food situation would improved. It is inferred that better food situation households tend to have more family members and a higher proportion of family labors doing non-farm activities. As Derek Byerlee indicated, in the environment "that the economy is closed, an

increase in agriculture's output is likely to increase migration out of agriculture..." (1973). Based on the results of this study, Byerlee's statement may not be totally true. First, with the exception of the case in the CMDT, the labor migration (or doing non-farm activities) rate of the food deficit households were higher than that of the food surplus households in general. This result may be expected by many economists. The basic rural labor migration model (e. g., Harris-Todaro,) might predict that less migration from rural areas of high production potential (Katz and Stark, 1986). In other words, the lowest income households and region would have higher rural migration. This is what the survey result partially illustrated. Second, as the census analysis indicated, the food deficit households had more members of the household doing non-farm activities. This is because the food deficit households usually had a relatively smaller amount of land and large families and hence surplus labor. The only fact that supports Byerlee's statement is that food surplus households had a higher proportion of family labors doing non-farm activities. The surveyed data indicated that 62.9% of household workers of the grain surplus household were engaged in non-farm activities. This is in comparison to only 58% of the household workers of grain deficit households had engaged in non-farm activities. Thus, it is not clear whether or not the non-farm activity had positive role for improving the household food situation. The problem will be explored in the quantitative analysis in chapters five and six.

Land Quality, Technology Adoption and Fertilizer Utilization

Land Quality (grain and cotton yields)

Crop yields are important measures that reflect the farmland quality (land productivity). Even though many factors can affect the crop yields,

such as fertilizer utilization, irrigation, new higher yielding varieties, the crop cultivation method and field management (such as pest control), the natural fertility of the farm is also important. The natural fertility of farmland may be influenced by the soil type, geographical location and other natural environmental conditions. Without an explicit study of the fields, the factors affecting the natural fertility of land might not be measurable. Therefore it can not be stated that different crop yields of different households were affected heavily by the natural fertility of the crop land. In other words, it may not be inferred that a food deficit household had low crop unit yields simply because it had low level of input utilization, because yield are also influenced by low quality land.

The average household in the survey produced 559 kg (SD=412) of grain products per ha of grain crops. The figures are 460 kg. and 642 kg for food-deficit households and food-surplus households respectively. A food-surplus household had 40% higher food crop yields than a food-deficit household. In the CMDT zone, the average food crop yield for each household was 594 kg (SD =425) or 13% more than a household in OHV zone

Table 4-8 Grain and cotton production of the sample households

(Kg/ha.)

	CMDT		OHV		TOTAL	
	Grain	Cotton	Grain	Cotton	Grain	Cotton
All surveyed households						
Mean value	594	815	526	590	559	775
Standard Deviation	425	456	392	177	412	429
Food deficit households						
Group mean	355	858	487	613	460	730
Standard Deviation	284	377	285	157	290	305
Food Surplus households						
Group mean	640	785	605	546	642	766
Standard Deviation	427	463	609	221	478	452

(526 kg; (SD=392)). In the CMDT zone, a food surplus household had grain yield 80% higher than that of a food deficit household. In the OHV zone, a food surplus household only 24% higher grain yields than did a food deficit household. (See table 4-8).

The difference in grain yield between the CMDT and OHV zone may reflect the greater use of fertilizer in cotton production by food surplus households in the CMDT zone. Thus the "residual impact" of cotton fertilizer on the succeeding grain crop will cause the grain yield to be substantially higher.

Technology adoption

In Chapter 2 the structure of the equipment status of the different households has been presented. The proportion of household with different

Table 4-9 Farm equipment level of different food situation households

	Equipped (%)	Semi-Equipped (%)	Non-Equipped
All Surveyed Households(100)	25.8	46.3	27.9
Food Deficit Households(100)	19.5	45.5	35.1
Food Surplus Households(100)	31.6	48	20.4
CMDT Zone (100)	30.2	46.9	22.9
--Food Deficit Households(100)	20	33.3	46.7
--Food Surplus Households(100)	32.9	51.3	15.8
OHV Zone (100)	21.3	45.7	33
--Food Deficit Households(100)	19.4	48.4	32.3
--Food Surplus Households(100)	27.3	63.6	36.4

equipment situation is similar between zones and regions. Hence, it is more meaningful to observe the equipment status of the different food situation households.

As showed in table 4-9, food surplus households had a higher proportion of the better equipment status than the food deficit

households.

About 32% of the food surplus household were fully equipped, while only 20% of the food deficit households were equipped. Only 20% of the food surplus households were non-equipped, while 35% of the food deficit households were non-equipped. The difference were larger when comparing the different food situation households in the CMDT zone. Only 16% of the food surplus households were non-equipped, while 46.7% for the food deficit households were in this category.

Fertilizer Utilization

Fertilizer utilization of the surveyed households was stated in terms of total fertilizer level, fertilizer applied per hectare of food and cash crops and fertilizer applied per hectare of grain crops. As showed in table 4-10, the average level of household fertilizer utilization varied in different zone and for different food situation households. Comparing the CMDT and OHV zones, and the food surplus households and deficit households, fertilizer use is less in the OHV zone and in food deficit household. Because cotton was grown mainly in the CMDT zone, the fertilizer utilization in the CMDT was several times greater than the usage rate in the OHV zone. For food and cash crop acreage and the grain crop acreage, the fertilizer level, the fertilization rate in the CMDT zone was 3.8 times greater than in the OHV zone.

Access to Formal Credit

Even though the variable "household access to formal credit" is an important indicator of the impact that institutional factors have on the rural households, the inherent drawbacks of using a categorical variable

limits the analysis that can be accomplished. However, given the limitation the analysis can still provide come incites.

Table 4-10 The average fertilizer utilization of each household

	Fertilizer level per household (kg)	Fertilizer per ha. of crop (kg/ha.)	Fertilizer per ha. of grain crop (kg/ha)
Whole surveyed households	130	18	37
(Standard Deviations)	(204)	(22)	(95)
Food deficit households	52.6	10.5	23
(Standard Deviations)	(109)	(2.3)	(87)
Food surplus households	204	24.7	52.4
(Standard Deviations)	(243)	(22.3)	(104)
The CMDT Zone	224	28.8	55.9
(Standard Deviation)	(240)	(23.3)	(109)
--Food deficit households	150	27.3	48
(Standard Deviation)	(186)	(31.7)	(132)
--Food surplus households	263	28.5	60
(Standard Deviation)	(252)	(21.7)	(108)
The OHV Zone	41	7.5	15
(Standard Deviations)	(95)	(15.3)	(63.4)
--Food deficit households	34	7.1	10.7
(Standard Deviation)	(70)	(14.2)	(48.1)
--Food surplus households	69	10.4	29.8
(Standard Deviations)	(146)	(19.4)	(97.2)

The households' ability to obtain credit in the past five year was recorded, (See table 4-11).

About 35.5% of the surveyed households did not have access to credit. For the food deficit households of both regions, 60% lacked access to credit. For the food surplus households, only 16.5% did not have access to credit. In the CMDT zone, 93.3% of the food deficit households had access to credit. And 94.7% of the food surplus households had access to credit. However, in the OHV zone, less than 35% of the households had access to credit with only 26.7% of the food deficit households having access to credit.

Table 4-11 The number and proportion of different food situation households having access to formal credit in the survey area

	The CMDT		The OHV		Total	
	No.	%[1]	No.	%	No.	%
All surveyed households	85	94.4	26	31.7	111	64.5
--Food deficit households	14	93.3	16	26.7	30	40
--Food surplus households	71	94.7	10	45.5	81	83.5

whereas, 45.5% of the food surplus households had access to credit.

It is believed that in the OHV zone, households had lower access rate to the formal credit when compared to those of the CMDT zone, because the credit rating of the households in the OHV was considered poor. Oftentimes, the households in the OHV failed to pay back the money they owed. Consequently, credit was constrained in the OHV zone. On the other hand, in Mali the credit provided was usually associated with cotton production or the production of other cash crops. Since the households in OHV zone had limited of cotton production, it might not be easy or necessary for them to have credit. A similar explanation holds for the food-surplus and food-deficit households across the different zones. As indicated previously, the food surplus households had more cotton production than did the food deficit households. Thus, there were more food surplus households in the CMDT zone and therefore, food surplus households would had a better chance of accessing credit. Finally, perhaps because of the better institutional environment, the CMDT zone had better collective action of different households. In other words, the better development of village associations in the CMDT may reinforced the " rules

[1] The percentage of households having access to credit is obtained by divided the number of households that had access to credit by the total number of households of same situation households of the same zone. The eleven food equivocal situation households are not included.

of the game". Individual may be more likely to obey the rules because of pressure from the other farmers and the village associations. Whereas in the OHV, the role of the collective action of the households may be weaker or non-existent. In chapter five, the impact of access to credit on household food situation and the associated factors will be further analyzed.

Farm Households Food Marketing Performance

Net food sales and net purchase

The real meaning of the net food sales and purchases may be better understood as "food net trade-out or Trade-in". Four basic four items are included in the computation of the household food transactions: 1)food sales, 2) food purchases, 3) food barter-out and 4) food barter-in. If food sale plus food barter-out minus food purchases and food barter-in is greater than zero.

Table 4-12 Food trade of different food situation households

	The CMDT (%)	The OHV (%)	Total (%)
All survey households			
Food Net Traded-in			54.2
Food Net traded-out			45.8
Food deficit households			
Food net traded-in	71.2	63	74
Food net traded-out	28.6	27	26
Food surplus households			
Food net traded-in	27.4	52	32.7
Food net traded-out	72.6	48	67.3

the household was classified as food net sales households.

Based on the survey data, the food trade situation of different survey traded-out household. If opposite is true, the household was classified as food net traded-in household.

As indicated in table 4-12, 45.8% of the households were food net trade-out and 54.2% were food net trade-in. Among the food deficit households, 26% were food net trade-out and 74% of them were food net trade-in households. Whereas 67.3% of the food surplus households were food net trade-out and 32.7% were food net trade-in. In the CMDT zone, 28.6% of the food deficit households were food net trade-out households, while 72.6% of the food surplus households were food net trade-out. In the OHV zone, about 27% of the food deficit households were food net trade-out, while 52% of the food surplus households in the OHV zone were classified as food net trade-out.

It is widely believed that the pattern of food deficit households being net food sellers can be explained by taxation policy. The rural poor because of have heavy tax burden might be forced to sell grain even though they are consuming inadequate levels of grain. This will be further explored in the later part of this thesis.

Timing of the grain trade

Due to the existence of seasonal food price fluctuations, we may hypothesize that the timing of food sales and purchases were much important for households having large food transaction activities. It is hypothesized that food deficit households might sell grain in the market shortly after harvest, which results in a lower price, in order to pay their taxes obligations. Also, they might be forced to purchase food for consumption when the price are higher. This situation will be evaluated in chapter six.

Tax Payments of Different Food Situation Households

Not surprisingly, with the existence of the head tax system, a

household with a large number of taxable people would usually pay more taxes than a household with smaller number of taxable people. This is particularly true if tax rates for between regions are not substantially different. As table 4-13 indicated, each household was asked to pay 17,317 CFAF tax in 1986, and 17,278 CFAF in 1987[2]. In reality the actual tax payment of a household in 1986 an of 19,300 CFAF. The actual tax payment of 1987 is not available. Based on the survey data, the actually tax payment of a household is about 11% higher than the tax claimed by the government in 1986. Thus, households actually paid 11% more tax than it was supposed to pay. For the different food situation households, the excess tax payments were different. A food deficit household had to pay an average of almost 20% more tax than it should have. Yet, a food surplus household only paid 6.3% more tax than it was supposed to pay. The reasons for tax over-payment could be very complex. It is believed that the tax policy or system was not strictly implemented by the local tax collectors. Many households in the survey area did not know how mach tax they where supposed to pay (Dioné).

Another possible explanation is that the food surplus households might or might not be asked to pay more tax. Perhaps the tax rates vary between regions, and by the size of the family. If the tax rate does not vary across regions because the food deficit households had more taxable people, the food deficit households might be asked not only to pay more tax but also to pay a higher tax per person. In reality, the tax rates per person do very by region, depending on the perceived wealth of the region. Therefore, tax rates are higher in CMDT than in OHV, since more of the

[2] During this period, the exchange rate was roughly 300 CFAF = US $1.

grain-deficit households are in the OHV zone. This may explain why the average tax payment of the grain-deficit households was lower than that of the food surplus households. On the average, a food deficit household was asked to pay only 91-96% of the tax of a food surplus household.

However, because of large families a food deficit household has paid

Table 4-13 The average tax claimed and paid of the surveyed households (1986-1987, Mali)

	Tax claimed (CFAF)		Tax paid (CFAF)		Excess payment (%)	
	1986	1987	1986	1987	1986	1987
All Survey Households	17317	17277	19200	NA*	11	NA
--Food Deficit Households	16608	16690	19907	NA	20	NA
--Food Surplus Households	18228	18151	19376	NA	6	NA
The CMDT Zone	19019	19061	19897	NA	5	NA
--Food Deficit Households	18156	18681	18929	NA	4	NA
--Food Surplus Households	19184	19135	20084	NA	5	NA
The OHV Zone	15542	15470	18808	NA	21	NA
--Food Deficit Households	16191	16154	20133	NA	24	NA
--Food Surplus Households	14907	14731	17255	NA	16	NA

* NA means " not available ".

2.7% more taxes than a food surplus household. In the OHV zone, where a large percentage of households had food deficit situation, a food deficit household had to pay an average of 16,150 CFAF tax in 1986 and 1987. This is 8.6 and 9.7% more than that of a food surplus household. In 1986, a food deficit household paid an average of 20,133 CFAF tax, 24% more than the amount the government claimed, and 16.7% more than a food surplus household paid. It is not known if the grain deficit households were paying deferred taxes of prior drought years might be causing the situation.

Heterogeneity of The Food Deficit Households

The primary interest of this thesis is to look at the situation of rural food-deficit families through group analysis. By viewing food

deficit households as a homogeneous group, we have found the basic characteristics of food deficit households as a whole. There are however, some differences from household to household within the food deficit group. The group mean values may not properly represent the characteristics of food deficit households. Therefore, it is necessary to examine food deficit households in more detail.

The frequency counts and descriptive analysis on the food deficit households indicate that for some variables (factors) had high variation. This is indicated by the standard deviations related to these factors. Thus, the mean value of the variables may not represent the individual household appropriately.

For most of the variables selected, at least 10% of the food deficit household had reached the mean value of the food surplus households. For instance, it is hypothesized that the number of family members is one of the more important factors affecting the food situation of the households. As the population increases rapidly in Mali, if food production could not keep pace, the food situation will deteriorate. Nevertheless, 49% of the food deficit households had the same family size or no larger than that of the average size of the food surplus households. To evaluate the impact of the family size on the household food situation, it is desireable to examine another important variable, household on-farm labor grain productivity. The results show that about 11% of the food-deficit households had the same grain labor productivity as the mean value of the food surplus households. All other things being equal, it may be inferred that the food situation of this type of food deficit households was only affected to minor extent by the family size, whereas for other food

deficit households this might not be the case. Of course, the analysis is not that simple, since if the 11% households had a smaller family size, the number of workers would also be reduced which could affect household food production.

In cotton production, at least 65% of the food deficit households did not grow cotton, while 19% of the food-deficit households had a higher cotton acreage ratio than the mean value of the food surplus households. About 9% of the food deficit households had more cotton production than the group mean value of the food-surplus households.

In food production, 10.4% of food deficit households produced more food than the group mean value of the food surplus households. However, fifty percent of the food deficit households only produced less than 35% of the mean value of food surplus households. About 22% of the food deficit households had more land (total crop acreage) than the mean value of the food-surplus households, whereas 50% of the food deficit households had less than 40% of the mean value of the food surplus households. About 40% of the food deficit households had access to credit, while 60% of the food deficit households did not. More than 27% of the food-deficit households had a higher labor/consumption unit ratio or lower dependency ratio than the group mean of the food surplus households, However, 50% of the food-deficit households had only reached the 76% of the group mean level of the food surplus households. About 26% of the food deficit households had higher grain yields than the group mean value of the food surplus households, On the other hand 50% of the food deficit households had less than 54% of the mean grain yield of the food-surplus households.

Summary of Chapter Four

In this chapter, the main characteristics of the different food situation households in different regions and within a region have been presented. The major differences and characteristics between food deficit households and food surplus households with regard to food production and transactions also have been discussed. These differences have helped identify important factors affecting household food situations. The results provide an idea about the basic situations of the surveyed households. Nevertheless, this is not the final purpose of the study. To test the hypotheses, it is important to understand not only differences between type of household but also in what extent the differences are interrelated to each other. Further, we need to explain and predict why the poor stay poor and in order to draw certain policy implications based on the observed factors. Therefore, we need to conduct a more detained quantitative analysis. This analysis will be presented in the next two chapters.

Chapter Five

Factors Affecting the Household Food Situation --The Econometric Analysis

In Chapter four, the basic characteristics of different food situation households have been described. The analysis of chapter four provides an understand of the general situation of the surveyed area regarding factors that influence the food situation of different farm households. Given this understanding, several important questions remain and need to be addressed. First, to what extent would different factors such as technology, natural and institutional environment, household labor and other resource conditions affect the food situation and income generation of the surveyed households? Second, which factors are more important in the determination the food situation of households? Third, what are the relationships of the different factors (independence, substitution or complement) in affecting the household food situation? Finally, what are the important factors that can be used to distinguish the different kinds of food situation households? To address these questions, econometrics and discriminant analysis will be used.

In this chapter econometric methods will be used to examine the different factors affecting the surveyed household situation. Several linear models will be utilized. Before presenting the econometric analysis, the relevant factors affecting household food production and food access need to be discussed.

Factors affecting the farm household food situation

1).Food Production

Many factors can affect the farm household food production. The main elements are grain crop acreage and grain yields, since yield times the acreage equals the total production. Hopefully, if the factors affecting the grain yield and grain acreage can be quantified, then the estimation of the food production equation become simple. The factors expected to influence acreage are the quantity and quality of family labor or hired labor available. equipment status such as animal traction, oxen, sprayer and multi-purpose plow, also, weather (rainfall and temperature) affects the tillage of crops in different regions. Technology employed will affect the size of the total crop land cultivated. Cash crops would compete with grain crops for land and other resources at the farm level. Of course, there are some complementarities between cash and grain crop production. Under the current price system, if farmers have a large amount of cash crop production, more income would be generated. Hence, these farmers have a greater ability to invest in new food production such as acquiring more land. Policy (mainly the price policy) would affect the strategy households follow in allocating resources to different activities, thus affecting the acreage of the crop grown.

Yields are likely to be affected by such factors as soil conditions, natural conditions (rainfall, solar energy), natural land fertility, land improvement, different input utilization and cropping patterns, cultivation experience and management, adoption of new varieties and so forth.

Factors affecting food access

Two main factors affect the food access of farm households. One is the household's own food production. Any factors which affect the household's food production would also affect food access (availability). The other factor which may affect food assessment is the farm household income situation. This is influenced by the level of non-farm activities, cash crop production, household welfare (e.g., saving, real estate, inheritable property), and factors affecting income redistribution such as the rural taxation policy. Food storage, food marketing and other institutional conditions also affect the farm food access of the household.

Although many different factors can affect the rural household's food situation, with respect to food production and access, some factors are not observable or measurable quantitatively for lack of adequate information. The time constraint and higher cost of obtaining the information are the main reasons for not having the adequate data. Technically, some factors are very difficult to be measured quantitatively. For instance, both the labor quantity and quality (i.e., managerial skill) will affect the labor endowment in food production. Labor quality includes educational level, motivation, initiative, attitude to risk and factors related to personality. Inheritable characteristics of labor are almost impossible to be measured quantitatively.

Other factors, such as input-output ratios and food consumption patterns, only can be observed accurately with a high investigation cost. For many researchers and scientists, it is not possible to collect detailed data because of time and cost constraints. Therefore, many

factors which may be important for the determination of the food situation of different households may not be observable or are lacking. Thus, to quantitatively measure the overall impact of the different factors on rural households' food situation and income generation is extremely difficult.

Considering the constraints mentioned above, the factors that can be used for quantitative analysis are listed below. Also included in the discussion are some of the important factors that are not available for inclusion in the analysis.

Continuous variables that reflect the factors affecting the household food situation

1). Basic variables

Family Size (POP)

Family size is seen as an important variable affecting the food situation of different households when the household food situation is stated in per capita terms. Family size is measured by the number of household members. It is expected that a large family size will have a negative impact on the per capita food situation of farm households.

Farm Household Labor Force (ACT)

Based on census data in the survey area, the total number of the household workers (adult workers) includes the laborers doing on-farm activities and laborers doing off-farm activities. It is expected that the household labor force is correlated with the family size, since a large size of household tends to have more workers. Hence, it may not be desireable to use this variable in regression analysis because of a serious multicollinearity problem.

Land Size (TOTACREA)

As indicated in chapter four, land size is the total crop acreage (hectares) cultivated by the farm household . It is frequently argued that there is abundant land in Mali relative to population density. Hence land may not be the constraint in food production. Land resources are limited if: 1) there are limited amounts of high quality land suitable for agriculture. (perhaps the available land is not suitable for agricultural production; or 2) as Malian population grows rapidly, the land resource per capita may be decreasing. In general, it is reasonable to assume that high quality agricultural land is an constraint on African food production.

Food Crop Yield (LANDQU1A)

Although the yield (measured in terms of kilograms of grain equivalent per hectare) is derived from the total food production and food acreage, it is an important variable that represents the productivity of a household. It is also an important indicator of the quality of the crop land.

Cotton Production (QC)

Cotton production (measured in the total kilograms of cotton a household produced) is an important cash income source for households, especially those in the CMDT zone. Based on the assumption of risk aversion of the rural households, farmers are expected to increase cotton production only when they have achieved a certain level of food self-sufficiency. Hence, cotton production is expected to be an endogenous variable of household food production. Food and cotton production are interrelated. A better food situation would lead to an increase in cotton production.

Fertilizer Utilization (TOTFERTI)

This variable is measured in terms of the total kilograms of fertilizer used by a household in its production activities. Fertilizer may be an important factor affecting food crop and cotton yields. Based on the analysis of chapter 4 many households especially the food deficit households did not use fertilizer on their food and cash crops. There were also household that had high levels of fertilizer use. Therefore, the fertilizer level may be an important indicator which reflects the family's income and welfare situation. It may also be related to the adoption of new technology (high yielding variety) and access to credit.

Number of Taxable Persons (NBIMP)

This variable (measured in terms of the total number of people who actually paid taxes), reflects how many productive people there are in a household, since the taxable person is of working age. On the other hand, based on the head tax policy mentioned in chapter four, the greater the number of taxable persons within a household, the more taxes paid. The more taxable persons a household had, the more household income would be reduced for paying taxes, thus causing the household food situation to worsen.

Tax Claimed by the Government (TAX1 TAX2)

Two years (1986 and 1987) of data are utilized in the calculation of the total taxes (CFAF per household) claimed by the government for each household. The variables represents the amount of taxes the government claimed for each farm household based on the tax rate (CFAF per taxable person) and the number of taxable persons. Using this variable and the next variable enable an examination of the impact the government policy

(fiscal) on the household food situation.

Tax Payment of the Households (TAXPAY86)

This is the variable that represents the actual taxes a household paid in 1986. The size of the tax payment is expected to have a negative impact on household income generation and the food situation.

2). Transformed variables

Transformed variables are not obtained directly from the original data but through the computation or manipulation of the data. The reasons for the creation of transaction variables is related to the inappropriateness of using the basic data. In particular, it is necessary to reduce problem related to multicollinearity. Second, it is not appropriate to measure each individual household food situation in terms of its total level since the family size varies considerably. Thus the food situation of each farm household should be stated in terms of food per household member (or per capita).

Based on these two considerations, additional variables are computed. These variables are:

Household Consumption Unit (SUMCONSU)

The method of computation of this variable was introduced in Chapter 2. Basically, it represents the standard unit for food consumption. This is a key variable when comparing different household food situations.

Household Labor Per Consumption Unit Ratio (ACTRATIA)

This variable is obtained by dividing the number of household laborers by the size of household consumption units. It is the inverse of the dependency ratio. This variable is used for the comparison of different levels of labor availability among households with different

family sizes. This variable also indicate the relative productive of a household. The higher the ratio, the higher the expected productive of a household.

Grain Acreage Cultivated Per On-Farm Laborer (GLABORHA)

This variable (calculated by dividing the total household food crop acreage by the number of on-farm workers) measures how intensive the food production is for each household. Hopefully, this variable also represents the quality of household laborers. A high GLABORHA implies that the household labor is using labor-saving technologies, (i.e., equipment to replace labor), but also is more active and productive.

Grain Acreage Per Consumption Unit (GRAINACR)

To avoid the multicollinearity between family size and grain crop acreage, the household food crop acreage can be stated as the acreage per consumption unit. The variable is obtained by dividing the total household food crop acreage by the total number of consumption units.

Household Crop Acreage Per Consumption Unit (ACREAGMA)

Like the variable GRAINACR, this variable is calculated by dividing the total crop acreage of a household by total number of consumption units.

Cotton Acreage Per Total Crop Acreage Ratio (PERCECOT)

Since total cotton production varies widely from household to household, for a better measurement of the cotton growing specialization of each household is to state cotton production on a relative scale. The cotton production level is measured as a percentage of the total crop acreage of each household.

Food Production Per On-Farm Laborer (MEKGONFL)

This is the variable that measures how productive a household's on-farm labor is. The creation of this variable is based on the assumption that hired labor does not play an major role in food production.

Fertilizer Level Per Hectare of Crop Land (MEFER)

This variable is obtained through dividing the total household fertilizer (kg) use by the total hectares of crop land. This variable represents the relative level of fertilizer utilization and avoids problem related to multicollinearity. This variable also state the intensity of farm production.

Grain Crop Fertilizer Utilization (GRAUNFER)

This variable is obtained by dividing the amount of fertilizer utilized for grain production by the total grain crop acreage (Kg/ha. of grain crop). It is possible that cotton production highly correlates with the total fertilizer utilization. To make an accurate comparison of grain fertilizer use between different households, this variable is needed.

Categorical Variables

Categorical variables are used because there were not enough data to describe the real situation. Categorical variables are also used in the quantitative analysis. A categorical variable in the econometric model is represented by a dummy variable (a variable only having a value of zero or one). The six categorical variables used in analysis are:

Production Zone (Z)

Empirically, it is believed that for the two institutional zones, CMDT and OHV, the CMDT zone has the better institutional environment. It has a better functioning public sector, more experience in the institutional management, better extension and other services, and highly

organized farm associations. The value of the dummy variable for the households in the CMDT is one and zero for the household in the OHV.

Sub-Zone of Production (SZ)

This dummy variable is used because the natural factors such as rainfall and soil type have an impact on crop production in the different areas. These factors impact make the production situation of various regions different, especially between the northern and southern areas. To reflect the differences between the south and north regions of the study area, this dummy variable is used. The value is one for the households in the south, and zero for those in the north. Presumably, the natural conditions in the south are more favorable for agriculture than those in the north.

Equipment Status (STRDUMMY)

As mentioned in the Chapter 2, the survey data originally divided the studied households into four groups based on the three different levels of the equipment status and household food situation. The values of the categorical variable are: 1= The households had a better food situation and better equipment status; 2= The households had a good food situation and fair equipment status; 3= The households had a poor food situation and fair equipment status; and 4= The households were not equipped. In order to create the appropriate dummy variables with the value one and zero, it is assumed that there are no big differences in the equipment status between the households classified into the "1" and "2" groups and the households classified into the "3" and "4" groups. Even though the households classified into "2" and "3" both have a fair equipment status (semi-equipped), there exists a difference in equipment

level between the good food situation households and the poor situation households. Therefore, the dummy variable would have the value one if the original households were classified into 1 and 2 household groups, and zero otherwise.

Access to Formal Credit (CREDIT)

This variable was relatively easy to obtain from the original survey data. The dummy variable was created. When a household had access to formal credit in the past five years, it received a value of one, Otherwise, the zero value was assigned.

Households With Non-Farm Activities (EMIGRAT)

Although the size of household labor force engaged in non-farm activities is available from the farm census data, the data had contain serious problems, and was not reliable for use as a continuous variable. For instance, some households had more household laborers than the total number of household members. From the survey, the dummy variable labor migration is used to represent the non-farm activities of the farm households. If a household had any laborer doing migration, it was assigned the value one. If the survey households did not have labor force doing migration during the survey years the value of the dummy variable was zero.

Household Is Net Seller Or Net Buyer Of Food (NETSALE)

The value one of this dummy represents a household that had an outflow of grain (sales plus barter) greater than its inflow (purchases and in-barter) and value zero if a household had net inflow of grain.

Other important variables that are unavailable

In attempting to use the census data to describe and explain

reality, many factors should be represented by relevant variables in the models. But the data is lacking. For instance, the household income information is not available in the data sets. Important information such as the household food consumption patterns, adoption of the new technology such as higher yielding varieties, relevant information about the labor market, and other data mentioned in the Chapter 2 are also lacking. Given this situation, the options are not to do the detailed quantitative analysis, or create proxy variables which may approximately represent the missing variables. The latter method will be employed in the next stage of the analysis.

Building the quantitative models--an econometric analysis.

Multiple linear regression models are used for the econometric analysis. The linear model was chosen to study the household food situation because it fits the assumption that the household food situation is a linear function of the selected independent variables and unobserved system error (disturbance term). The linear form is used instead of quadratic or other forms because the linear function is relatively easy to fit given the limited data set. The estimators of the variables of the majority of the linear models will be obtained through the Ordinary Least Squares method. When necessary simultaneous equations (a two stage model) will be used to obtain the estimators (i.e., we may find that the cotton production is an endogenous variable of grain production and there are instrumental variables that determine the cotton production and grain production simultaneously).

1. Food Self Sufficiency Model

In order to study the quantitative relations between household food

production and the deterministic factors (independent variables in the model), a set of equations are established. Food self sufficiency is defined simply as the household providing enough food for the household members from its food production.

Basically, production is determined by yield and grain crop acreage. Two econometric linear models that reflect the contribution of the factors to the grain crop unit yield and grain crop acreage are built. Generally only one year of data are utilized since the total complete information only can be obtained in the production year 1985/1986.

(1) The Unit Yield Equation

The dependent variable is grain crop average yield per ha. The equation for the grain yield is expressed as:

$$L = \alpha + B1 \cdot X1 + B2 \cdot X2 + B3 \cdot X3 + B4 \cdot X4 + B5 \cdot X5 + B6 \cdot X6 + B7 \cdot X7 + B8 \cdot X8 + e1$$

Where:

L is the dependent variable LANDQU1A, the grain crop yield.

B1-B8 are the coefficients for the variables from X1 to X8. and:

α is the constant of the equation.

e1 is a stochastic error term.

X1 is the household labor force/ consumption unit ratio (ACTRATIA).

X2 is a dummy variable, representing farm household equipment status.

X3 is the dummy variable, subzone (SZ).

X4 is household grain crop acreage per consumption unit (GRAINACR).

X5 is the ratio of household cotton acreage and crop acreage (PERCECOT).

X6 is acreage of grain crop cultivated per on-farm labor (GLABORHA).

X7 is the fertilizer utilization per ha. of grain crop (GRAUNFER).

X8 is the dummy variable representing the institutional impact(Z).

There may be some interrelations between certain variables, such as X1 and X6. However, the correlation between the inverse dependency ratio and grain crop acreage per on-farm labor would not be expected to be very high since the higher level of grain acreage per on-farm labor did not have a direct connection with the inverse dependency ratio. It could be that a household that had a high level of grain acreage per on-farm worker, also had small inverse dependency ratio. Or it could be that the household had more laborers doing non-farm activities.

In Table 5-0, the variables with two asterisks should not be included in the equation, because of low level of significance. Thus it is not known the impact these variables had on yield. Consequently, the four

Table 5-0 Original household original grain unit yield equation for the CMDT and the OHV zone, Mali (1985-1986)

Equation A: Original Unit Yield Equation
Dependent Variable: Landdqula (Unit Grain Yield)
Adj R^2= .344 F=11.32 Signif F =.0000 Residual= 168

Independent Variable	B	SE B	Beta	T	Sig T
(CONSTANT)	256.2	99.17		2.58	.0106
X1 (ACTRATIA)	336.28	180.1	.123	1.87	.0637 *
X2 (STRDUMMY)	96.99	56.2	.117	1.73	.0862 *
X3 (SZ)	158.06	63.6	.19	2.48	.014
X4 (GRAINACR)	-166.7	99.7	-.134	-1.67	.0965 *
X5 (PERCECOT)	1385.8	276.5	.46	5.01	.0000
X6 (GLABORHA)	-37.47	39.59	-.07	-.95	.3454**
X7 (GRAUNFER)	-.245	.30	-.054	-.813	.4176**
X8 (Z)	-52.97	77.42	-.064	-.684	.4948**

* represents the variable that is not significant at 5%
** represents the variable that is not significant at 10% level (the same as in the later result).
variables that should be dropped from the equation are the variables X6-X8. These variables are: the grain crop acreage per on-farm laborer,

fertilizer level per ha. of grain crop, and the institutional environment.

The result of the computer analysis is listed in table 5-0.

Normally fertilizer use and credit are usually significant for determining crop yields. This is especially true of fertilization levels. These factors are not significant in this research because of poorly recorded data. One hundred thirty seven of 190 studied households had a zero value for the fertilizer utilization or missing values. Also fertilizer use is highly correlated with cotton cultivation. Therefore, it had indirect influence on grain yield since relative cotton area had a large impact on grain yield.

The refined equation for the grain unit yield after dropping the relevant variables can be seen in Table 5-1.

Before estimating the final result of the regression, it is expected that

Table 5-1 Correlation between the Variables in the Final Grain Yield Equation, Mali (1985-1986)

	GRAINACR	SZ	STRDUMMY	PERCECOT	ACTRATIA	LANDQU1A
GRAINACR	1.00					
SZ	-.187	1.00				
STRDUMMY	.036	-.01	1.00			
PERCECOT	.028	.397	.283	1.00		
ACTRATIA	.245	-.078	.013	.235	1.00	
LANDQU1A	-.195	.377	.196	.522	.142	1.00

no serious multicollinearity exists between the independent variables in the model (see table 5-1).

This is the case since all the correlation coefficients are all less than 0.4. On the other hand the correlation between the dependent variable and the independent variable relative cotton acreage is high as indicated by the beta value. Since its beta is the highest the cotton acreage has

made the greatest contribution to the grain crop yield among the all independent variables.

We may notice that the value of adjusted R^2 is fairly small, (.335). The

Table 5-2 Refined unit grain crop yield equation

Dependent Variable: LANDQUIA (unit grain crop yield)
Adj R^2 =.335 F=19.65 Singnif F = .0000 Residual =180

Independent Variable	B	SE B	Beta	T	Sig T
α (CONSTANT)	282.8	93.5		3.02	.0029
X1 (ACTRATIA)	299.91	174	.111	1.72	.0865
X2 (STRDUMMY)	74.4	52.1	.091	1.43	.155
X3 (SZ)	156.16	56.2	.19	2.78	.006
X4 (GRAINACR)	-249.57	77.99	-.2	-3.2	.0016
X5 (PERCECOT)	1179.6	213	.4	5.54	.0000

assumption of linearity of the equation may be weak. Part of the reason for the low R^2 is that categorical variables, such as SZ and STRDUMMY, can have a strong impact on the R^2 value. Consequently, the explanatory power of the estimators is not strong enough. Caution should be taken when using the result.

Implications Based on the result of table 5-2, in the final equation, all the variables except the variable that represents the household equipment status are more significant than in the original equation. Based on the results, it can be concluded that the household labor per consumption unit ratio, equipment status and the natural environment condition and cotton acreage ratio had a positive impact on the household grain yield, while the grain crop acreage per household consumption unit had a negative effect on grain yield. More implicitly, holding other things constant, when a household labor per consumption unit

ratio increases an additional 10%, its unit grain yield would increase approximately 30 kg/ha. On the average, the household with the better equipment status would have a 74 kg/ha. higher grain yield than a household with the poor equipment status. A household in the south of the study area tended to have 156 kg/ha. higher grain yield than a household in the north. A household with a higher ratio of the cotton acreage also tends to have a higher grain yield. If the cotton crop per total crop acreage ratio of a household is 1% higher than another household, the former would have about 11.8 kg/ha more than the latter. If a household is to increases its grain yield by 250 kg, it needs to reduce grain crop area by one hectare.

(2) Grain Acreage Equation

Since household food sufficiency is define as a household consumption unit had adequate food from the family food production, it is better to use the grain acreage per consumption unit rather than total food crop acreage as the dependent variable for the grain acreage equation. This results in a more meaningful comparison that includes different household situations rather than household size. The equation can be expressed as:

$$G = \alpha 2 + B1 \cdot W1 + B2 \cdot W2 + B3 \cdot W3 + B4 \cdot W4 + B5 \cdot W5 + B6 \cdot W6 + B7 \cdot W7 + B8 \cdot W8 + e2$$

Where:

G, the dependent variables, is the grain crop acreage per consumption unit of a household.

a2 is constant.

e2 is error term.

W1 is total consumption units of a household.

W2 is the dummy variable Z, representing the difference in institutional environment between the CMDT and the OHV zone.

W3 is grain acreage per each on-farm laborer.

W4 is the variable representing the natural environment (SUBZONE).

W5 is the dummy variable representing the household equipment status.

W6 is the variable representing the on-farm labor grain productivity.

W7 is household labor per consumption unit ratio.

W8 is cotton acreage per total crop acreage ratio.

B1 to B8 are the coefficients of the variables W1 to W8 respectively.

The results of the regression are listed in the table 5-3.

Table 5-3 Original Grain acreage Original Equation for CMDT and OHV in Mali (1985-1986)

Adj R^2 = .55 F = 27.9 Signif F =.0000 Residual = 168

Independent Variables	B	SE B	Beta	T	Sig T
α (CONSTANT)	.49	.049		9.98	.0000
W1 (SUMCONSU)	-.0154	.0024	.37	-6.4	.0000
W2 (Z)	.15	.045	.226	3.34	.0010
W3 (GLABORHA)	.335	.035	.80	9.53	.0000
W4 (SZ)	-1.25	.042	-.187	-3.0	.0031
W5 (STRDUMMY)	.074	.04	.11	1.85	.0667*
W6 (MEKGONFL)	-.00028	.00006	-.382	-4.11	.0001
W7 (LANDQU1A)	.000013	.00002	-.016	-.233	.8161 **
W8 (PERCECOT)	.20	.189	.085	1.08	.2798 **

* represents the variable that is not significant at 5%
** represents the variable that is not significant at 10% level (the same as in the later result).

In the original model, the variables W7 and W8 are not significant at 10% level, and hence should be dropped form the model. After dropping these two variables, the regression result of the refined grain acreage equation can be seen as in the table 5-4.

The adjusted R^2 value is relatively bigger than that of the yield

Table 5-4 Final grain crop acreage equation for CMDT and OHV in Mali (1985-1986)

Equation B2: the Refined grain crop acreage equation
Adj R^2 = .5523 F= 37.18 Signif F = .0000 Residual = 170

Independent Variables	B	SE B	Beta	T	Sig T
α (CONSTANT)	.481	.042		11.5	.0000
W1 (SUMCONSU)	-.015	.0024	-.367	-6.4	.0000
W2 (Z)	.18	.037	.268	4.82	.0000
W3 (GLABORHA)	.327	.03	.78	10.76	.0000
W4 (SZ)	-1.06	.037	-1.58	-2.89	.0043
W5 (STRDUMMY)	.083	.039	.123	2.14	.0341
W6 (MEKGONFL)	-.000027	.00006	-.37	-4.5	.0000

model. This means that the linear relation between the dependent variable and the independent variables in the grain acreage equation is slightly better. Therefore, greater confidence can be assumed when interpreting the estimated parameters.

The results indicate that the natural condition have a major affects on the level of grain acreage per consumption unit. A household in the good natural condition (the southern) area would have a smaller grain crop acreage than that of a household in the poor natural condition (the northern). In the better natural condition area, the household tends to be more intensive in crop production. The on-farm labor grain productivity has a negative impact on grain crop acreage per household consumption unit. As hypothesized in chapter 2, farm households might try to achieve the goal of maximizing total household income after achieving household food self-sufficiency. Based on the equation, if a household laborer can produce an extra 100 kg grain products, the household will tends to reduce its food acreage by .3 ha. This is based on the assumption each household had 11 consumption units, (grain crop acreage per household consumption unit decreases by .027 ha,) when holding other factors constant. Under

the current price policy, a farm household with higher labor productivity in grain production may devote its relative surplus land and labor to other activities such as cash crops and non-farm production, because of better opportunities.

Family size (represented by the household consumption units) is also negatively related to the grain acreage per consumption unit. Based on the results of the regression, when the family increase, the household grain acreage per consumption unit increases at a slower rate. Consequently, the larger the family, the lower the food acreage per household consumption unit.

On the other hand, the household equipment status and the institutional condition tend to have a positive impact on the household grain acreage per consumption unit. The acreage per consumption unit in a household of the CMDT would be .18 ha. more than that in the OHV zone. A household with a better equipment status tends to have .083 ha. more of grain crop land per consumption unit than that of the household with a poor equipment status.

With the estimation of the grain yield and acreage equations, the household food self-sufficiency equation is examined in the following section.

(3) Food self-sufficiency Equation

Based on the results of the previous two linear equations (grain yield and grain acreage), the household food self-sufficiency equation is expressed in the following mathematical expression.

$$F(X) = f(x)g(x),$$

In this case, F(X) is the estimated function of household food

production per consumption unit. f(x) is the estimated grain yield equation, and g(x) is the estimated grain acreage equation. Since total grain production is equal to the grain yield times the grain crop acreage, then estimating grain production is fairly straight forward. Based on the estimated grain yield equation, a household's grain yield can be given as:

$$L = 282.8 + 299.9X1 + 74.4X2 + 156.2X3 - 249.6X4 + 1179.6X5$$

And a household's grain crop acreage(hectare) per consumption unit can be estimated with:

$$G = 0.48 - .02W1 + 0.18W2 + 0.33W3 - 1.06W4 + 0.08W5 - 0.00003W6$$

If the F(X) can be used to estimate a household food production per consumption unit, indicating with F, then,

$$F = L*G = (282.8 + 299.9X1 + \ldots + 1179.6X5)(0.48 - 0.02W1 + \ldots - 0.00003W6)$$

X1 is the household labor force per consumption unit ratio (ACTRATIA).

X2 and W5 is a dummy variable, representing farm household equipment status.

X3 and W4 is the dummy variable, subzone (SZ).

X4 is household grain crop acreage per consumption unit (GRAINACR).

X5 is the household cotton acreage per total crop acreage ratio (PERCECOT).

W1 is the total number of consumption units of a household.

W2 is the dummy variable Z, representing the difference in institutional environment between the CMDT and OHV zones.

W3 is grain acreage per each on-farm laborer.

W6 is the variable representing the productivity of the on-farm labor in grain productivity.

Actually, X2 = W5 (household equipment status) and X3 = W4 (subsone); Therefore, we may infer that household equipment status and the natural environment impact may have a quadratic relation with the household grain production, since $X2*W5 = (X2)^2 = (W5)^2$;

If food self sufficiency level of a household is the sole indicator of the farm household food situation, based on the estimated household food production equation per consumption unit it may be concluded that natural conditions (such as rainfall, soil type), cash crop production, household equipment status and the labor to consumption unit ratio are the most important aspects affecting the household food situation in the surveyed area. It is difficult to estimate the "elasticity" of these variables and their effect on the production level with the above estimated grain production equation, because the impact of a single variable can not be separated from the other variables (multiple relations). The other form of analysis (such as those done by D'Agostino and Dioné) may be more effective in generating the results that consider elasticity.

In reality, food production is only one dimension of the household food situation, since access to food does not depend entirely on the household food production. Market and non-market food transactions also provide access to food. To deal with the problem of farm household access to food, a food self-reliance model is used.

2. Food Self-Reliance Model

Food self-reliance is defined as the farm household's access to food

through food production and market and non-market food transactions (or food trade). Household purchasing power per capita is a main indicator for determining the level of food self reliance. Because of the lack of data, household incomes are not known. Therefore, the net household food availability per consumption unit (FOODAVME) is utilized as the dependent variable in the model. This dependent variable is obtained through the following computation: total grain production plus food inflow through market and non-market transaction (food purchased, food gift received and food barter-in), minus food outflow through market and non-market transaction (food sales, food gift made and food barter-out). Finally, the values obtained are divided by the number of consumption units of each household. The household food self reliance equation can be expressed as:

$$H = \alpha 3 + B1 \cdot S1 + B2 \cdot S2 + B3 \cdot S3 + \ldots + B11 \cdot S11 + e3$$

H, the dependent variable, is net food availability per consumption unit for 1985 and 1986.

α is the constant of the equation.

S1 (SUMCONSU) is number of household consumption units.

S2 (PERCECOT) is cotton acreage per total crop acreage ratio.

S3 (EXACTNAG) is dummy variable, representing whether the household had the non-farm activities.

S4 (MEKGONFL) is the on-farm labor grain productivity.

S5 (STRDUMMY) is the household equipment status.

S6 (Z) is a dummy variable, representing the institutional impact of the different zones (the CMDT =1, the OHV =0).

S7 (SZ) is the dummy variable for natural condition of the different areas (the southern area =1, and the northern area =0).

S8 (ACTRATIA) is the household labor per consumption unit ratio.

S9 (GRAUNFER) is the fertilizer utilization per ha. of grain crop.

S10 (CREDIT) is the dummy variable for household access to formal sector credit (Access to credit=1, no access to credit =0).

S11 (NBIMP) is the number of taxable persons in each studied household.

These independent variables represent the factors affecting not only the household food production but also income generation.

Table 5-5 The estimated household food self reliance original equation for the CMDT and the OHV zones, Mali (1985-1986)

Equation D1: Original household food self-reliance equation
Dependent Variable: FOODAVME (food availability per consumption unit)
Adj R^2 = .445 F = 13.61 Signif F = .0000 Residual = 162

Independent Variables	B	SE B	Beta	T	Sig T
α (CONSTANT)	209.80	41.74		5.03	.0000
S1 (SUMCONSU)	-8.69	2.66	-.42	-3.26	.0013
S2 (PERCECOT)	306.44	100.3	.257	3.06	.0026
S3 (EXACTNAG)	46.40	20.94	.136	2.22	.0281
S4 (MEKGONFL)	.114	.025	.32	4.64	.0000
S5 (STRDUMMY)	42.44	22.96	.129	1.85	.0664 *
S6 (Z)	87.87	29.11	.266	3.02	.0029
S7 (SZ)	-24.9	23.85	-.08	-1.04	.2979**
S8 (ACTRATIA)	25.84	69.39	.024	.372	.7101**
S9 (GRAUNFER)	-.016	.116	-.009	-.14	.8901**
S10(CREDIT)	-23.8	29.3	-.068	-.815	.4162**
S11(NBIMP)	2.45	4.18	.071	.587	.5583**

* indicates that the variable is not significant at 5%
** that variable that is not significant at 10% level.

B1-B11 are the estimated coefficients of the variables S1-S11 respectively.

The result of the regression of this original food self reliance equation are shown as in table 5-5.

The variables S7-S11 are insignificant and hence should be dropped

from the model. By examining the correlation coefficients between different variables, the problem of multicollinearity does not occur in this model. The highest correlation coefficient is .51 between the variable the cotton acreage ratio and the variable institutional environment. Other correlation coefficients are much lower than this figure. (see table 5-6)

Table 5-6 Correlation coefficients of different variables of the household food self reliance equation

	MEKGONFL	EXACTNAG	Z	PERCECOT	STRDUMMY	SUMCONSU	FOODAVME
MEKGONFL	1.000						
EXACTNAG	-.048	1.000					
Z	.317	-.119	1.000				
PERCECOT	.366	.157	.509	1.000			
STRDUMMY	.274	.214	.119	.271	1.000		
SUMCONSU	.210	.103	-.097	.061	.422	1.000	
FOODAVME	.405	.105	.491	.470	.167	-.244	1.000

After dropping some factors, the regression model is shown in table 5-7.

Table 5-7 Household food self reliance equation of the CMDT and the OHV zones, Mali (1985-1986)

Equation D2: The refined food self reliance equation
Adj R^2 = .444 F = 24.46 Signif F = .0000 Residual= 170

Independent Variables	B	SE B	Beta	T	Sig T
α (CONSTANT)	207.86	20.84		9.98	.0000
S1 (SUMCONSU)	-7.3	1.3	-.36	-5.64	.0000
S2 (PERCECOT)	227.14	82.75	.194	2.75	.0067
S3 (EXACTNAG)	43.69	20.15	1.3	2.17	.0315
S4 (MEKGONFL)	.107	.023	-.2975	4.66	.0000
S5 (STRDUMMY)	40.77	21.59	.125	1.89	.0607
S6 (Z)	86.52	22.59	.264	3.83	.0002

Implications of the result As hypothesized, the cotton acreage ratio, institutional environment factor, non-farm activities and the household equipment status are the most important factors affecting the food self

reliance.

The result of table 5-7 implies (examine at the B values) that when holding other things equal, an increase of 1% of the cotton acreage ratio for a household would increase by 2.27 kg the net food availability. When other variables fixed, a household with non-farm activities (S3) would have 43.7 kg more net food availability per consumption unit than that of the household without non-farm activities. Similarly, if a household had a better equipment status, its food net availability per consumption unit would be about 41 kg more than that of household with a poor equipment status.

Also, a household in the better institutional environment zone, the CMDT, would have about 87 kg more food net availability per consumption unit than that of a household in the OHV zone.

If a household increased by one more unit consumption unit, holding other factors fixed, the food net availability per consumption unit of the household would drop by 7.3 kg.

When other variables are fixed, if a household's labor productivity in grain production increase by 10%, the net food availability per consumption unit would only increase by slightly more than 1 kilogram.

Finally, the net food availability per consumption unit in a household is 207.84 kg in a year. Based on the standard level of measuring the farm household food situation, Of all the surveyed farm households might be regarded as being a food deficit or equivocal food situation households.

The limitations of the econometric analysis

In this chapter, we have identified the impact of the major factors

on the food situation of the surveyed households. The relevant hypotheses have been tested using regression analysis. However, there are some limitations of the analysis. First, due to lack of detailed data, it is not possible to estimate the factors affecting the independent variables in the econometric models. For instance, it is known that the institutional environment condition is an important aspect affecting the household food condition. However, it is not possible to provide a quantitative analysis of the factors affecting this variable. The same situation holds for the household non-farm activities, labor productivity, household equipment level and so forth. In order to overcome these shortcoming of the in quantitative analysis, more detailed data needs to be collected. Secondly, the econometric analysis fails to provide the predictive power to explain the different food situation households. Third, because of adjusted R^2 is relatively low the predictions based on the linear models might be weak for drawing conclusions about equity among different farm households, and thus, may not provide enough evidence for the relevant policy analysis. For instance, if the objective of the food policy is to improve the food situation of food-deficit households rather than increase the household income of all households,then great attention needs to be given to the food problem of food deficit-households. In all, it is difficult to use econometric methods to predict if a household is a food deficit household or not. Considering these limitations, a discriminant analysis will be provided in Chapter six. The attention will be on two or three different kinds of food situation households, (the food deficit and food surplus households and equivocal food situation households). The discriminant analysis will provide more implications

regarding equity issues. The discriminant analysis may question if the previous food policies were appropriate to improve the equality of different food situation households.

CHAPTER SIX

Explanation of Households' Food Situations: Discriminant Analysis

This chapter examines issues not addressed in chapter five. A major issue examined is the reasons why households have different food situations. It is desirable to determine why the food surplus households and food deficit households are different. Based upon this analysis it should be possible to predict different food situation households. To determine which factors are more important than others in distinguishing different kinds households with regard to food situations discriminant analysis is used

Discriminant analysis

Discriminant analysis, developed by R. Fisher (1954), is "a statistical technique which allows the researcher to study the differences between two or more groups of objects with respect to several variables simultaneously" (Klecka 1980, pp.7). The main purpose of discriminant analysis is to utilize the main known factors to predict the different characteristics of different things (or people). The basic steps for discriminant analysis are: (1). Selection of variables. These variables are the ones that are hypothesized to have the greatest power for group classification. (2). Selection of cases. These cases (samples of households) are used in preparing the computation of scores in the discriminant function. Cases with missing variable must be excluded. (3). Conducting the test. This test indicates the explanatory

power of the variables; (4). Refine the variables selected. Those variables that are not significant statistically (based on the F-test) are dropped from the analysis; (5). Evaluation of the estimated function. This involves evaluating the contribution of different factors to the estimated function, accuracy of the estimated function, and whether the basic assumption about the analysis holds is appropriate; (6) Using estimated function for prediction purpose. The function that gives certain characteristics of a new observations should be able to predict into which group it should be classified.

The purpose of the discriminant analysis in this study is to identify 1) if the different mean values of the selected variables of sample cases of different classified groups are statistically different; and 2) whether the sample results can be used to predict the characteristics of the total population of the surveyed area. With the creation of the discriminant function, the " discriminant scores" of each individual household can be calculated, which is the basis of classification for different food situation households.

Before applying the discriminant analysis, certain assumptions and statistical considerations should hold true. To provide a classification rule that minimizes the probability of misclassification, the assumptions for forming the linear discriminant function needs to be met: 1) each group must be a sample from a multivariate normal population, 2) the population covariance matrices must all be equal (James 1980).

When applying the discriminant analysis, certain criteria are commonly used to evaluate the results. The following criteria are the

most important ones used when employing discriminant analysis.

The significance level

If the observed significance level (F test) is less than 5%, the hypothesis that all group means are equal is usually rejected.

Wilks' Lambda

When variables are considered individually, lambda is the ratio of the within-groups sum of squares to the total sum of squares.

A lambda of 1 occurs when all observed group means are equal. Values close to 0 occur when within-group variability is small compared to the total variability. Thus, most of the total variability is attributable to differences between the groups. Whereas, large values of lambda (near one) indicates that the group means do not appear to be different.

Correlations

The interrelation of different variables in the discriminant function can be measured with the correlations between different variables. Like the interpretation of the result of econometric analysis, correlations of different variables demonstrate the complementarity of different factors affecting the household food situation. High multicollinearity can cause problems and variable may need to be dropped.

Percentage of "grouped" cases correctly classified

This measures is similar to adjusted R^2 of econometric analysis. It is used to judge if the estimated linear discriminant function is accurate for prediction of different group classification. The percentage of correct classification of the study cases is an important

indicator. The higher the percentage of correct case classification, the more predictive power the estimated discriminant function would have.

Eigenvalue

Eigenvalue is the ratio of the between-groups to the within-groups sums of squares. Large eigenvalues indicate the estimated linear discriminant function is a good function and low eigenvalues mean is less accurate.

Discriminant Function Coefficients

Since the variables are correlated, it is impossible to assess the absolute importance of individual variables. However, the relative importance of variables can be found. Variables with large coefficients are often thought to contribute more to the overall discriminant function. However, the magnitude of the unstandardized coefficients is not a good index of relative importance when the variables differ in the units in which they are measured. The actual signs of the coefficients are not useful in determining the value of the coefficient. The negative coefficients could just as well be positive if the signs of the other coefficients were reversed.

Variable selection for the discriminant analysis

To prepare the discriminant analysis of different household with food situations, 20 independent variables were selected for the linear discriminant equation. This equation can be expressed as follows:

$$D = B0 + B1X1 + B2X2 + B3X3 + \ldots + B20X20$$

where:

the X's = the values of the independent variables.

B's = coefficients of the variable X's estimated with the data.

The linear discriminant equation is used to distinguish different food situation households by the discriminant score (value of D); the two (or three) different classified groups should differ in their D values. Using the results of chapters four and five, the variables selected as the independent variables of the linear discriminant equation are:

X1 (Z): The institutional environment factor.
X2 (STRDUMMY): The household equipment status.
X3 (SUMCONSU): The number of household consumption units.
X4 (PERCECOT): Cotton acreage per total crop acreage ratio.
X5 (GLABORHA): Grain acreage cultivated per on-farm unit of labor.
X6 (POP): Family size.
X7 (GRAUNFER): Grain crop kilograms of fertilizer utilization per hectare.
X8 (CREDIT): Household access to formal credit.
X9 (ACTRATIA): Household labor per consumption unit ratio.
X10 (MEFER): Fertilizer kilograms per hectare of crop land.
X11 (GRAINACR): Grain acreage per consumption unit.
X12 (TOTACREA): Household total land size.
X13 (LANDQU1A): Yield of Grain crops per hectare.
X14 (ACREAGMA): Household crop acreage per consumption unit.
X15 (MEKGONFL): Food productivity of on-farm household labor.
X16 (TOTFERTI): Household total fertilizer utilization.
X17 (QC): Household cotton production.
X18 (TOTFOOD): The total grain production of the household.
X19 (NBIMP): Number of taxable persons of the household.
X20 (NETSALE): Household is a food net seller or a net purchase of grain.
X21 (EMIGRAT): Household non-farm activities or labor migration.
X22 (TAX1): Household tax claimed by the government in 1985.
X23 (TAX@): Household tax claimed by the government in 1986.
X24 (TAXPAY86): The actual tax paid by the farm household for 1986-87.
X25 (SZ): The natural environment condition (e.g. rainfall, geographical location).

It is not the common practice to include basic variables (reflecting the absolute level of different factors to determine different food situation groups such as total food produced, total fertilizer utilization, number of taxable persons, etc.) and calculated variables (reflecting the relative level of different factors used to

determine different food situation groups such as, fertilizer utilization per hectare, cotton acreage ratio, grain acreage per consumption unit, etc) as group variables to form the discriminant function. However, using basic and calculated variables above for better identifications of the characteristics of different food situation groups. For instance, it would be useful to determine if a better food situation household is more likely to have higher total fertilizer utilization, or a higher level of fertilizer utilization per area crop production, or both. It is possible that a household may have had higher total fertilizer utilization but not a higher level of fertilizer per unit of crop land, or vice versa.

The results of Discriminant analysis

Part One: The discriminant analysis of different food situation households across two different zones.

1. Two group classifications The two different groups are classified according to their differences in the level of net annual food availability per household member. If the net food availability per household member is less than 188 kilograms, the household is classified under group ne, the food deficit household group. If the net food availability per household member is more than 216 kilograms, the household will belong to group two, the food surplus household group. These households (accounting for about 6% of the total effective sample that had net food availability per household member more than 188 kg. and less than 216 kg. are excluded from this discriminant analysis. These households will be classified as the equivocal food situation group and considered in the three-group classification discriminant analysis. Besides the 10 equivocal food situation households, another

20 households are not included in the analysis because the households had at least one missing discriminating variable and hence could not be used in the analysis.

For making the two group discriminant analysis, all 25 variables presented earlier were used as the independent variables for forming the estimated linear discriminant equation. The discriminant analysis provides the information for testing of significance of the variables using F test and for identifying the equality of different group means for each selected variable. Based on the earlier discussed criteria, if

Table 6-1 The significance level of different observed variable

Variable	Significance
X1 (Z)	.0000
X2 (STRDUMMY)	.0009
X3 (SUMCONSU)	.0192
X4 (PERCECOT)	.0000
X5 (GLABORHA)	.0029
X6 (POP)	.0046
X7 (GRAUNFER)	.0228
X8 (CREDIT)	.0000
X9 (ACTRATIA)	.0001
X10(MEFER)	.0003
X11(GRAINACR)	.0000
X12(TOTACREA)	.0000
X13(ACREAGMA)	.0000
X14(LANDQU1A)	.0085
X15(MEKGONFL)	.0000
X16(TOTFERTI)	.0000
X17(QC)	.0003
X18(TOTFOOD)	.0000
X19(NBIMP)	.0685 *
X20(NETSALE)	.0000
X21(EMIGRAT)	.2617 **
X22(TAX1)	.3948 **
X23(TAX2)	.4515 **
X24(TAXPAY86)	.8165 **
X25(SZ)	.8668 **

* The variable is not significant at the 5% level.
** The variables are not significant at the 10% level.

the observed significant level using the F test is less than 5%, the hypothesis that the group means of certain variables are equal is rejected. If the observed significant level under the F test is more than 5%, we may not reject the hypothesis that all group means are equal.

Table 6-1 contains the result of an F test for different variables. It illustrates that the majority of the selected variables are significant at 5%. Only five variables are not significant at 10% or lower levels using the F test.

The variables X21-X25 are not significant at the 5% level. Hence the hypothesis that the group means for these variables are equal can not be rejected. Thus, based on the sample data, it is not possible to confirm that natural environment, household non-farm activities, tax claimed by the government and the actual tax paid by the household contributed to the distinguishing of food deficit and food surplus households. Thus, these variables should be excluded from the final estimated discriminant equation. The refined equation therefore includes 20 independent variables. After excluding the five insignificant variables, the sample size has been slightly increased because less households with missing variables. Now the discriminant analysis includes 164 effective cases instead of the previous 160. Therefore, the results of the significant level of different variables will also changes slightly. The results can be seen in Table 6-2.

As mentioned earlier, the discriminant analysis also provides the Wilks' Lambda values. This value can be used to identify which variable

had the greatest difference in group means. The larger the Wilks' Lambda, the less difference between the group means of the different food situation groups.

Table 6-2 Significance tests and the ranking of different variables in the refined discriminant function

Variable	Wilks' Lambda	Ranking	F	Significance
X1 (Z)	.69003	2	72.77	.0000
X2 (STRDUMMY)	.93956	14	10.42	.0015
X3 (SUMCONSU)	.96211	18	6.38	.0125
X4 (PERCECOT)	.86104	7	26.14	.0000
X5 (GLABORHA)	.95061	16	8.416	.0042
X6 (POP)	.94619	15	9.213	.0028
X7 (GRAUNFER)	.96899	19	5.182	.0241
X8 (CREDIT)	.83430	4	32.17	.0000
X9 (ACTRATIA)	.91115	11	15.80	.0001
X10(MEFER)	.91704	12	14.65	.0002
X11(GRAINACR)	.73698	3	57.82	.0000
X12(TOTACREA)	.89112	10	19.79	.0000
X13(ACREAGMA)	.64822	1	87.92	.0000
X14(LANDQU1A)	.95310	17	7.972	.0053
X15(MEKGONFL)	.86469	8	25.35	.0000
X16(TOTFERTI)	.88869	9	20.29	.0000
X17(QC)	.92062	13	13.97	.0003
X18(TOTFOOD)	.84541	5	29.62	.0000
X19(NBIMP)	.97652	20	3.895	.0501
X20(NETSALE)	.85213	6	28.11	.0000

The variable rankings is shown in Table 6-2. The ten most important variables with respect to different group means are: 1. Total crop acreage per consumption unit; 2. Institutional environment condition; 3. Grain acreage per consumption unit; 4. Household access to credit; 5. Total food production level per household; 6. Household food net sale or purchase condition; 7. Cotton acreage per total acreage ratio; 8. On-farm labor grain productivity; 9. Total fertilizer utilization; and, 10. Total household land size.

Based on the correlation analysis, there are some complementary

relationships between certain variables. The correlations between different variables are shown in Table 6-3.

Table 6-3 Relatively high correlation between certain variables

Variable	Variable	Correlation coefficient
X1(Z)	X8(CREDIT)	.56
X2(STRDUMMY)	X6(POP)	.50
X2(STUDUMMY)	X12(TOTACREA)	.46
X2(STRDUMMY)	X18(TOTFOOD)	.48
X4(PERCECOT)	X8(CREDIT)	.52
X4(PERCECOT)	X10(MEFER)	.69
X4(PERCECOT)	X14(LANDQU1A)	.53
X4(PERCECOT)	X16(TOTFERTI)	.56
X12(TOTACREA)	X16(TOTFERTI)	.55
X12(TOTACREA)	X17(QC)	.47
X15(MEKGONFL)	X18(TOTFOOD)	.44
X16(TOTFERTI)	X17(QC)	.73
X17(QC)	X18(TOTFOOD)	.45

Because of relatively high correlations between different variables the following can be inferred: A household in the zone with better institutional environment tends to have more access to credit. Family size is correlated with the household equipment status. Household with a large number of household members also tends to have a relatively good equipment status. The household equipment status also correlates with the total crop acreage cultivated. With better equipment, such as animal traction, or multi-purpose plows, a household would be more capable of expanding its land size. Since the household equipment status is correlated with the household's total land size, it also correlates with the total food production. As was expected, the cotton acreage ratio correlates with household access to credit. Access to credit also had a high correlation with the total fertilizer and crop fertilizer utilization per hectare. This may partly explain why the cotton acreage ratio is correlated with household access to credit.

Another important fact is that the cotton acreage correlates with the grain crop yield. As discussed earlier, the cotton residual fertilizer may increase the grain yield since the grain crop often follows the cotton crop (Dioné). It is also possible that the farmer in the household with a high level cotton production may also have higher skills in field management and better knowledge on how to use technologies appropriately. The total family size correlates with the number of household taxable persons. The more consumers a household had, the more taxable persons it would have. Total crop acreage correlated highly with total fertilizer utilization and total cotton production. In other words, if a household had more fertilizer utilization, it tended to have more crop acreage (land size) and more cotton production. Finally, two important relationships should be noted. First, if the household had a higher labor grain productivity, it tended to have a higher level of household food production. Secondly, if a household had larger total grain production, it also tended to have higher cotton production.

The estimated linear discriminant function

Based on the two group classification and the characteristics of the selected variables, the estimated linear discriminant function is obtained and is as follows:

$$D = -2.3 + .5363X1 + .3833X2 - .2649X3 + 2.108X4 - .2650X5 - .0770X6 + .0013X7 + .2583X8 + .5584X9 - .0079X10 + 2.99X11 - .0277X12 - .8341X13 - .00003X14 + .00057X15 - .00068X16 - .000022X17 + .00047X18 + .012X19 + .454X20 ;$$

Based on the values of Wilks' Lambda and Standardized Canonical

Discriminant Function Coefficients[1] of different variables in the estimated linear discriminant function, it is expected that variables such as X18, X11, X6, X4, X13, X15, X1, X5, X3 and X20 are the most important variables in making a contribution to the entire discriminant function. The importance of these variables for distinguishing food deficit and food surplus households in descending order are as follows: 1> Total household food production has a positive impact. 2> Grain acreage crop per consumption unit is positively related. 3>. Population size has a negative impact. 4>. The cotton acreage ratio has a positive effect. 5>. Total grain productivity of labor has a positive impact. 6>. Crop acreage per consumption unit has a positive effect. 7>. The good institutional environment improves the food situation. 8>. Grain acreage per household on-farm labor is negatively related. 9>. The total number of household consumption units has a negative impact. And 10>. Net sales or purchase of food is positively related.

Using the D value, if the value is less than zero, the household would be predicted to be in a deficit situation. If the D value is greater than zero, the household would be predicted to be in a food surplus situation.

As the results indicate, the estimated discriminant function had a 93.9% chance of predicting cases correctly. The discriminant equation is relatively accurate in predicting the food surplus families correctly (94.8%), and slightly less accurate in predicting the food

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[1] As in multiple regression, the standardized coefficients are used when the variables are standardized to a mean of 0 and standard deviation of 1. A canonical discriminant function is a linear combination of the discriminant variables which are formed to satisfy certain conditions (Klecka, pp.15).

deficit households correctly(92.5%).

Three group classification discriminant equation

The food equivocal situation households are not included in the above analysis, based on the assumption that the equivocal food situation households may make the classification less accurate. On the other hand, including the food equivocal situation household would be more meaningful, since we cover
all kinds of food situation households in discriminant analysis. Adding the food equivocal situation households into the discriminant analysis, the studied sample size becomes larger. Ten of the 11 food equivocal situation households are included in the three-group discriminant analysis. Thus, the total number of effective sample households is 164 out of possible 174.

Like the two-group discriminant analysis, the three-group discriminant analysis also includes 25 variables in forming the discriminant linear equation. Using the F test, five variables are judged to be not significant. These five variables are: Taxes claimed by government in 1986 and 1987, taxes paid by the households, household labor involved in non-farm activities, and natural environment conditions. The number of household taxable persons is a marginal variable. Nevertheless, it is kept as part of the estimated linear discriminant equation.

After dropping the five insignificant variables, the final equation contains 20 variables. The result of the F test and the relative significance of the group means of different variables for

distinguishing the different household food situations are shown in Table 6-4. The results of the three-group discriminant analysis is similar to that of the two group discriminant analysis. The similarity is that the ten most important variables in the group mean values between food deficit and food surplus households in the three group discriminant analysis are the same as those of the two group discriminant analysis.

Table 6-4 Significance tests and the ranking of different variable group means of the refined three-group discriminant function

Variable	Wilks' Lambda	F	Ranking	Significance
X1 (Z)	.7042	35.92	2	.0000
X2 (STRDUMMY)	.9338	6.06	14	.0029
X3 (SUMCONSU)	.9573	3.82	18	.0239
X4 (PERCECOT)	.8601	13.91	8	.0000
X5 (GLABORHA)	.9368	5.77	15	.0038
X6 (POP)	.9439	5.09	16	.0071
X7 (GRAUNFER)	.9612	3.45	19	.0339
X8 (CREDIT)	.8435	15.87	6	.0000
X9 (ACTRATIA)	.9149	7.96	12	.0005
X10(MEFER)	.9206	7.37	13	.0008
X11(GRAINACR)	.7393	30.14	3	.0000
X12(TOTACREA)	.8745	12.27	9	.0000
X13(ACREAGMA)	.6487	46.31	1	.0000
X14(LANDQU1A)	.9551	4.02	17	.0197
X15(MEKGONFL)	.8447	15.72	7	.0000
X16(TOTFERTI)	.8818	11.47	10	.0000
X17(QC)	.9150	7.94	11	.0005
X18(TOTFOOD)	.8413	16.12	5	.0000
X19(NBIMP)	.9722	2.44	20	.0900
X20(NETSATE)	.8256	18.06	4	.0000

However, household access to credit, cotton acreage ratio, household on-farm labor grain productivity and household land size are more important in distinguishing different food situation households in the three-group discriminate analysis whereas the total household fertilizer utilization is more important in the two group discriminant analysis.

The estimated three group classification linear discriminant functions are given in Appendix I. Also given are the standardized canonical discriminant function coefficients. According to these results, the following 10 variables had the most importance arranged in descending order of importance) in predicting the three different kinds of food situation households. 1. Household total food production; 2. Number of household members; 3. Grain acreage per consumption unit; 4. On-farm labor grain productivity; 5. Cotton acreage ratio; 6. Grain acreage cultivated per on-farm labor; 7. Household food marketing situation; 8. Institutional environment condition; 9. Household equipment status; and 10. Land fertilizer utilization per hectare.

The results also indicate that in the three group discriminant analysis, household population, on-farm labor grain productivity, grain acreage cultivated per on-farm labor, the household food sale/purchase situation, household equipment status and land fertilizer utilization have more predictive power in determining the different kinds of food situation households than in the two group discriminant analysis. Variables such as grain acreage per consumption unit, cotton acreage ratio, institutional environment condition, mean acreage per consumption unit and number of household consumption units in the three group estimated discriminant linear function are less powerful than they are in the two group analysis.

On the other hand, the three group discriminant linear function has only an overall chance of 79.9% to predict different food situation households correctly. The reason for its the lower predictive power is that the characteristics of the food-deficit households are not easily

ascertained. The discriminant functions only had a 71.6% chance of predicting the food deficit households correctly, while for the food equivocal and food surplus households, the chances are 80% and 85.6% respectively.

An evaluation of the effectiveness of the estimated discriminant functions classifications can be found in Appendix I. In general, both the two-group and the three-group discriminant functions give good results. If the two different classification discriminant functions are composed by their ability to predict cases correctly there is little difference. Just by random chance two-group classification discriminant analysis would have a 50% chance of predicting cases correctly. However, the results significantly better than random change. The two-group linear discriminant function has a 94% of chance if predicting cases correctly.

For the three group discriminant analysis the expected random chance of predicting cases correctly is 33.33%. The actual chance of predicting cases correctly is 80% for the estimated function. Without using special measurements or other criteria, it is not possible to judge which of the two estimated functions is better, since he larger number of the group classifications would lead to more chances for misclassification.

The implication of the across-zone household food situation discriminant analysis

If the major factors which influence each food situation group under certain conditions and assumptions are correctly identified, some important policy conclusions can be drawn. One of the most important food policies that needs to be considered is increasing the total amount

of household food production, especially food production of the rural food deficit households. For the survey households, the main problem may not be that of food access (food entitlement) but the problem of food production or food supply. In other words, the farmers of rural poor food deficit households may not have the capability and resource to produce adequate food for consumption. Therefore, food policies are needed to enhance the farm food production of food deficit households. However, for food surplus households, the desire is how to stimulate the farmers to increase their capacity to generate marketable surplus food production. To produce more marketable food will not only increase the farmers income, but also increase the security of rural peoples' access to food at local food market at a reasonable price.

Also, there are likely some interrelation between household food production and food marketing. Since the household food situation is closely linked to on-farm grain production, this may reflect problems in grain marketing. The appropriate policy would help to improve the marketing system.

Based on the results of discriminant analysis, the second item of concern related to food policy is controlling the size of the family, specifically, farm household size. This may be accomplished by use of family planning policies, such as family planning education, or providing birth control aid.

Based on the results of discriminant analysis, the third food policy issue is land allocation or the land distribution, particularly the grain crop land expansion and land redistribution between food deficit households and food surplus households. For land expansion, the

relevant policy should encourage farmers in the poorer food situation households to enlarge their food acreage. This might be achieved by subsiding farmers of food deficit households to cultivate new land and or encouraging labor mobility within the farming areas. The land distribution policy needs to be considered as a means to overcome the barriers that prevent the different households from having equal access to land of similar quantity.

Based on the above analysis, the fourth food policy issue related to improving rural household human capital. By providing basic education and training through a rural job training programs, the quality of the labor force can be improved. This should increase the farmers' capacity to produce food and cash crops.

Therefore, the food situation and income level of the farmers would improve. On the other hand, the food policy should give higher priority to the increasing diversification of on-farm activity. More explicitly, the policy should encourage the food deficit households to increase cash crop (i.e., cotton) production. Providing technical assistance,and pre and post-harvest services, and special credit programs would likely increase the relative level of cash crop production by the food deficit households.

To deal with the rural household food problems in Mali, concern should also be given to improving the institutional environment and farm households' equipment status. As the survey indicates, better institutional environment is mainly represented by an effective extension service, better farmer associations, cooperation, collective action and better managerial experiences. The policy should stimulate

these regions with poor institutional environments (e.g., the OHV zone). Improvement in this area should make it easier for farmers to obtain formal credit, provide equality in the process of tax collection and so forth.

Part Two: The discriminant analysis within a zone

1). The reason for doing discriminant analysis within a zone

The first discriminant analysis made comparison across zones. The main purpose of so doing this analysis was to determine the institutional impact on different households in the different regions. This analysis focused on the CMDT and the OHV zones because they are significantly different in their institutional environment conditions. The result based on the econometrics and the discriminant analysis indicate that there are many factors that can be used to distinguish different food situation households, including different institutional environment conditions. Across region studies may yield satisfactory results for particular analysis situations. However, across region studies can give misleading results if one fails to evaluate the historical background and other factors that influence the differences in institutional environments between zones. For instance, the historical factors in the context of the development of a certain region, such as the background of early household land settlement, migration, culture and so forth may not be easily detected. As Dioné states, French colonization had a impact on the institutional environment in the CMDT zone. The higher level and larger proportion of households involved in cotton production is associated with the past influence of the French colonialists. History cannot be changed.

Trying to find means to improve how to improve the institutional environment condition in the OHV zone, one should not simply recommend that the OHV should learn from the experience of the CMDT zone.

Generally, when the assumption that other things may not be equal, it seems totally appropriate that a within zone study should also be conducted. Since there was an imbalance in the proportion of food deficit households relative to food surplus households in the CMDT zone (only 15% of the total farm households in the CMDT zone were food deficit households), the OHV is selected as the preferred zone for study. IN the OHV zone about 60% of the farm households were in food deficit situation and less than 40% had food surpluses.

2). Discriminant analysis in the OHV zone

1.Two-group classifications Among the 94 sample cases in the OHV, 73 households could be used for the initial two-group discriminant analysis. The rest of the 21 cases are not included in the analysis because of missing or bad data. The criteria for the household classification and selection of the variables in the OHV zone discriminant analysis are almost the same as those in across zone discriminant analysis.

Twenty-four variables are selected initially for forming the estimated linear discriminant function. Based on the F test, only 8 variables are significant at 5% or less, one variable is significant at a marginal level (8%). Thus, only nine variables had a significant difference in the group means between the food deficit households and food surplus households. Therefore, these nine variables are included for forming the refined estimated two group discriminant equation. The F

test and the ranking of the variables that represent the degree of the difference between the food deficit households group mean and food surplus household group mean can be seen in Table 6-4. The results show that the three variables which had the greatest difference in group means between the two food situation households in the OHV zone analysis are similar to those in the across zone analysis. The grain labor productivity, family size, and household labor per consumption unit

Table 6-4-2 Significance test and the ranking of different variables in the refined two group discriminant function of the OHV, Mali

Variable	Wilks'S Lambda	Ranking	F	Significance
X1 (SUMCONSU)	.9477	8	4.14	.0455
X2 (GLABORHA)	.9599	9	3.13	.0809
X3 (POP)	.9396	5	4.82	.0312
X4 (ACTRATIA)	.9421	6	4.61	.0351
X5 (GRAINACR)	.6995	2	32.21	.0000
X6 (ACREAGMA)	.6512	1	40.17	.0000
X7 (MEKGONFL)	.9314	4	5.52	.0214
X8 (TOTFOOD)	.9150	3	6.97	.0101
X9 (NETSALE)	.9439	7	4.46	.0381

ratio are more significant in examining the difference in group means when compared with across the zone study.

The differences of the two group means for variables such as equipment level, fertilizer utilization, cotton production, access to credit, and grain yield are no longer statistically significant in the OHV discriminant analysis.

The estimated final two group discriminant function can be expressed as follows:

$$D = -1.465 - 4.757X1 + .9035X2 - .8979X3 + .9125X4 - 2.355X5 + + 4.522X6 - .000042X7 + .00086X8 + .7247X9$$

Based on the estimated equation, if a household has a discriminant scores less than 0, it would be classified under the food deficit household group. If the discriminant score for a household is greater

than 0, it would be classified as a food surplus households. The above discriminant function had a 97.4 % chance to predict different households correctly. To correctly predict the food deficit households, the function has a 98.2% of the chance of success. This is more accurate than the prediction of the food surplus households (95.5%).

The values of the standardized discriminant function coefficients

Table 6-5 The relative importance of the different variables for distinguishing different food situation households of the OHV, Mali

Variable	Standardized Coefficient	Ranking
X1 (SUMCONSU)	-.42771	5
X2 (GLABORHA)	.06688	9
X3 (POP)	-1.0096	3
X4 (ACTRATIA)	.13829	8
X5 (GRAINACR)	-.65923	4
X6 (ACREAGMA)	1.2145	2
X7 (MEKGONFL)	-.14032	7
X8 (TOTFOOD)	1.5033	1
X9 (NETSALE)	.33405	6

which indicate the relative contribution of different variables to the overall discriminant function are shown in Table 6-5

Because of the correlation of the relevant variables, it is difficult to evaluate the absolute importance of the variables contribute to the overall discriminant function. The ranking of the variables represents the relative importance of the variables.

Table 6-5 demonstrates that total household food production is the most important factor for determination of the estimated discriminant function. Total crop acreage per consumption unit is the second most important variable. The relative importance in descending order of all variables is a follows: 1. Household food production, 2. Household land devoted to crops per consumption unit, 3. Family size, 4. Grain acreage per consumption unit, 5. Number of household consumption units, 6.

Household food sale or purchase situation, 7. On-farm labor grain productivity. 8. Household labor per consumption ratio and 9. Grain acreage cultivated per on-farm labor.

When comparing the results of the discriminant analysis within the zone and across the zone, it can be observed that in the OHV zone discriminant analysis, on-farm labor productivity was negatively related in the determination of the discriminant function. Thus, increasing the on-farm labor grain productivity may not play an important role in changing the food deficit household food situation. This is not the sign expected. This may be related to errors in the data sets. If this sign is correct additional research is need to determine why in the OHV, the poor food situation households had high grain labor productivity, and in the other region this did not hold true.

2. Three group discriminant equation

The results of the three group discriminant analysis in the OHV are similar to the two-group discriminant analysis above. The major difference is that the three-group analysis had more effective cases. To form the final three group discriminant function, 83 of the 94 sample households in the OHV are included. The number of household consumption units, food sale or purchase situations, total household food production and crop acreage per consumption unit are more important in differentiating three different food situation groups than in the two group analysis. Another five variables are statistically significant.

The estimated three group discriminant function has nearly an 82% chance of predicting different households correctly. The function is more accurate for predicting the food equivocal situation households

correctly. The chance for correcting prediction of the food equivocal households is 100%, while for the food deficit and food surplus households, the correct prediction rate is approximately 80%.

Implications of the discriminant analysis of the OHV zone

Based on these findings, the estimated two-group linear discriminant function within zone analysis has slightly more predictive power than the across zone analyses. The within zone study had an overall 97.4% chance of predicting different households correctly, whereas, the across zone figure is 93.9%. Thus the within zone estimated linear equation obtained through discriminant analysis is preferred to predict the different food situations of different households in the OHV zone.

Based on the within zone discriminant analysis, it is possible to draw similar conclusions for food policy as mentioned in the across zone discriminant analysis. Since the most important variables (top ten factors) that affect food situation of different households in the survey area are almost identical between the within zone and across zone analyses, the policy recommendations are also similar.

In general, according to the different discriminant analyses, it is possible to conclude that poor food situation households are such because of their small scale of land farmed, large family size, relatively small grain and other crop acreage, net food purchase in the market, lower labor per consumption unit ratio (or high dependency ratio), lower relative and absolute level of cash (cotton) production, and, in OHV zone higher intensive use of on-farm laborers in grain production. A food surplus household, on the other hand has the exact

opposite situation.

The original linear discriminant equations based on either across zone or within zone analyses provide other facts which are not discussed in the interpretation of the final discriminant linear equation (the one estimated after dropping non-significant variables). These facts are: 1). Non-farm activity of the surveyed household cannot be used to explain the difference between the food situation households, 2). The difference in tax claims between food deficit households and food surplus households is not statistically significant even though the sample mean value of the different food situation households is different. 3) Whether food deficit households actually pay more taxes than food surplus households is also not significant statistically.

Two other factors that failed to be observed in the discriminant analysis are food deficit households which sell their food on the market at a low price and late purchase food at the market for a relatively high price. In the next discussion, evaluation of these issues and their impact on the food situation of different farm households in terms of equity, taxation policy, and so forth, will be made.

Non-farm activity

In the discriminant analysis it was determined that non-farm activity was not a good variable to distinguish different food situation households. As indicated in the analysis presented in chapter four, a larger proportion of the food deficit households engaged in non-farm activity in comparison to food surplus households, However, when viewed on a worker basis food surplus households had a higher percentage of household workers doing non-farm activities than food deficit

households. The regression analysis also provides evidence that household non-farm activity is positively related to household net food availability (household food self-reliance). Because more non-farm activities should lead to a higher level in total household income, the household has greater capacity to acquire food through transactions.

However, the discriminant analysis indicates that there is little difference between the different food situation households with respect to non-farm activity. Several reasons may explain these differing results. First, there are data limitations. Non-farm activity is measured as a categorical variable, and only indicates if a household had non-farm activity or not. The variable used in analysis did not indicate the number of household workers were involved in non-farm activities. On the other hand, due to the risk and uncertainty related to food production in Mali, the food deficit situation households may have more incentives to adopt strategies which lead to more diversification of household activities. Therefore, a higher percentage of households in the poor-food situation are expected to participate in non-farm activities. Presumably, better food situation households may not pursue high diversification of household activities since they have more cash crops and higher household income which can be used to purchase food.

The second possible reason might be related to the possibility that food deficit household labor force has lower skills. Thus, the labor force of the poor food situation household would be doing jobs demanding low skill which results in lower wage rates and earnings. In contrast, the labor force of the better food situation households may

be doing jobs demanding higher skills and hence earning higher pay. Therefore, it is the quality rather than the quantity of the labor force that determines the household food situation and income generation. Furthermore, there may be many different types of non-farm activities, and the workers in different households may be paid differential wage rates.

The third reason might explain why there are no major differences observed of non-farm activity between different food situation households is that the correlation between household non-farm activity and the household food situation might not be a linear relation, (e.g., a "U"-shaped relationship). Thus, when a household had a poor food situation and a low level of household income, it may divert its household labor force to non-farm activities. When the food situation improves, a household may need to increase its on-farm activity, thus reducing its labor force engaging in the non-farm activities. When the household food and income situation improves there has been a growth in labor and land productivity but at a decreasing rate. Thus, the marginal returns of on-farm labor will decrease relative to off-farm labor. Thus, there are incentives for more non-farm activities.

Considering these reasons, it remains unclear whether food policy should be considered as part of the employment policy and whether the government should give a higher priority to the promotion of non-farm activity. Although the econometric analysis in chapter five shows that household's non-farm activities are positively related to household food situations and estimated income. However, based on the discriminant analysis, it is unclear whether households having better food situations

were so because of more non-farm activities, or if the poor food situation households were so because of less non-farm activity. Thus, by simply stimulating non-farm activities, food deficit households might not be in a better position. Devising a better rural labor employment policy in conjunction with food policies is a future challenge for the policy makers in Mali. The ways and types of rural jobs training, or the kinds of job opportunities made available to the rural poor to improve their food and income situation are some aspects of this challenge.

Farm household tax claimed and actual tax payment

Based on the analysis in chapter four, the sample mean values show that the survey food deficit households not only were asked to pay more tax but actually did pay much more tax than the food surplus households. Since there was a high variation of tax payments from household to household, and the difference in tax payments between food deficit households and food surplus households was not large, it was not possible to infer whether food deficit and food surplus households paid different taxes based on the discriminant analysis and the T-test. However, it could be inferred that the food deficit household did not pay less taxes than the food surplus households.

Based on this fact, an equity issue can be raised. The equity issue of rural households can be examined by comparing the different food situation households to key variables or factors. The following are the results of these comparisons.

For the across zone study, a food deficit household had 15.6 household members (Skewness = 1.36), while the food equivocal household had 10.2 household members (Skewness = 1.3). A food surplus household

had only 11.1 household members (Skewness = 1.9). Considering the skewness values, the differences in family size between different households with different food situation households may be greater than the mean value, since a relatively large percentage of the food surplus households had household members above the mean value, while the food deficit households had relatively small percentage of the households above the mean values[2].

The inequity of tax payments of different food situation households can be interpreted from the results of Table 6-6.

Table 6-6 Proportions of population, households and tax payment of different food situation households

	Population (%)	Household (%)	Taxable Person (%)	Tax Payment (%)
Food Deficit Household	49.5	41.4	47.4	43.7
Food Equivocal Situation	4.6	5.9	4.7	4.6
Food Surplus Household	44.9	52.7	47.9	51.7
Total	100	100	100 *	100

* Four households had missing variables, so a total of 98.6% of the households are included for the computation.

Based on the results in Table 6-6, the total sample food deficit households accounted for 49.5% of the total survey household population and 46.8% of the total taxable persons. The actual tax payment of food deficit households accounted for about 43.7% of the total actual tax payment of all survey households. Food equivocal situation households

[2] Skewness measures how data are distributed unsymmetrically about their central value. If a sample distribution is said to be skewed to the right the result is the sample mean exceeding the median, and vice versa if the sample distribution is skewed to the left. Positive value skewness means the distribution is skewed to the right, and negative value skewness means the distribution is skewed to the left. Using the term of "skewness" is necessary since the mean and standard deviation offer no information about the skewness of a distribution.

accounted for 4.6% of the surveyed household population and 4.7% of the total taxable persons. Food equivocal households also paid 4.6% of the total tax of the all surveyed households. The food surplus households accounted for 44.9% of the total surveyed household population and 47.2% of the total farm household taxable persons. They actually paid about 51.7% of the total tax. However, if households rather than individual household members are considered in tax payment, food deficit households account for 41.4 % of the total number of surveyed households, but had 43.7% of the total tax paid by the total number of surveyed households. Therefore, because of their large families size food deficit households paid more tax proportionally than did the food equivocal and surplus situation households. According to these results, it can be concluded that at the household level rather than household member level, food deficit households pay slightly more tax than do the food equivocal and food surplus households. This problem is compounded because food deficit household generally have lower quality of resources and income levels than food surplus households. It is worth noting when comparing food deficit and food surplus households, that the total number of food surplus households had 44.9% of the total surveyed population but accounted for 47.2% more taxable persons. Thus a food surplus household is more likely to have more middle aged or productive household members than the food deficit households. A food deficit household tends to have more young children (younger than 14 years) or aged people (older than 60 years). Thus it would be expected that food deficit households to be less productive than food surplus households.

The second concern regarding the inequality of tax payment between

different food situation households is based on the assumption that different food situation households had different income, food production, and resource available (i.e., land) for farm and non-farm activities.

Table 6-7 represents total food production, cash crop production, and total land size by different food situations. In order to take into

Table 6-7 Proportion of land size, food production, and cash crop production of different food situation households

	Deficit Situation (%)	Equivocal Situation (%)	Surplus Situation (%)	Total (%)
TOTFOOD *	26.34	4.3	69.36	100
Skewness	2.13	1.24	1.69	1.95
COTTON *	17.65	2.5	79.85	100
Skewness	4.24	1.62	2.42	2.94
TOTLAND *	30.08 **	3.3 ***	65.86	99.24
Skewness	1.29	-.101	1.04	1.03

* TOTFOOD is the total food production of the households. COTTON is the cotton production of the households. TOTLAND is the total crop acreage of the households.
** There are three variables missing in the food deficit household group.
*** There is one missing variable from the food equivocal household group.

consideration the variation of the each individual household, the skewness of the distribution of the sample cases are also listed in the table. Table 6-7 indicates that food deficit households accounted for slightly more than one quarter of the total food crop production and less than 18% of total cotton production of the households, while the food surplus households accounted for more than two thirds of the total food crop production and nearly four fifths of the cotton production of the surveyed households. If we assume that the non-farm activities of

food deficit and food surplus households generated nearly the same amount of household income (in fact, based on information presented earlier, food surplus household may have earned more income through non-farm activities), and use household total food production and cash crop production to roughly represent total household income, we can easily conclude that if tax payment were based on the situation of the income levels of different households, food deficit households paid much more tax then they should have. The table also shows that food deficit households have less than one-third of the total land resources, while food surplus households had occupied almost two-thirds of total land resource for all surveyed households. If the tax imposed is based on household land area, food deficit households definitely paid much more tax than food surplus households. If we compare the land size and family size of different food situation households simultaneously, a food deficit household had only 42.4% of the crop land per consumption unit that of a food surplus household.

Based on these facts, the head tax policy is seriously biased against the food deficit households and improving their food situation and income generation. Considering the negative impact of the current tax policy on the different food situation households, a tax policy reform needs to be seriously considered in Mali.

The timing of farm household food sales and purchases

Since food prices are not seasonally stable in rural markets, the timing of food sales and purchases would be expected to influence household income. It is logical to assume that different food situation households may receive different food sale and food purchase prices

depending on when they are active in the grain market. The food deficit households are more likely to sell their grain in the early stage of the post-harvest, since taxes are due then and they need the funds. Dioné found this to be true during his research. Since the households had to pay taxes in cash, this was the primary motivation for selling grain soon after the grain harvest (Dioné 1989). Post harvest is when grain price are the lowest. Since food deficit households need to acquire food from the market, they may have to buy food at a higher price. Consequently, the seasonal food price pattern and tax policy with regard to the collection timing makes the food deficit households worse off in their food and income situation. Because the data set has differences, this hypotheses cannot be adequately tested.

Among the all sample households, only 38.9% reported information about the amount of food purchased at certain prices. And only 52.1% of the households provided information about the timing of food sales and prices received. Based on this information, the mean sale and purchase price was calculated. The mean food purchasing price for the whole year (1986/87) for the household that offered information was 49.47 (kg/CFAF). The mean food sale price for the year 1986/87 was 35.10 (kg/CFAF). Obviously, the food sale price is much lower than the food purchase price.

According to the results of the statistical test (T-test), it can not be inferred that food deficit households were paid a lower food sale prices and paid higher food purchase prices than a food surplus households. Since food sale and purchase prices are assumedly to relate to the timing of these sales and purchases, it is not possible to infer

that food deficit households sold food shortly after harvest and purchased food later more so than food surplus households. Table 6-8 provide the mean prices of food sale and purchase for different food situation households.

Table 6-8 shows that food deficit households not only paid a relatively higher food purchase price (4.8%) than did food surplus households, but they also received a relatively lower price for their food sales than did food surplus households. Due to the large variation between different households, the T- test of the difference of the two group mean is not significant at the 10% level or less. The mean difference test for food sale between food situation households is significant at the marginal level (for across zone T-test, the significant level is 12.4%. For the within zone test the significant level is 19.7%).

Table 6-8 Mean prices of food transaction for different food situation households

	Selected Deficit	Selected Surplus	Selected Total
Number of Households	44 / 31[3]	21 / 63	74 / 99
% of Surveyed Households	24 / 17	11 / 34	40 / 53
Mean purchasing price	50.29	47.98	49.47
Mean sale price received	33.99	35.86	35.10
Purchasing minus sale price	16.3	12.1	14.4

Perhaps the limited data (a larger percentage of households had missing values concerning the timing of food sales and purchases) and

[3] **A / B** This figure in the table can be interpreted as: **A** is the number of households that provide food purchase information. **B** is the number of households that provide food sale information. i.e., 44 / 31 means that 44 food deficit households had the food purchase information, 31 of the food deficit households provided food sale information.

the bias of cross-zone comparison (food surplus households in the southern part of the CMDT zone sold food later than the households in the OHV zone) contributed to the problem of testing this hypotheses. The difficulty of making a seasonal household food trade analysis (such as the analysis Dioné has done) is hindered by the data problem. To be able to analyze different kinds of households' food trade at different times (e.g., using three of four month period), it appears that little data available for each sub-group. Therefore, whether different kinds of food situation households sold and purchased food at different times remains unclear.

The impact of the institutional environment on the income distribution of the survey households

Since income information on the surveyed households is not available, to evaluate the income inequality of the households in the OHV and CMDT zones, net food availability was used as a proxy for income. Five different measurements are implemented. The measures are shown in Table 6-9.

Table 6-9 Five different measures of income inequality for households in the OHV and CMDT zone

	OHV	CMDT
Variance	12580.7	26249.7
Coefficient of Variation	0.6566	0.4932
Relative Mean Deviation	42.346	33.58
GINI Coefficients	0.3746	0.2973
Variance of Logarithms	0.066	0.044

As shown in Table 6-9, with the exception of variance, the surveyed households of the CMDT zone had more equal income distribution or better income equality than the households of the OHV zone. It is commonly regarded that variance is not an accurate measurement of

income inequality. If every household's income increases at the same rate, the real income equality may not change, but the variance would increase significantly. Thus a limitation of the variance increase. To avoid this shortcoming, the coefficient of variation is used. Based on the coefficient of variation, the households in the CMDT zone had better income equality than those of the OHV zone. When using the relative mean deviation[4] to measure income inequality, it tends to be true that by only transferring the income from rich households to poor households would reduce the value of the relative mean deviation. If the very rich households gave their income to other above average middle level income households the relative mean deviation value would not be reduced. Gini coefficients weigh heavily on the middle-level income households. In other words, until the majority of the middle level income households share equality, the value of the Gini coefficients will not be reduced. In contrast, the variance of logarithms weighs heavily the lower-income households. Unless the poorest rural households improved their income situation, the variance of the logarithms will not change significantly.

Basically, the results of the different measurements of estimated income inequality of the surveyed households in different zones support the hypothesis stated in chapter two: The better the institutional setting of a zone, the more equal its income distribution and the higher the homogeneity of the household food situation.

The impact of different taxation policies on the income equality and food situations of different households

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[4] Relative Mean Deviation is the value of sum of ratio of individual sample and group mean minus 1.

Rural taxation policy not only affects the food situation and investments in new technology of different households, but also the income equality of different households. Dioné estimates that, on the average, taxes accounted for 39% of the estimated average cereal deficit of farm households in the relatively poor food situation zone, the OHV zone, (Dioné 1989, pp.214).

Obviously, head taxes also affect the income equality of different households, especially, the rural poor. Head tax policy makes certain households pay more taxes from household income. It is not based on a household's real income or uses of resources (i.e., land), but on the household's taxable persons. If the head tax system was replaced by a tax based on land utilization or level of food net availability of different households, it would be interesting to determine who would be better off and who would get worse off under the new taxation system.

Tax payment based on the level of land utilization

If households paid taxes based on land utilization by the household rather than on the number of taxable persons, the food situation and income distribution of different households would be altered. It is assumed that different households have the same quality of land (actually, food deficit households and food surplus households may not have the same quality of land. Food surplus households are likely to have better quality land). With the land based taxation system, some food deficit households would be fairly better, since food deficit households tend to have smaller crop acreage than food surplus

households[5]. As Table 6-10 demonstrates, 63.6% of the food deficit households would be better off, while only 27.3% would be worse off,

Table 6-10 Change of Net food availability of different food situation households with implementation of the recommended land based tax reform.

	Better off	Worse off	Missing & No change	Sum
Food Deficit Household	56	24	8	88
% of deficit households	63.6	27.3	9.1	100
Food Surplus Household	24	72	2	98
% of surplus Households	24.5	73.5	2	100

with the land based taxation system. Conversely, 73.5% of the food surplus households would be worse off, and 24.5% of the food surplus households would be better off.

Also, by adopting the recommended tax reform, the number of food surplus households would decrease from 98 to 88. Food equivocal situation households would increase from 11 to 16. And food deficit households would increase from 77 to 82 but the level is less severe. Also the general income inequality of different households improved under the new taxation system. In other words, many households will remain as food deficit households after the tax reform, but their food situation regarding the level of food deference is getting better.

Tax payment based on the level of household net food availability

If the net food availability is a good estimation of the income of

[5] This section and the next section provide simple simulations of tax reforms. The two simulations assure 1) the rural households pay their tax based on crop or agricultural land utilized instead of the number of taxable persons. Each household pays tax proportionately to land resource utilization; 2) the rural households pay their tax based on food net availability or the estimated income situation. Better food situation households pay more tax than poorer food situation households. Frequency and descriptive analysis are utilized for conducting simulated tax reform analyses. For more details on the simulations, see Appendix III.

different farm households, it can be assumed that certain households would be better off under a taxation system that different households pay taxes based on their total level of food net availability. The total net household food availability is used rather than net food availability per consumer for equity measurement because it accounts for the impact of household population size.

Based on the analysis of this tax reform option, 76.1% of food deficit households would benefit, while 17% of food deficit households would be disadvantaged. 26.5% of the food surplus households would gain and 68.4% of the food surplus households would be worse off (see table 6-11)

Table 6-11 Who benefits from the recommended net food based tax reform

	Better off	Worse off	No change & missing	Sum
Food Deficit Household	67	15	6	88
% of Deficit Household	76.1	17.05	6.82	100
Food Surplus Household	26	67	5	98
% of Surplus Household	26.5	68.4	5.1	100

According to this tax reform, the number of food surplus households changes from 98 to 93. The number of food equivocal situation households increase from 11 to 17, and the number of food deficit households would increase from 77 to 80.

Other tax reforms could be introduced. Taxes could be based on household per capita income or food situation per household members. The key problem would be how to determine the tax rate of different households with different income and food situations. When evaluating new taxation system, the planners or decision makers must determine if the tax policy exempts tax payments of households with larger populations. If so, it may punish other households who are more

efficient yet relatively smaller in size and thus having higher per capita income and a better food situation per household member. With abolishing the head tax system, it is expected that larger households could benefit most. It would also be likely that same taxation system would have a negative impact on household population control. The head tax encourages smaller families. Thus, the problem of rapid growth of the rural population may get more serious. Therefore, it becomes extremely difficult to design a new tax reform which not only lessens inequality, but not have some possible negative aspect such as higher birth rates.

Also, under any taxation system, the government desires to collect same amount of taxes. However, the different food situation populations do not change significantly under the different taxation systems. The food surplus populations accounts for 42-50% of the total surveyed population, the food deficit situation population accounts for 50-51% of the total population, and the food equivocal situation population is about 4-7% of the total survey population. Thus, the government may not see much to be gained from changing the systems relative to the risks involved.

The Impact of three different taxation policies on the inequality of the survey households in Mali (1985-1987)

Based on the simulated tax reform analysis, different taxation policies would have different impacts on the inequality of income of households. The basic results can be seen in Table 6-12. The head tax (the original taxation system), the land tax system (tax each household

pays determined by how much land it utilizes) and the income tax system (based on total net household food availability) are compared.

Table 6-12 shows that having households pay taxes according to their estimated income level is the better tax reform method based on equality. Households under the land tax and estimated income tax system have better income equality than under the original head tax system. Since Table 6-12 underestimate the value of the coefficients because of missing values The missing values are treated as zero for the ease in computation. In reality, the values of these missing variables are much greater than zero.

Based on the five different measurements of inequality, except for the

Table 6-12 Estimated income inequality of different Households under the different taxation system

	Head Tax	Land Tax	Estimated Income Tax
Variance	25702.3	23812.9	21709
Coefficient of Variation	0.638	0.657	0.624
Relative Mean Deviation	88.28	93.40	92.96
GINI Coefficients	0.391	0.352	0.314
Variance of Logarithm	0.079	0.066	0.060

coefficient of variation, the households under the two recommended taxation systems would share more equality than they would under the old head tax system.

The two new recommended taxation policy reforms may be different in practice. The land tax system may be more easily implemented than the income tax system, since information about land utilization can be more easily obtained than food net availability. If the government tried to obtain food availability information of different households in

different years, it would have to make a huge investment in monitoring cost in order to prevent the cheating of individual households. Hence, the "land tax" system may be more workable. The implementation of this recommended tax reform could be done simply. The government is encourage to replace the old head tax system with a land based system given additional analysis regarding the two systems.

Chapter Seven

Conclusions and Implications

With the utilization of descriptive and frequency analysis, econometric analysis, and discriminant analysis of the survey data, the factors affecting the farm household food situations in Mali (both food production and food net availability) have been explored, Given the current situations regarding resource endowments, technological conditions, institutional environment conditions and other factors, the household grain production strategies are observed. Based upon these observations several results of the study were achieved. This chapter will summarize three areas: 1). The major findings; 2). policy implications; and 3) further research questions.

Major findings of the study

As expected, household food self-sufficiency or household food production per capita is positively related to: 1) better equipment or technology utilized by the household; 2) better conditions of natural and institutional environment; 3) decreasing the consumption unit per labor ratio (or increasing the inverse dependent ratio of the household); 4) the grain acreage cultivated per on-farm adult worker; and 5) the relative size of cash crop production (mainly the cotton crop). Household food self-sufficiency is negatively related to the household population. Size of the arable land farmed by households is positively related to the household food self-sufficiency. Grain crop

acreage is positively related to better equipment status of the household, the institutional environment, and the intensification of grain production by on-farm workers. Household grain acreage per household consumption unit is negatively related to household size, natural condition and household labor grain productivity. Relatively, the farmers of poor natural condition areas tend to cultivate a larger areas of grain crops per consumption unit than do those of better natural zones. Household grain crop acreage tends to decline as households increase their labor productivity with respect to food production.

Farm household food net availability (estimated household income per capita)

Several variables are statistically significant in affecting a farm household's net food availability based on the multiple regression analysis. Increasing the relative scale of cash crops (cotton), non-farm activities of the household, grain productivity of on-farm labor, household equipment status and the institutional environmental conditions are positively related to the improvement of household food availability. As was expected, increasing household size is negatively related to improvement of net food availability for the farm households. The results of the regression analysis also shows that natural conditions within a zone, the dependency ratio, household access to credit, fertilizer utilization per hectare of grain crop, and the number of taxable persons, were not statistically significant and can not be used to explain the change of the household net food availability.

Farm households' performance in food marketing.

The study indicates that it is difficult to identify if a food deficit household sold grain at a lower price than a food surplus household in the cross region comparison. The study does revealed that there were some differences in the timing of food sales and purchases between food deficit and food surplus households. However, the results can not be used to make inferences regarding the population because of a low level of statistical significance. Therefore, a judgement that the food deficit households relative to food surplus households sold their food earlier post-harvest and bought their food late at a higher price could not be made.

Food situation vs. non-farm activities

Based on the study farm household production in non-farm activities is positively related to the estimated household incomes situation. However, it becomes less clear whether better food situation households were more likely to engage in non-farm activities than were food deficit households.

Prediction of different food situation households

Using discriminant analysis it is possible to predict which of three different type of food situation households a given household will fall with 70-80% of accuracy. If only two types of household model is used the accuracy increase to over 90%. It is easily to predict different food situation households correctly within a zone rather than across zones. The within zone analysis holds greater explanatory power (less predictive error) and needs fewer explanatory variables.

The result of the study indicates that the poor food situation households are such because they tend to have lower level household food

production, a larger family size, relatively less grain acreage and total crop land, higher dependency ratios, lower grain productivity level of on-farm labor, lower cash crop (cotton) production, and higher intensive of on-farm labor utilization in grain production in the OHV zone only), and more likely to buy food from the rural market.

Equity issues

Food deficit households in the sample actually paid more taxes than did the food surplus households. Nevertheless, it is difficult to infer statistically that the food deficit households paid more taxes than the food surplus households. It can be inferred that, a food deficit household paid at least as much tax as a food surplus household. Considering the small absolute and relative scale of food production, the small scale of land utilization, and the lower level of estimated household income per capita of food deficit households in comparison to food surplus households, the food deficit households paid proportionally more of their incomes as taxes.

Income distribution across two different zones

Based on the five different equality measurements, it was demonstrated that the CMDT zone had a more equal income distribution than the OHV zone. The CMDT zone had better institutional environment conditions and better agricultural markets for food sales and inputs.

The impact of changing fiscal policy on estimated income equality of different farm households

The simulated tax reform analysis indicated that when the current head tax system is changed to a new tax system where each household pays

tax based on the level of estimated income per capita (or food availability) or the level of land utilization, the overall income equality of all the farm households can be improved. This results in most food surplus households paying more taxes and most of food deficit households paying less taxes than under the head tax system.

Policy implications

Food policy priorities for decision makers

Different food policies tend to be interrelated because no single factor determines the food situation of households. Within the policy process, policy makers may need to prioritize certain food related policies. Based on the research results presented in previous chapters, the relative importance for making different food or food related policies can be arranged in the following descending order: 1. Household food production policy; 2. Family planning or population control policy; 3. Land tenure policy; 4. Human capital investment policy; 5. Food marketing policy; 6. Fiscal policy; 7. Labor employment policy; and 8. Investment policy.

Facing the food problem in Mali, the most urgent food policy to consider should be that of a food production policy. The peasants in the food deficit households have lower capability to produce food. This problem is more pressing than that of food and income distribution or the general food entitlement problem.

With regard to the promotion of food production and better equality in obtaining food for farm households, perhaps the most important policy considerations for policy makers is helping households select appropriate production technologies. Because the farm households

have different natural environments they need different technology adapted to their food production. For instance, households in the northern part of the survey area tend to have more extensive grain crop cultivation than households in the south. Among the strategies employed by farm households related to food production will be the selection of appropriate cropping technologies. Different technologies may involve different institutional arrangements and research and extension services.

In making food-related policies in Mali, the second policy to consider is population control. Larger families tend to have poorer food situations. The policy makers need to understand the factors that influence the household family size. This may require further research regarding rural population issues.

Another policy issue is the land tenure system. Because better quality crop land is limited in Mali and because land redistribution in Mali is very difficult to implement, policy makers may consider modifying the taxation policy. Households with large amounts of better quality land should pay more taxes than the households with relatively poor quality crop land. Due to the lack of land tillage records, a land tax may be difficult to implement in Mali. However, a progressive land tax as discussed in chapter 6 may become increasingly more important as population growth put increasing pressure on the land resources. Already, private land appropriation is beginning in Mali.

Policies related to human capital and rural labor off-farm employment should also be examined. Before a rural employment policy can be developed, further research on the impact of different rural off-

farm jobs on the food and income situations of different households needs to be conducted. A major concern is how different rural employment policies could affect the well-being of the rural poor. The goal of these policies should be to improve the capacity of on-farm workers of poor food situation households in food production. This may lead to diversification of household activities, hence increasing security by producing more food and higher household income.

Food marketing policies are a very important part of the food situation of Mali. The marketing policies include a food price policy, policies that regulate marketing channels rules and influence the incentives for different households, and the development of a marketing infrastructure. The policy makers need to evaluate the effects of different alternatives. If the food producer price is too low, the households with the greater capacity for increasing food production may choose not to expand production because of poor institution. But if the price is too high, the majority of poor food situation households that purchase food at rural food markets would be adversely affected. Allowing the majority of the people to receive benefit from food market trade should be the main objective of the food marketing policy.

Fiscal policy is important in affecting the food situation and rural income of different households. To achieve better income equity, reform of the taxation policy is needed. With implementation of a new taxation system, poor food situation households should reduce their tax payments, while some of the better food situation households should increase their tax payments. By reducing the size and adverse timing of the tax payments, the poor food situation households may benefit from

more food market trade.

Finally, the policy makers should pay greater attention to the equity problem related to cash crop production. They should aim to reduce the concentration of cash crop production among the different farm households. The goal should be to balance the cash crop production efficiency and equality across households.

This study provides some evidence that using international aid for investment in the food marketing system may not be the best choice of using limited financial resources to help alleviating the rural food crisis in Mali.[1] Rather than emphasizing investments to improve the food marketing situation (food distribution problem), the investment should be used to improve food production of the rural households, especially the poor food situation households. Also, investment should be given to the improvement of family planning or birth control education, and community development in order to improve the land distribution among households. In order to help farm households increase their capacity for land expansion, the investment policy needs to emphasize the improvement of the equipment level of households, especially the poor food situation households. This might include subsidies for households that have a lower capacity to invest in new equipment. Perhaps some programs in equipment purchases would be utilized.

Toward Workable and sustainable long run food policies in Mali

Like many less developed nations, the Mali government has a low

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[1] The discriminant analysis in chapter 6 provides evidence that marketing performance was not ranked highly in determination of the food situation of different rural households.

capacity to invest in agriculture. Low investment in agriculture is the main constraint or bottleneck for improving the rural food situation and agricultural development. Many food policy recommendations require high investment. Such policies include price support, subsidized credit, technology investment, and so forth. Since this type of policy recommendation requires high capital investment conditions, it is not very useful in guiding food policies in Mali. Nevertheless, decision makers may use such policies in the short-run in order to reinforce the power and prestige of government. When the political situation is not stable, the decision makers tend to use short-run policies to address a long run problem. Therefore, the long-run policies may not be effective or may conflict with the short run policies. Because combatting the food crisis in Africa is a long-run battle. Any neglect of long-run food policies will likely cause future food problems. Furthermore, if international aid cannot be maintained in the long-run, the current (short run) reforms may only compound the problem. The food marketing reforms and the use of other relevant policies would have a short life if the donor agency did not continuously supply financial resources to Mali. Without donors' commitments, reforms might be destroyed in one day. A key consideration is how the country can build its own capacity in achieving food self-reliance. What can be done by policy makers in making food and food related policies without demanding high investments is still a major question in many less developed nations. Consequently, food policies in less developed countries like Mali should not be made on the basis of high capital investment, but on other factors such as changing the institutional conditions, changing the behavior of people

and changing the rules of the game. Thus, food policies should not be viewed as strictly investment decision. Policy is a process that links the interactions of different people and organizations. The food policy needs to be treated more as an "institutional policy" rather than an "investment policy" in most less developed nations.

Areas for Further Study

The data utilized in this thesis provide explanations and predictions regarding the main characteristics of different food situation households and the major production and marketing behavior strategies of different farmers in the surveyed areas. It also provides an understanding of the interaction of environmental change and the strategies employed by farm households. It also examines the impact of possible new policies on the household food and equity situation.

One topic for further study is the equity issue in terms of land distribution among households in the two zones. This effort should identify the relationship that exists between resource distribution and the poor food households. It should address the issues of why different regions have different levels of unequal land distribution and the impact of "cultural endowments". The land distribution study might also identify the quantitative impact of the managerial factor of different regions. This would make the quantitative analyses more accurate and meaningful.

The second research area for further study is the impact of different non-farm jobs on the food situation of households. This may include two research activities. First, better means of quantifying household non-farm activities needs to be developed. Second, the relationships between

household income, food situation and different non-farm job needs to be identified. These might help determine if rural labor off-farm employment is an effective means to improve the food situation of households.

The third research area needs to examine to what extent the taxation policy affects food deficit households food marketing pattern. This effort should examine the food marketing performance of different food situation households. The usefulness and the limitations of the marketing reforms in Mali may be better understood through such analysis.

A fourth further research area relates to the exploration why different farm households in the poorer natural condition areas have more extensive crop cultivation than the households in the better natural condition zones. Different factors such as population density, diversification of household activities and access to arable land can be included. The findings may provide incites on which production technologies are appropriate. The fifth additional research issue relates to the impact of some factors on household adoption of new technology. The most difficult thing is to weigh the different factors appropriately. Using continuous variables rather than categorical variable is desirable in this analysis. The analysis may provide evidence that technology policies can help most poor food situation households.

Finally, through study of institutional factor, it should be possible to evaluate the institutional impact on the behaviors and characteristics of different households in different zones. If this

study can be done in the micro-level, the regional developmental strategies and policies might be made effectively.

APPENDIX I

ESTIMATED THREE-GROUP LINEAR DISCRIMINANT FUNCTION

For the across zone three group discriminant analysis, the final estimated linear functions are as follows:

Function One

D1= -2.2 + .48(X1) + .38(X2) - .16(X3) + 1.9(X4) - .3(X5) - .87(X6) + .14(X7)
+.21(X8) + .5(X9) -.82(X10) + 2.5(X11) - .14(X12) -.41(X13) - .31(X14)
+.67(X15) - .79(X16) -.2(X17) +.47(X18) +.62(X19) + .49(X20);

Function Two

D2= .20 + .39(X1) + .82(X2) - .35(X3) - .91(X4) + .5(X5) +.16(X6) - .14(X7)
+.66(X8) + .86(X9) -.17(X10) + 5.9(X11) - .53(X12) - 6.5(X13) - .91(X14)
-.17(X15) + .17(X16) +.95(X17) +.39(X18) +.85(X19) - 1.1(X20)

Group Classifications

Based on the two estimated linear discriminant function, two discriminant scores are calculated. If D1 is much greater than zero, and D2 is less than zero, the case (household) would be classified under group 3 (food surplus household). If the D1 value is around zero (either positive or negative), and if D2 is much greater than zero (greater positive value), the case would be classified under group 2 (food equivocal household). If D1 is less than zero (greater negative value),and D2 has a small positive or negative value, the case would be classified to group 1 (food deficit household).

The group means for the two estimated linear discriminant

functions can be seen in the following. Group 1 has negative means for both functions; Group 2 has negative mean for function 1 and a positive mean for function 2; Group 3 has a positive mean for function 1 and a negative mean for function 2.

Canonical Discriminant Functions Evaluated at Group Means (Group Centroids)

Group	Function 1	Function 2
1	-1.62	-.12
2	-.75	1.14
3	1.19	-.04

Accuracy of the Discriminant Function

Whether the estimated functions are accurate or not can be examined with Canonical Discriminant Functions. The result of Canonical Discriminant Functions can be listed as follows:

Canonical Discriminant Functions

Fcn	Eigenvalue	Pct of Variance	Cum Pct	Canonical Corr		After Fcn	Wilks' Lambda	Chisquare	DF	Sig
					:	0	.3225	182 76	40	.0000
1	1.867	95.82	95.82	.8070	:	1	.9246	12.66	19	.8555
2	.815	4.18	100.00	.2746	:					

The first Function had the largest between-group variability. As the above results show, Function 1 accounts for 95.82% of the total between-group variability, while function 2 only accounts for 4.18% of the between-group variability (the values are represented by "Pct of Variance").

The significance of the discriminant functions indicates that the second discriminant function does not contribute substantially to group differences, since it is not significant at a low percentage level.

For each of the two discriminant functions, the eigenvalue is the ratio of between-groups to within-groups sums of squares. Function 1 had a larger eigenvalue than that of function 2, which means function 1 is weighted more for group classification, and is a fairly good function.

For within the zone (the OHV) three group discriminant analysis, the final estimated linear functions are as follows:

Function One

$$D1 = -1.42 - .06(X1)^2 + .1(X2) - .09(X3) + .85(X4) - 2.47(X5) + 4.6(X6) - .0005(X7) + .0009(X8) + .74(X9)$$

Function Two

$$D2 = -1.57 + .13(X1) + .21(X2) - .02(X3) + .65(X4) - 7.3(X5) + 8.1(X6) + .0009(X7) - .0006(X8) + 1.09(X9)$$

Canonical Discriminant Functions

Fcn	Eigenvalue	Pct of Variance	Cum Pct	Canonical Corr		After Fcn	Wilks' Lambda	Chisquare	DF	Sig
					:	0	.3243	85.58	18	.0000
1	1.83	95.34	95.34	.8042	:	1	.9178	6.51	8	.5895
2	.815	4.18	100.00	.2746	:					

Canonical Discriminant Functions Evaluated at Group Means (Group Centroids)

Group	Function 1	Function 2
1	-.89	-.07
2	-.25	-1.05
3	2.16	.11

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[2] The variables X1-X9 refer to the same variables in page 101 of chapter 6 .

The interpretation of Canonical discriminant functions and Group Centroids is similar to the above across zone three group discriminant analysis.

APPENDIX II

Household Crop Acreage Estimation

Not all the households studied provided crop acreage information. Some households had missing values, both certain crop acreage and crop production (i.e. millet acreage and production), but other households had the information of production, yet were missing values of crop acreage. This kind of household's crop acreage is estimated by first estimating the crop yield through the group mean crop yield in the region, then using the estimated group mean crop yield to approximately represent the missing crop yield of the households that had crop production. After the estimated crop yield is obtained, the households' missing crop acreage can be estimated by dividing the crop production by the estimated crop yield. Therefore, 25 farm households of the sample area had the cultivated millet growing acreage instead of real acreage (15% of the households which had grown millet crop). Six households had the calculated sorghum crop acreage (4% of the households which had grown sorghum), and 16 households had the calculated maize crop acreage (17.6% of the households which had grown maize crops).

APPENDIX III

The Procedures for Simulating the Tax Policy Reforms

1. Land Taxation System

The Goal of implementation of the land taxation system rather than the head tax system is that the government imposes the same amount of tax under the new tax system as it had under the head tax system.

The amount of tax each household should pay is based on the total amount of crop land the household utilizes (quality of land is not considered for imposing the household tax). Each household would pay tax proportionately to the crop land the household utilizes. Hence, one hectare of crop land should pay 3,247.7 CFAF tax, (i.e., if a household utilized 4 hectares of crop land, it should pay tax equivalent to 3,247.7 * 4 = 12,990.8 CFAF).

Since the new land tax is still based on total land instead of per capita land utilized in each household, and without considering quality impact, food deficit households, or poor food situation households pay more tax than if the tax imposed is based on per capita land utilization and land quality, since poor food situation households have large families and are assumed to have relatively poorer quality land.

The impact of land tax on the household food net availability is calculated by transferring the cash income to the food purchased or sold, i.e., if a household is a food net purchasing household, it will buy food at the price it actually paid. Unless the price information is missing, the households would pay 49.47 CFAF to buy 1 kg of coarse

grain. Based on the study, 116 households had this calculated mean price to buy coarse grains. If a household is a food net selling household, it would sell its cereal products at the actual price it received. Unless the household had missing value for grain sales, it would receive a mean food sale price of 35.1 CFAF to sell 1 kg. of the cereal (91 households had received this group mean price to sell 1 kg of cereal). Then, the cash a household paid or received from the simulated land tax reform will transfer to the kilograms of grain (net food availability) the household would increase or decrease when the new tax system was implemented. Based on equity measurements, the land tax system would increase the equity of different farm households' net food availability (estimated income).

2. Estimated Income Taxation System

Using household total net food availability as a proxy of household income, some households would pay more tax than other households. Since this system still uses the total level of food net availability instead of per capita food net availability to measure household tax payment, it underestimates the inequity between good and poor food situation households. A better food situation household tends to provide not only better food net availability than for poor food situation households, but also much better net food availability per capita.

Under the estimated income tax system, each household pays tax proportionately to the total household food net availability. Hence, a farm household would pay 6.822 CFAF for each 1 kg of food a farm

household obtained, (i.e., if a household had 1000 kg of grain products that are ready for consumption, the household must pay 6,822 CFAF as their income tax to the government).

The estimated food purchasing and food sale prices for some households which had missing information for food trade are estimated in the same way as mentioned in the land tax system reform.

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