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Linkages Between Agricultural Growth and Improved Child Nutrition in Mali

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with the participation of Modibo Diarra, Isaac Niambélé, Keffing Cissoko, and Modibo Kamaté

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This report presents the results of the exploratory/hypothesis-generating phase of the project to **Strengthen Linkages Between Agricultural Productivity Growth And Improved Childhood Nutrition.**

This project is being coordinated jointly by Michigan State University (MSU), *Institut du Sahel* (INSAH/CILSS), and the *Division Suivi de la Situation Alimentaire et Nutritionnelle* (DSSAN) of the *Cellule de Planification et de Statistique* (CPS) in the *Ministère de la Santé* (MS). The project is financed by United States Agency for International Development (USAID) Mali through the USAID-MSU Food Security II Cooperative Agreement (managed by Global Bureau, Center for Economic Growth and Agricultural Development, Office of Agriculture and Food Security).

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EXECUTIVE SUMMARY

Despite Mali's strong economic and agricultural growth over the past decade, levels of child malnutrition remain alarmingly high. A 1995-96 Demographic and Health Survey (DHS II) found 23% of the children (under 3) surveyed to suffer from wasting and 30% to suffer from stunting. These statistics are considerably higher than those from an earlier DHS study in 1987, which found 11% of children surveyed to suffer wasting and 24% to suffer from stunting. Between 1985, real gross domestic product (GDP) grew at an average annual rate of 3.5%, with the agricultural sector averaging 3.9% growth over this period. The rate of economic growth has been particularly robust following the 1994 devaluation of the *Franc de la Communauté Financière d'Afrique* (CFA Franc), and especially for the cotton and rice sectors, which grew at annual rates of 12% and 10%, respectively.

This paper presents the results of the first phase of a project aimed at analyzing the links between agricultural growth in Mali and child nutritional status. The objective of this project is to strengthen these links through applied research and extension. The first phase of the project was designed to generate hypotheses concerning the relationship and review existing data to test these hypotheses, generate new hypotheses and draw policy implications. The second phase of this project will carry out in-depth research to address the critical questions left unanswered in phase I and initiate actions designed to improve these links.

The first phase research and analysis involved researchers from the DSSAN, of the Malian Ministry of Health, INSAH, MSU, DNSI, and the IER in Mali. The first step was to review the theoretical and empirical literature on the major determinants of child health and nutrition and on the linkages between agricultural growth and child nutrition. Second, various hypotheses concerning these linkages were formalized. Finally, these hypotheses were tested with existing data, and the researchers reviewed other studies in Mali which dealt with theses issues, both directly and indirectly. The results from the first phase research were presented to the ad hoc committee on nutrition in Mali at a workshop on February 10 and 11, 2000. This report incorporates the input from the members of the committee.

SUMMARY OF KEY FINDINGS

Lowering average unit costs of production is the principal means by which increasing agricultural productivity enables households to raise incomes while lowering real food prices for urban and rural households. This process is predicated on well-functioning markets. When markets function properly, households do not need to be self-sufficient to be food secure but do need to possess effective demand to enable them to purchase foods. Rising agricultural productivity leads to higher effective demand, but higher real incomes are only a means to improving health and nutrition. Households must then choose to consume more food and more nutritiously diverse foods. Many other factors play a fundamental role in determining child health and nutrition, including feeding practices, disease, water quality, sanitation and knowledge of health and nutrition, many of which may also be correlated with income levels.

The main findings from phase I of the research are:

- Agricultural growth has led to higher rural incomes for some households, particularly those better-equipped with animal traction and those with access to irrigated rice production in the Office du Niger (ON).

- The incidence of child illness and malnutrition is high, as measured by the DHS II, but has not necessarily worsened from the DHS I study; these surveys are representative of different samples.

- Income is positively but weakly related to better child health and nutrition.

- Infrastructure is positively related to better health and nutrition. To the extent that community infrastructure is financed by agricultural profits, this serves to strengthen the link between agricultural-led growth and child health.

- Price effects are difficult to interpret, depending on the household's position in the market, but well-functioning markets are essential to sustainable, long-term development.

- Hypotheses concerning certain negative repercussions from agricultural-led growth, in particular the effects of increased female labor in agriculture and the role of increasing cash income in the hands of men, cannot be adequately tested with existing data.

POLICY IMPLICATIONS

Results from this research show that health and other community infrastructure is positively related to better child health and nutrition. Moreover, community health centers are the focal point for health policy in Mali. Consequently, to the extent that proceeds from agriculture can be used to develop this infrastructure and help finance their programs, agricultural growth can have a positive impact on child health. While measures of household income are positively related to better child nutrition, the relationship is weak. Thus, it is not clear that simply raising rural incomes will lead to noticeable improvements in child health over the short run.

Another important area of concern is the level of human and institutional capacity in Mali to address these issues. While Mali has a cadre of highly qualified health professionals, there is still a need for continued training and education to strengthen analytic skills (e.g., in the areas of community nutrition and statistical analysis) in order for Mali meet these challenges. Without qualified personnel in public health and community nutrition, no solution is ultimately sustainable.

SUGGESTIONS FOR FUTURE RESEARCH

Further research is necessary to strengthen our understanding of the many complex issues that underlie the links between agricultural-led growth and improving child health. However, before moving forward with new research, the first objective must be to coordinate ongoing and planned research by Malian institutions and donor organizations. All to often, one organization will collect vast but limited information on one aspect of this dilemma but fail to provide social scientists with a broad enough range of information on other key variables necessary to begin investigating these causal relationships.

The major gap in our understanding of the problem is the relation between the different strategies pursued by households in assuring food security and their effects on health and nutrition throughout the year. Such an endeavor would require information concerning on- and off-farm income, expenditures by individuals within the household, measuring consumption and monitoring feeding and child care practices. Collecting household-level information on both agricultural and health data demands an innovative research design that builds on existing research efforts, particularly in agriculture. Coordinating this research with future activities, such as a micro-nutrient and a budget-consumption study, would provide an extremely rich source of information. Other areas of research may focus on examining the effectiveness of health and nutrition interventions in Mali. All research should be coordinated through the DSSAN and reflect the priorities of the ad hoc committee on nutrition.

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ACRONYMS

CFA Franc	*Franc de la Communauté Financière d'Afrique* (Currency of 13 West African countries belonging to the African Financial Community)
CMDT	*Compagnie Malienne pour le Développement des Textiles* (Malian Textile Development Company)
CPS	*Cellule de Planification et de Statistique* (Planning and Statistics Unit of the Ministry of Health)
CSCOM	*Centre de Santé Communautaire* (Community-managed Health Center)
CV	Coefficient of Variation
DHS	Demographic and Health Survey
DNSI	*Direction Nationale de la Statistique et de l'Informatique* (National Statistical Office)
DSSAN	*Division Suivi de la Situation Alimentaire et Nutritionnelle* (Division to Monitor the Food and Nutritional Situation)
EMCES	*Enquête Malienne de Conjoncture Economique et Sociale* (Malian Study of Socio-Economic Circumstances)
GDP	Gross Domestic Product
HAZ	Height-for-Age Z Score
IER	*Institut d'Economie Rurale* (Rural Economic Institute)
IFPRI	International Food Policy Research Institute
INRSP	*Institut National de Recherche en Santé Publique* (National Public Health Research Institute)
INSAH	*Institut du Sahel* (Sahel Institute)
MS	*Ministère de la Santé*
MSPAS	*Ministère de la Santé, des Personnes Âgées et de la Solidarité* (Ministry of Health, the Elderly and Solidarity)
MSMF	Millet, Sorghum, Maize, and Fonio
MSU	Michigan State University
NCHS/CDC	National Center for Health Statistics/Center for Disease Control and Prevention
NGO	Non-governmental Organization
OHV	*Office d'Haute Vallée du Niger* (Upper Niger River Valley Development Authority)
ON	*Office du Niger* (Niger River Rice Development Authority)
OPAM	*Office des Produits Agricoles du Mali* (Malian Grain Marketing Board)
PMA	*Paquet Minimum d'Activités* (Minimum Package of Health Services)
PRMC	*Programme de Restructuration du Marché Céréalier* (Cereals Market Restructuring Program)
PDDS	*Plan Décennal de Développement Sanitaire et Social* (Health Sector Development Plan: 1998 - 2007)
PRODESS	*Programme de Développement Sanitaire et Social* (Health Sector Development Program - first half of the PDDSS)
SYCOV	*Syndicat des Producteurs de Coton et des Vivriers* (Malian Farmers' Union)
USAID	United States Agency for International Development
VA	Value-added
WHO	World Health Organization
WHZ	Weight-for-Height Z Score

1. INTRODUCTION

Many agricultural sector policies and rural development projects in Africa have been based on the premise that increased household income, either through improved agricultural productivity and expansion of cash cropping, or through expanded non-farm incomes, will automatically improve household or individual food security.

The standard definition of food security stresses the importance of food availability, access and utilization which together should lead to better nutritional status. Yet Mali faces a paradox wherein there has been strong agricultural growth over the past decade, but the most recent nutrition surveys show alarming levels of childhood malnutrition. Recent statistics of child anthropometry show high rates of both "wasting" (low weight-for-height) and "stunting" (small height-for-age).

At first glance, data from the previous ten years seem to indicate that the situation is worsening and that childhood malnutrition is a long-term problem. The paradox of persistent malnutrition in the face of an expanding agricultural sector raises the questions of what the relationship is between increased agricultural production and improved food security and what actions are needed to reinforce the benefits of agricultural-led growth to improved nutrition.

1.1. Problem Statement

Aggregate measures of economic growth show that Mali experienced positive growth from 1985 through 1999, with real GDP increasing at an average rate of 3.5% per year and aggregate value added increasing at 3.2% per year. Performance in the agricultural sector was even better, with value added growing at an average rate of 3.9% per year. It is also encouraging to note that years with the strongest growth tend to be the more recent years following the 1994 devaluation (4.8-5.1% for GDP, 4.6% and 4.7% for national and agricultural value added), as this suggests potential for strong growth in the in the future. Growth in the cotton (11.7%) and rice (9.6%) sectors was particularly strong after the devaluation (DNSI 1999).

Despite the relatively strong growth in the agricultural sector over the past decade, rates of preschool child malnutrition remain alarmingly high, even in regions that have benefitted from strong agricultural growth. The most recent DHS II, conducted from November 1995 to May 1996, found that nation-wide, 30% of children surveyed under three years of age suffered from "stunting." Furthermore, nearly one-quarter, 23%, of the children surveyed suffered from "wasting." In the higher agricultural production regions of Sikasso (cotton) and Segou (rice and cotton), the DHS II reports that 33% of the surveyed children are stunted, while wasting affects approximately one-fourth of the children (Haggerty et al. 1998). With genetic differences accounting for only a small percentage of the variation in children's weight and height,[1] we can

[1] The World Health Organization (WHO) reports that genetic differences between young children (under 5) only result in a variation of approximately 1 cm difference in height (WHO 1995).

assume that children's nutrition status in Mali stems primarily from differences in environmental, behavioral and socio-economic factors.

While the current rates of preschool child malnutrition in Mali are disheartening, these figures also appear to represent a deterioration in nutritional status from earlier studies. Compared with the first DHS I conducted in 1987, the percent of children in the DHS II sample classified as "wasted" more than doubled, rising from 11% of the children measured under three years of age to 23%. Stunting increased by one-quarter, from 24% to 30%, from the first to the second survey. It is not clear, however, that these statistics are truly comparable; differences in sample selection, sample size, lower mortality rates and seasonal variation in weight and height could have contributed to higher rates of child malnutrition in DHS II versus DHS I.

1.2. Research Objectives

USAID/Mali, as part of its strategic objectives to improve the welfare of Malian youth and consequently the productive capacity of the Malian economy, initiated a research/action project in 1999 to support the efforts of the Government of the Republic of Mali to improve the nutritional status of Malian children. This project is implemented jointly by the Food Security II Cooperative Agreement at MSU, DSSAN, CPS, Ministry of Health (MS), and INSAH. Its overall objective is to better understand the effects (direct and indirect) of agricultural development on child health and nutrition and to determine mechanisms to improve these linkages.

The project is divided into two phases: 1) an exploratory/hypothesis-generating phase; and (2) an in-depth research/action phase. The objective of the first phase is to use existing sources of information to gain a more complete understanding of Malian agricultural productivity growth, child health and nutrition in an effort to explain the seeming paradox of worsening rates of child malnutrition despite increases in agricultural production. By determining what is known about agricultural production-childhood nutrition linkages in Mali and by identifying knowledge gaps concerning this relationship, the first phase results and subsequent discussion of these findings with analysts and policy makers will serve as the basis for designing a program of applied research and actions to be undertaken in a second phase. The objectives of the second phase will be to plan and initiate various actions designed to improve these links and to carry out in-depth research that will address critical questions not answered in the previous phase.

It is hoped that the multi-disciplinary approach and active participation of analysts from several different ministries and research institutes in Mali will serve as an example for future effective collaboration between the numerous sectors working on nutrition issues.

1.3. First Phase Research Methodology

During this first phase, researchers from MSU, DSSAN, INSAH, IER and DNSI carried out the following tasks in order to better understand the paradox described above:

- Review the theoretical and empirical literature on:
  - The major determinants of child malnutrition;
  - The nature of linkages between agricultural development and child malnutrition.

- Apply the information obtained in the literature reviews to:
  - Generate hypotheses specific to Mali concerning agriculture-nutrition links;
  - Test these hypotheses to the extent possible using available data;
  - Use results from the hypothesis tests to develop recommendations for further analysis of existing data, additional data collection as well as policies and actions that will improve the contribution that agricultural development makes to nutritional status.

A review of selected literature on the subject and results of similar research undertaken in other countries served to assist in the development of hypotheses on the relationship between agriculture and nutrition. This literature review also included an examination of hundreds of documents, research reports, policy papers and project evaluations related to nutrition (agriculture, education, health, industry, water) in Mali. While every effort was made to obtain and examine all documents related to this vast, multi-sectoral topic, the large number of organizations working on nutrition-related issues over the last fifteen years made it virtually impossible to become familiar with all relevant information.

Analyses of Malian-specific hypotheses use information and data sets from studies that were made available to the project: *Enquete Demographie et de la Sante*, 1987 DHS I and 1995-96 DHS II, the *Enquete Maliene de Conjoncture Economique et Sociale* (EMCES) 1994, the *Enquete Budget-Consommation* 1989, the ongoing *Enquête Agricole* by the DNSI, and the ongoing *Suivi-Evaluation Permanente* conducted by the IER. If other data sets relevant to this topic have not been included in the analysis, it is because we were unable to get access to the data or we do not know about it. The research findings and recommendations presented in this paper are partial and provisional, and may be expanded and improved in the second phase as more data become available.

1.4. Report Organization

This report is organized as follows: Section 2 presents a brief review of policy reforms in Mali focusing on the Agriculture, Education and Health sector; Section 3 examines recent trends in basic indicators of agricultural performance and nutritional status; Section 4 follows with a discussion of hypotheses and empirical findings on the linkages between agricultural productivity growth and child nutrition; and Section 5 presents conclusions and recommendations.

2. A REVIEW OF AGRICULTURE AND HEALTH AND NUTRITION POLICY IN MALI

To many observers, Mali's success in reforming certain sectors (agriculture, health) over the last twenty years is in part due to the design of policies that are empirically grounded and whose implementation proceeds incrementally and sequentially. A cohesive set of accompanying measures that empower individuals and organizations to act in a manner consistent with the desired performance has also figured prominently in their successful implementation. Finally, a well-integrated national program through which the multitude of government, donor and civil society actions are coordinated has also proven to be critical to the success of the reforms.

Over the last fifteen years, the Malian government has undertaken substantial policy reforms in the agricultural and health sectors. A common theme in most reforms has been to achieve sector goals and improve human welfare by encouraging greater reliance on and sustainability of individual and collective actions that seek to improve access to quality health care and economic opportunities.

Although nutrition is a multi-disciplinary issue related to several sectors, most activities and actions undertaken to date have primarily been supported by departments and institutions affiliated with the Ministry of Rural Development and Water, and the Ministry of Health. The following brief discussion of policy centers on these two ministries.

2.1. Agricultural Policy

Since the early 1980s Mali has undertaken a slow but steady program of liberalizing agricultural markets, investing in irrigation infrastructure, and adopting macroeconomic and sectoral policies to decrease national debt and encourage greater private investment and productivity growth.

Reform in the coarse grain sector began in 1981 with the Cereals Market Restructuring Program (PRMC). The PRMC reforms included the legalization of private cereal trade and the removal of official prices. Prior to 1981, the Malian grain marketing board, (OPAM), maintained a legal monopoly on the sale and distribution of coarse grains. The PRMC process of reform gradually reduced the role of OPAM to managing and replenishing the national food stock, maintained in case of severe drought.

The most important changes in the rice sector came from investments to improve the irrigation infrastructure in the ON and the decision to restructure the Office, transferring many of its functions to the private sector. Infrastructure investments were accompanied by a progressive liberalization of rice prices and marketing which began in 1980 and ended with a full liberalization of the market in 1990. This was followed by the privatization of industrial rice mills in 1996. The government has also used import tax policies (changes in the tax rate on rice imports) to balance the demands of urban consumers for low-cost rice against rice producers' desire to obtain remunerative output prices; these policies have been particularly successful since the devaluation, permitting Malian farmers to export their high quality rice to the coastal

countries and consumers to purchase lower-quality (and lower-cost) Asian rice. A major unresolved issue in the rice sector is producer credit – access is difficult and reimbursement rates are often poor.

The cotton sector has also undergone substantial change in the past decade. Following the overthrow of Moussa Traore in 1991, substantial unrest among cotton producers led to the creation of the Malian farmers' union, *Syndicat des Producteurs de Coton et des Vivriers* (SYCOV). Through SYCOV, cotton producers became partners with the Malian Textile Development Company (CMDT) in a contract-plan that stipulates farmers' participation in decisions related to the organization of the cotton sector. Successful transfer of certain functions to other actors (e.g., seed cotton assembly to village associations, seed cotton and lint transport to private firms, numerous non-cotton development activities to other organizations) has contributed to lower CMDT operating costs and higher profits. It has also generated revenues for village associations that have been used to finance investment in social infrastructure (e.g., schools and health centers).

The devaluation of the CFA Franc in January 1994 was a boon for both livestock and agriculture, particularly in helping restore profitability to the cotton sector and making Malian rice more competitive throughout West Africa. Today, overall, Mali's agricultural sector is market-based, and continues to develop new opportunities for exportable commodities. Horticultural products, such as green beans, are exported to Europe, and Côte d'Ivoire is a large consumer of Malian onions. Processed livestock commodities, mainly hides and skins, are being exported as well.

2.2. Health Policy

In a similar way, the health sector has designed and implemented since the late 1980s, a series of reforms aimed at improving the health of the Malian population, particularly of women and children. Using the recommendations of the 1987 WHO/UNICEF-led Bamako Initiative as a guide, health sector reforms have focused on developing a decentralized, vertically-coordinated network of financially-autonomous, community-managed health centers (CSCOM) through which the local population living within a 15 kilometer radius can gain access to essential medication, vaccinations and a minimum package of health services (PMA). Services offered in the PMA include curative, preventive (e.g., micronutrient distribution) and promotional (e.g., education) activities.

CSCOM are managed by locally-elected associations. Revenues generated by CSCOM are generally used to cover operating costs (e.g., salaries of health personnel, supplies and medication, motorcycle use and maintenance). Prioritization of health center activities and strategic planning and budgeting are carried out annually by every CSCOM in collaboration with district level health personnel and other representatives of civil society. CSCOM plans are then compiled at the district and regional levels and integrated into a national health budget which is submitted to donors and the government for financing.

National health goals and program guidelines have been set forth for 1998-2007 in the *Programme de Développement Sanitaire et Social* (PRODESS), which is the initial five-year plan of the Plan Décennal de Développement Sanitaire et Social (PDDS) 1998-2007. The initial five year plan covers activities in five areas: expanding the coverage and improving the quality of health care; improving the welfare of socially-disadvantaged groups; developing alternative health care financing mechanisms; developing human resources; and, strengthening health institutions (Ministere de la Sante des Personnes Agees et de la Solidarite 1998).

2.3. Nutrition Policy

Over the last 15 years, efforts to improve nutrition in Mali have been generally approached from a project perspective, with a myriad of activities undertaken by various ministries and non-governmental organizations (NGO). The emergence of nutrition as a national priority was instigated by the 1995/96 DHS results reporting high rates of child malnutrition throughout the country. Although malnutrition is a multi-dimensional problem involving agriculture, education, health, sanitation and water among others, the development of nutrition as a key policy issue for the Malian government has to date been driven by efforts to reform the health sector which were ongoing when the DHS II survey results appeared.

A multi-disciplinary nutrition working group came together to help the ad hoc group (established by the Ministry of Health to prepare the reform) develop the nutrition component of the new 10 year health sector strategic plan. With the main objective being to reduce the incidence of child malnutrition, low birth weights, and micro-nutrient-related morbidity and mortality, the nutrition section of the plan advocated strengthening and improving nutrition-related activities and child growth monitoring as one of the basic services constituting the PMA to be offered by CSCOMs. The plan highlighted the importance of institutional capacity building, training and information dissemination to improved nutrition policy and coordination of nutrition-related activities in Mali. In particular, the group recommended the creation of a Food and Nutrition Monitoring Unit to coordinate nutrition policy and activities in Mali (Ministere de la Sante des Personnes Agees et de la Solidarite 1998).

In April 1999, the Ministry of Health announced the creation of the DSSAN in the CPS of the Ministry of Health. Although part of the Ministry of Health, the DSSAN is mandated to take a multi-disciplinary and multi-sectoral approach in its work to coordinate nutrition policy and programs in Mali.

These efforts to develop an integrated, national nutrition policy represent a positive step toward improving the nutrition status of children in Mali. The creation of the DSSAN, in particular, establishes a mechanism through which the results of future empirical research can be disseminated to policy makers and subsequently used to improve the effectiveness of actions aimed at strengthening the positive effect of agricultural growth on child nutrition.

3. WHAT ARE THE RECENT TRENDS IN CHILD NUTRITIONAL STATUS AND AGRICULTURAL PRODUCTIVITY IN MALI?

In Section 1.1 we noted that despite the evidence of positive growth in the Malian agricultural sector since 1988 and relatively strong growth since 1994, child malnutrition remains high. In this section we provide an in-depth picture of what the available data reveal concerning patterns of childhood malnutrition and agricultural growth in Mali. We first address two key questions about malnutrition:

- How high is childhood malnutrition in Mali?
- Is childhood malnutrition increasing?

We then turn to agriculture to examine these questions:

- What is the nature of Mali's agricultural growth?
- Is the distribution of agricultural growth across subsectors, regions and years skewed?
- What are the links between agricultural growth and growth in rural income?

3.1. Childhood Malnutrition in Mali

3.1.1. Measuring Childhood Malnutrition

One outcome of poor health and nutrition is growth retardation. "Z" scores are commonly used indicators of child malnutrition throughout the world based on anthropometric measurements of child height and weight. To the extent that child growth is used as an indicator of nutritional status and growth is a function of both the health and the nutritional status of a child, "Z" scores are an overall indicator of child health and nutrition. Moreover, health and nutritional status are mutually determined by one another. For example, children with diarrhea do not process nutrients effectively, while poor nutrition can increase susceptibility to diseases such as diarrhea.

The World Health Organization Technical Expert Committee (WHO 1995) reports that genetic variation accounts for only 1 centimeter of variation in height for healthy, well-nourished 5 year old children. Since 1 centimeter is a relatively small variation, this finding provides the basis for using growth as an indicator of health and nutrition for pre-school aged children.

The three most commonly cited "Z" scores are weight-for-height, height-for-age and weight-for-age. Weight-for-height (WHZ), an indicator of more immediate health and nutritional status, is often referred to as "wasting." Height-for-age (HAZ), or "stunting" is a long-run proxy for health and nutrition. Weight-for-age is a more ambiguous indicator of poor health and nutrition that will not be used in the analysis presented in this report.

A "Z" score is calculated by taking the child's measurements, subtracting the average measurement for healthy, well-nourished children of the same age and sex, and then dividing this result by the standard deviation of the measurements in the healthy, well-nourished population.

The healthy, well-nourished standards are derived from 2 studies conducted in the United States, and comprise the NCHS/CDC reference cited by studies collecting anthropometry.[2] For example, a male child of 22 months is measured at 80 centimeters. The standard at this age for boys is 86 centimeters in height, and the standard deviation is 3.1 centimeters.

$$\text{HAZ:} \qquad \frac{80\text{cm} - 86\text{cm}}{3.1\text{cm}} = \frac{-6\text{ cm}}{3.1\text{cm}} = -1.94 \text{ HAZ}$$

Since the convention among nutritionists is to report as "malnourished" the percentage of children with "Z" scores of less than -2, a child with a Z score of -1.94 would not be considered to have poor health and nutrition. However, it seems inappropriate to classify a child measured at 79.5 centimeters as "stunted" and yet to consider a child of 80 centimeters not to have health and nutrition problems. Similarly, while the DHS II reports that 30% of Malian children are stunted, it should not be inferred that the remaining 70% are healthy and adequately nourished. Because of this ambiguity, this paper reports average "Z" scores. Thus, reporting the average height-for-age Z score for children in the DHS II sample as -1.2 allows the reader to make better inferences regarding the extent of the problem in Mali. While the number of severely stunted children is high, poor health and nutrition is obviously a concern for closer to half of the children measured.

3.1.2. How High is Childhood Malnutrition in Mali?

The 1995/96 DHS reports that 23% of the children under age three in Mali are classified as "wasted" while 30% are classified as "stunted." These figures place Mali approximately in the middle of African countries reporting DHS survey results of children classified as "stunted" (see Table 1) (Haggerty et al. 1998). However, the statistics presented in table 1 are not meant for direct comparison, since differences in sampling procedures may account for some of the variation in Z score across countries. Rather, these figures serve to illustrate that small height-for-age is not unique to Mali, but is a problem throughout Sub-Saharan Africa.

[2] There is some controversy over this standard, but overall it is widely accepted as a useful indicator of health and nutrition (Martorell 1995).

Table 1. Percent of Children Classified as "Stunted" by Anthropometric Studies in Africa

Country	Year	% Stunted	Country	Year	% Stunted
Senegal	1992	19%	Togo	1988	31%
Zimbabwe	1994	21%	Kenya	1993	31%
Cameroon	1991	21%	Central African Rep.	1994	34%
Senegal	1986	23%	Zambia	1992	37%
Cote d'Ivoire	1994	24%	Nigeria	1990	37%
Mali	**1987**	**24%**	Uganda	1995	38%
Burkina Faso	1992	25%	Rwanda	1992	41%
Benin	1996	25%	Malawi	1992	41%
Ghana	1993	26%	Tanzania	1996	43%
Niger	1992	27%	Uganda	1988	44%
Namibia	1992	29%	Madagascar	1992	45%
Ghana	1988	29%	Tanzania	1991	47%
Mali	**1995**	**30%**	Burundi	1987	47%
Zimbabwe	1988	30%			

Source: Haggerty et al. 1998

Table 2 lists average child anthropometry by region of the country from the DHS II study. Weight- for-height measures range from -0.97 to -1.44 and height-for-age from -0.97 to -1.40, with little correlation between the two indicators. Before developing any hypotheses regarding regional differences, several important points should be considered regarding the "average" Z scores: the timing of the measurements; the age distribution of the children measured; and, the distinction between urban and rural children. For example, only children living in Bamako were measured in November, and the children in Timbuktu, Gao and Kidal were measured in the latter months of the study. Consequently, any seasonal differences due to disease and food availability will affect these averages. In Mopti, roughly half of the sample is under 1 year of age, which correspondingly affects the overall "average" Z scores - particularly height-for-age, which does not begin to manifest until the second year of life. While most of the southern regions have both urban and rural children, only urban children were measured in Bamako, Timbuktu, Gao, and Kidal.

Table 2. Weight-for-Height and Height-for-Age Z Score by Region

Region	Weight-for-Height	Height-for-Age
Kayes	-0.97	-1.36
Koulikoro	-1.09	-1.30
Sikasso	-1.15	-1.40
Segou	-1.05	-1.30
Mopti	-1.27	-0.97
Timbuktu	-1.44	-1.22
Gao/Kidal	-0.97	-1.24
Bamako	-1.14	-0.65

Source: Demographic and Health Survey 1995/96
Base = All children measured, ages 0 - 35 months

3.1.3. Is Childhood Malnutrition Increasing?

There is intense speculation over the issue of whether child nutritional status is worsening in Mali. A simple comparison of the 1987 DHS I and a more recent study, DHS II, conducted in 1995-96, leads to the conclusion that rates of "stunting" and "wasting" have increased in Mali. Yet careful analysis of DHS data and that from the EMCES in 1994, which also collected anthropometric data, does not permit us to say with certainty whether there has been a change in rates of child nutritional status. Several factors lead us to this conclusion.

Different Samples: One source of confusion over the question of rising malnutrition stems from the fact that the various studies used different samples. Essentially, rates of malnutrition, generally height-for-age and weight-for-height Z scores, are compared from studies that represent different segments of the population. For example, the DHS I measured children ages 3 to 36 months, the DHS II included children from 0 to 35 months, and the EMCES studied children 0 to 59 months. Due to the nature of growth retardation in preschool children, these sampling differences are not trifling, and will affect "averages" generated by each study.

Each of the three major samples also draw a different percentage of children from urban and rural areas. Typically, the children from urban areas have better height-for-age Z scores. Consequently, these varying distributions will affect the overall "averages" for the different studies. A priori, one expects that children in urban areas have better access to health (and other) facilities, and thus the opportunity cost of using these services is lower.

Month of Data Collection: There is substantial documentation of significant seasonal variation of weight among Africans, both adults and children (see for example Thompson and Rahman 1967; Schofield 1973; Cole 1993; Simondon et al. 1993). Consequently, the month in which the children were measured may have an impact on the observed height and weight. Measurements in the DHS I occurred primarily during March, April, June, July and August, while the DHS II measured children from November through April. It is difficult to sort out all of the seasonal effects. One expects to find greater food availability during the DHS II, but food availability has not proven to be a good indicator of nutritional status. The incidence of disease also varies according to season, and this may have a greater impact on child health. Further analysis of children throughout the entire year is necessary to identify the influence of seasonal factors.

Women's Education and Household Wealth: Many researchers point to the important role of women's education in improving child health and nutrition. Women in urban areas generally receive more formal education than do women in rural areas. Consequently, height-for-age Z scores, should be higher in urban areas. Urban women in the DHS I are more educated than their urban counterparts in the DHS II. Neither group of rural women in the DHS I and II has much formal education. In general, urban areas also have better access to infrastructure as well. The urban households studied in the DHS I are wealthier, in terms of asset ownership, than urban households in the DHS II. All of these factors, at least for urban households, would tend to bias height-for-age Z scores in favor of the DHS I, which will in turn affect "average" statistics reported by the two studies.

Rural households are somewhat wealthier in the DHS II than in the DHS I, which should offset, at least in part, the bias favoring better "average" statistics from the DHS I study. However, there are too many other mitigating factors that may be working either in favor or against any tendency toward different levels of health and nutrition between the two studies. Weight-for-height is even more problematic, because of its relationship to immediate problems, such as disease, that are not necessarily affected by factors such as wealth. There may be other household characteristics that are in some way correlated to income that may have an effect on the prevalence of wasting. Maternal education may be a more important factor, allowing women to treat diseases such as diarrhea more effectively. However, disease may be more easily transmitted in urban areas, which may offset positive affects from higher education in urban areas.

Age of Children: Another factor influencing the interpretation of the results of the studies is the different manner in which the results of child measurements were included in the final data tabulations. In the first study, if the household did not know the precise age of the child, year and month of birth, the child's score was not calculated as part of the average. The parents of these children were more likely to be rural and less educated, on average, than those who knew the precise age of their child. In the DHS II, it seems that the interviewers were permitted more leeway in identifying the correct age of the child; consequently, there was a much higher percentage of children in the survey with height-for-age Z scores included in the final data tabulations.

Table 3 compares weight-for-height Z scores for children ages 6 to 35 months. [3] Several statistics concerning the type of sample population surveyed by the three major studies are also listed to amplify their differences. Height-for-age statistics are not presented, primarily because the age distribution for young children in the EMCES study unequivocally indicates that many parents surveyed do not know the precise age (in months) of the child being measured. Weight and height, on the other hand, simply reflect physical measurement. The reason for excluding children under 6 months of age relates to measurement error. The instruments used for measuring children are somewhat crude, and the amount of error relative to the size of the child makes it difficult to reliably discuss Z scores that deviate from the NCHS/CDC reference population.

Although the studies differ on the levels of the Z scores, the "U-shaped" distribution of Z scores by age group across the age of the child is fairly consistent across all of the studies. The decline in weight-for-height is small for children under 12 months and those over 23 months but most pronounced during the second year of life, which coincides with the weaning process. During this time, the mother introduces solid foods and liquids into the diet, in addition to continuing to breast-feed. The process of weaning is one of the most critical elements, if not the single most important factor, in determining the health and nutritional status of the child (Martorell 1995). Children are also more capable of exploring their surrounding environment, and consequently increase exposure to many different diseases and pathogens.

The information concerning the structure of the sample presented in Table 3 indicates that it is very difficult to determine whether child nutritional status is improving or worsening in Mali. Weight-for-height does deteriorate between the first to the second DHS study. However, the DHS I study contains a higher portion of urban children, and the mothers of these urban children are more educated, on average, than their counterparts in the DHS II. The EMCES study is nearly 50% urban, yet comparing the EMCES with the DHS II would suggest that the number of malnourished children are decreasing in Mali for the general population and for the rural population but increasing for urban areas. Again, this is not a valid comparison given differences in sample composition. For example, EMCES has a larger percentage of children greater than 24 months who are more vulnerable than nursing infants.

Sorting out all of the differences between factors that may lead to different average Z scores between the DHS I and II is not possible. Ultimately, these studies represent different samples. Consequently, the statement that child malnutrition is worsening in Mali is not necessarily verifiable between the two studies. Regardless of whether malnutrition rates are slightly higher or lower from one study to another, in recent years, low weight-for-height and small height-for-age indicate unequivocally that poor child health and nutrition is a serious problem throughout all regions of Mali, urban and rural households, wealthy and poor alike.

[3] Children with weight-for-height Z scores more than 4 standard deviations below the NCHS/CDC reference mean are excluded from the sample, following the convention used by the Demographic and Health Survey.

Table 3. A Comparison of Children's WHZ Scores from Major Studies in Mali

	DHS I (1987)	EMCES (1994)	DHS II (1995-96)
Mean WHZ			
All children	-0.93	-1.39	-1.27
Urban	-0.91	-1.23	-1.31
Rural	-0.95	-1.54	-1.25
% of Sample from Urban Areas	42%	48%	30%
Mean WHZ by Child's Age			
6-11 months	-0.83	-1.19	-1.28
12-23 months	-1.12	-1.54	-1.50
24-35 months	-0.80	-1.35	-1.02
% of Children Ages			
6-11 months	26%	20%	24%
12-23 months	40%	37%	38%
24-35 months	35%	43%	38%
% of Mothers w/ some Education			
All mothers	20%	NA	15%
Urban	35%	NA	30%
Rural	9%	NA	9%
% of Households Owning			
No assets	24%	18%	21%
Urban	14%	15%	20%
Rural	31%	21%	21%
Radio	60%	69%	65%
Bicycle	40%	44%	45%
Motorcycle/moped	5%	29%	21%

Source: Demographic and Health Survey 1987 and 1995-96; Enquete Malienne de Conjoncture Economique et Sociale 1994

Base = All children ages 6 to 35 months with anthropometrics for weight and height.

3.2. How Has Agricultural Growth Evolved in Mali?

There are many ways of measuring economic growth. In section 1.1 we presented aggregate numbers showing that since 1985, real GDP grew by 3.5%, national value added by 3.2%, and agricultural value added by 3.9%. Since the 1994 devaluation growth of the overall economy and the agricultural sector speeded up, with annual GDP growth estimated at 4.8 to 5.1%, growth of aggregate value added at 4.6% and agricultural value added at 4.7% (DNSI 1999).

In recent years, a large percentage of this growth has been generated by agricultural exports, most notably cotton and livestock but also rice and maize. When considering the potential impacts of agricultural growth on food security and nutritional status, it is important to note that the impacts can be direct through an increase in the production of food consumed by households or indirect via an increase in income permitting households to purchase food and health services. Higher incomes resulting from increased specialization and intensification of production (e.g., rice and cotton) and higher demand from markets in neighboring countries can help rural households gain access to more adequate food supplies than they might have attained from complete reliance on household cereal production; but efficient, well-functioning agricultural markets are essential to attaining food security through market exchanges. Farmers must be able to earn income from non-cereal activities (sales of livestock, surplus food and non-food crops or non-farm activities) and be able to find desired food products in local markets at affordable prices. To ensure national food security the same scenario applies: Mali must be able to export goods and services permitting it to import desired food products.

Unfortunately, currently available data limits our ability to fully evaluate household food security as a combination of production and purchases. Due to a lack of information on household purchases and poor data on cereal trade within the West Africa region, our analysis focuses on recent production trends and the ability of domestic cereal production to meet estimated cereal demand. This is followed by a section showing how recent price trends have affected producer income and consumer expenditures. We then present the evidence we have found on trends in the farm-level profitability of crop production and real farm income, since it is increases in real income that make households better able to purchase foods and services that can improve nutritional status.

3.2.1. Agricultural Production Trends and Distribution

To understand better the relationship between agricultural growth and nutritional status in Mali, it is necessary to look at a disaggregated picture of major production patterns. We begin this task with a comparison of production trends in different agricultural sub-sectors and regions. It is also necessary to look at a variety of indicators. In the agricultural sector, increases in yields per hectare or production per labor day are the most common indicators of productivity growth (increased output for a given level of a limiting resource). For the purposes of this paper, however, we will complement the discussion of aggregate production indicators with a discussion of trends in production per capita. Doing this helps us ascertain the extent to which growth in agricultural production of food and non-food crops is keeping up with (or exceeding) population growth.

Distribution and Adequacy of Growth by Sub-sector: Table 4 reveals extremely strong growth (10% per year) in the modern cereal sector (primarily irrigated rice, but also some wheat and barley) since 1985. Performance in the cotton sector has also been strong with rates of 7% overall and almost 12% since the devaluation. Slower growth (2.7%) characterized the traditional cereals sector (millet, sorghum, maize, and fonio - MSMF) from 1985 to 1993. Between 1994 and 1999, the sector grew at a 5.6% annual rate. Although this aggregate

improvement is important for the sector that provides the principal source of consumable calories for Mali's rural population, growth expressed in per capita terms provides a more accurate view of how cereal kilocalorie availability has evolved relative to population growth.

As Mali's population is growing at a rate of 2% to 3% (depending on zone and year and assumptions), measures of growth per capita are considerably more modest than the growth rates shown in Table 4. Table 5 shows that GDP per capita grew by only 1.5% from 1986 to 1999 and by 2.3% from 1994 to 1999. Looking at the agricultural sector, per capita production of millet/sorghum **declined** at a statistically significant 1.8% annual rate. The decline in traditional cereal production per capita has been largely compensated for by the 14.4% annual per capita growth rate for rice (modern and traditional sectors combined).

An analysis of the trends in agronomic yields shows similar patterns as those for the per capita figures. Between 1992/93 and 1997/98, there is **firm** evidence showing maize yields up by approximately 70 kg/ha per year while cotton yields have been decreasing annually by about 40 kg/ha. There is, however, **weak** evidence that yields are rising for sorghum and peanuts at approximately 30 kg/year. In the rice sector, yields in the modern irrigated perimeter show a relatively weak upward trend (increasing at a rate of 48 kg per year) while those in the traditional schemes have remained stagnant. Millet yields have also been extremely variable over the last six years and exhibit no visible trend.

Table 4. Indicators of Aggregate Economic Growth, 1985 to 1999

Indicator	Average Annual Change (%)	
	1985-1999	1994-1999
GDP (real)	3.5	4.8-5.1 (range from several sources)
National Value Added (VA)	3.2	4.6
Agricultural VA	3.9	4.7
Trad. Cereals VA (MSMF)	2.7	5.6
Mod. Cereals VA (rice)	10.3	9.8
Cotton VA	7.3	11.6

Source: Authors' calculations from DNSI data

Table 5. Indicators of Income and Productivity Growth (Per capita)

Indicator	Average Annual Growth by Period (%)	
	1985-99	1994-99
GDP/capita (real)	1.5	2.3
	1986/7-1998/9	
MSMF production per capita	-1.8	
Maize production per capita	2.7	
Rice production per capita	14.4	

Source: Calculated by authors using DNSI data

Despite the relatively slow growth in the traditional cereals sector, average national production of MSMF from 1986 to 1999 exceeded estimated consumption requirements based on consumption patterns reported in the 1988/89 budget/consumption survey. Using region-specific estimates of 1988/89 traditional cereal consumption (ranging from 80 kg/capita in Gao to 249 kg/capita in Sikasso), average national consumption was estimated to be 168 kg/capita. This is equivalent to about 131 kg (or 1,250 kcal/capita/day) of consumable product after deducting for seed and post harvest and processing losses. We consider this estimate to be a reasonable representation of minimum coarse grain needs for Mali because (1) the year of the budget/consumption survey was also a year of unusually good coarse grain production, and (2) results from consumption studies in millet production zones of neighboring Senegal show that households meeting minimum FAO consumption standards (2,400 kcal/adult equivalent) consumed approximately 1,110 kcal/capita from coarse grains (Kelly et al. 1993). From 1986 to 1999, average annual production of traditional cereals was 188 kg/capita (approximately 1,400 kcal/capita), exceeding minimum estimated needs by 20 kg/capita. Aggregate production fell short of estimated needs in only 3 of the 14 years examined.

Rice production also exceeded estimated national consumption needs. Based on the 1988/89 budget/consumption data, annual national consumption per capita should be at least 34 kg of processed rice. In every year from 1992/3 to 1997/8 (the only years for which we have data on both traditional and modern rice production) aggregate national rice production exceeded consumption needs (48 kg/capita of consumable production vs. 34 kg/capita needed). During this period surpluses grew at an annual rate of 3 kg/capita and the average annual surplus was 14 kg/capita.

Combining estimated cereal needs from MSMF and rice, we find that a total of 1,588 kcal/capita/day is easily covered by domestic cereal production. Another important characteristic of aggregate national cereal production in Mali is the relatively low inter-annual

variability. A comparison of cereal production per capita for nine Sahelian countries showed that Mali had the lowest variability (coefficient of variation of 10% versus 14% to 69% for other countries).

Although we have focused on the adequacy of domestic production here, it is important to note two points:

1. Even if national production were less than estimated needs, it would be possible to meet these needs through imports – i.e., per capita cereal production levels below estimated needs should not be interpreted as a sign that there will be consumption shortfalls; and

2. We have not taken into account net cereal availability (production-exports+ imports) because of inadequacies in the data concerning cross-border trade in cereals with Mali's neighbors.

Regarding the adequacy of the 1,588 kcal/capita/day, we note that it represents 88% of FAO's minimum total calorie/capita recommendations for the Sahel (2,400 kcal/adult equivalent or approximately 1,800 kcal/person). Other Sahelian countries for which detailed consumption data are available (Senegal and Niger) indicate that rural households obtain 65% to 85% of total calories from cereals, depending on consumption preferences and cropping patterns; thus our estimate that minimum cereal needs must cover 88% of minimum caloric needs is **not** a conservative estimate. **Hence we conclude that high rates of malnutrition in Mali are not due to inadequate levels of national cereal production.**

This evidence on adequate average levels of cereal production at the national level leads us to the spatial and temporal distribution of production to examine the possibility that unbalanced distribution of production could contribute to malnutrition if markets were not working efficiently to move cereals from surplus to deficit areas, a situation all to common in many parts of Africa.

Regional Indicators of Production Trends: Ideally, we want to be able to disaggregate our analysis of agricultural productivity using variables that we think can explain where we are most likely to find cases of malnutrition, as this type of knowledge permits the design of programs and policies to reduce the problem.

Spatial dissaggregation by administrative units (regions, circles, districts, or sectors) or agroclimatic zones is an approach that can be used if one suspects that spatially distributed factors (climate, crops grown, infrastructure, market development, etc.) influence either production or nutrition. Temporal disaggregation can also help explain malnutrition (particularly wasting) to the extent that inter-annual or seasonal availability of cereals differs markedly from the aggregate numbers presented above, which showed only 3 of 14 years to have deficit cereal production. Thus far, we have only disaggregated the agricultural analyses to the regional level. Our initial efforts to look at temporal effects is through the use of coefficients of variation (CV)

that show how much the production for each year differs from the overall averages across a large number of years. The higher the percent variation, the more likely it is that production short-falls occurred during the period. Unfortunately, data are not available permitting an analysis of seasonal changes in availability.

Table 6 illustrates the importance of regional differences in the share of national agricultural production during the 1990 to 1998 period. Not unexpectedly, the Sikasso and Ségou regions together contribute 60% of the aggregate value of cotton and cereal production. Because these crops account for 60% of the agricultural value added nation-wide, one can infer that approximately 60% of cropping income[4] accrues to the rural residents of these two regions who represent only 35% of the total rural population.

Table 7 looks at the levels and variability of regional production of traditional cereals (MSMF). Given the vast climatic differences across Mali's seven administrative regions, it is not surprising to note that MSMF production ranges from a low of 12 kg/capita in Gao to 312 kg/capita in Sikasso. Inter-annual variability in production is inversely related to production per capita. Inter-annual variation is lowest in Sikasso (CV = 13%) and very high in the north (CV>90% in Tombouctou and Gao). The relatively low CV for the major production regions (Sikasso and Ségou and to a lesser extent Koulikoro) contributed strongly to the relatively low inter-annual variability in aggregate national production.

Table 6. Average Shares of Cereal and Cotton Production by Region, 1990 to 1998

Indicator/Region	Kayes	Koulikoro	Sikasso	Ségou	Mopti	Tombouctou	Gao
Share of aggregate national value produced (%)	6	15	28	33	12	5	1
Share of rural population (%)	15	18	17	18	17	9	4

Source: Authors' calculations from DNSI production data and average regional prices reported for rural markets

[4] Crop income estimated using annual regional averages of crop prices from rural markets to value total production (home-consumed and marketed).

Table 7. Average Annual Per capita MSMF Availability from Local Production, 1986 to 1999

Indicator/Region	Kayes	Koulikoro	Sikasso	Ségou	Mopti	Tombouctou	Gao
Mean annual cereal production per capita (kg)	133	236	312	303	173	56	12
Coefficient of variation for mean production (%)	32%	19%	13%	21%	23%	91%	92%
Mean annual cereal production per capita in (kcal)	1026	1820	2409	2338	1340	433	89

Source: Authors' calculations from DNSI data

Table 8 shows the average net MSMF balances by region for 1986/7 to 1998/9 after adjusting for seed and storage and processing losses. Sikasso and Ségou produced large surpluses every year and Koulikoro produced a small surplus 10 of the 14 years examined; all other regions are, on average, in a deficit situation. This pattern does not necessarily mean that the zones with MSMF deficits are more likely to experience higher rates of malnutrition because – as noted above – (1) average national production per capita exceeded estimated MSMF needs by 20 kg/capita and (2) Mali's liberalized cereals policy encourages private traders to import cereals (particularly important in years of domestic shortfalls, but also important in non-deficit years to compensate for exports of high quality rice that is priced beyond the budget of many Malian consumers). These results reconfirm the importance of efficient, well-functioning markets to deliver cereal from surplus to deficit households and zones in order for people to meet their consumption needs. They also highlight the importance of viable, remunerative, non-cereal and non-agricultural activities that provide local populations with income-earning opportunities which allow them to purchase sufficient quantities of food. **If** markets are functioning well and **if**

Table 8. Average Annual MSMF Per capita Surplus/Deficit Situation, 1986/7 to 1998/9

Indicator/Region	Kayes	Koulikoro	Sikasso	Ségou	Mopti	Tombouctou	Gao
Average annual surplus (deficit) from local production*	(34)	23	103	141	(6)	(69)	(68)
Number of deficit years in last 13 years	11/13	4/13	0/13	0/13	7/13	11/13	11/13

Source: Authors' calculations from DNSI agriculture and budget/consumption data
*Deficits shown in parentheses. Needs based on budget/consumption study conducted by DNSI (1988/89 data)

households in the MSMF deficit regions have income that can be used to purchase cereals, spatial variation in production and per capita availability will not be associated with higher levels of malnutrition. The challenge here is to empirically examine the extent to which these two **'if'** conditions are fulfilled in the MSMF deficit regions. Although the major share of cereal consumption consists of traditional cereals, rice consumption is also important with estimated needs ranging from a low of 12 kg/capita in Sikasso to 70 kg/capita in Gao. As noted above, the national average is 34 kg/capita of processed rice. Our data series on rice production from both the traditional and the modern sector has not yet been broken down by region, so at this time we present only numbers from 1997/98 as a rough indicator of the spatial distribution of aggregate rice production (Table 9). The concentration of rice production appears to be even greater than that of MSMF production – 76% of production comes from the regions of Sikasso and Ségou.

This concentration of production again calls attention to the need for well functioning markets, good market information systems, and good transportation infrastructure permitting traders to move cereals from surplus to deficit zones, to export production that exceeds national needs, and to import lower-quality/lower-cost cereals from other countries to better meet the demand of households with limited purchasing power.

3.2.2. Links Between Growth in Agricultural Production and Rural Incomes

Increases in aggregate agricultural production do not necessarily mean increases in rural household income. Growth in agricultural production can have a positive impact on rural incomes if the growth is associated with increases in agricultural productivity (greater output per unit cost) or if markets become more efficient (lower margins between producer and consumer prices). Although available data does not permit a thorough analysis of these production-income links, there is some evidence that markets have become more efficient and that real income has increased for some farmers.

Table 9. Spatial Distribution of Rice Production, 1997/98

Indicator/Region	Kayes	Koulikoro	Sikasso	Ségou	Mopti	Tombouctou	Gao	Total
Production of paddy (tons)	1055	35952	84824	345739	44683	38429	17693	568375
Percent of national production	<1	6	15	61	8	7	3	100

Source: Enquête Agricole de Conjoncture, December 1998, DNSI

Cereal Market Performance and Price Trends: An analysis of cereal prices shows that before the devaluation (between 1986 and 1993) real producer prices of coarse grains (MSMF) trended upward at the same time that real consumer prices were declining. This pattern indicates that "marketing margins were falling, with benefits being shared by both consumers and producers" (Dembélé and Staatz 1999). After the devaluation of the CFA franc in January 1994, the trend in real consumer prices of coarse grains reversed and began a significant upward trend. Rising MSMF prices since 1994 can partly be attributed to a slight national shortfall in cereal availability but also an increase in cereal exports to neighboring countries. Despite the general increase in prices of MSMF after the devaluation, intra-annual variability actually declined relative to the period 1986 to 1993, providing consumers with more stable prices. The average seasonal producer price rise of coarse grains between the months of January (after harvest) and August (hungry season) actually decreased after the devaluation.

In the rice sector, both real producer and consumer prices have exhibited a significant downward trend since the liberalization of the rice market which began in the late 1980s and was completed by 1990. This pattern illustrates how increased productivity through higher yields can improve farmer profitability even when prices are falling (see discussion of income trends below). Although rice prices fell, they were much more variable after the devaluation, particularly locally milled rice from Nino. Higher intra-annual variability of local rice was however moderated by the more stable prices of imported rice.

This analysis of trends in the level and variability of real prices indicates that there has been some improvement in the performance of the cereal market in Mali since the sector was liberalized in the 1980s. Price levels seem to reflect annual supply/demand conditions in the market and MSMF prices have become less variable between harvests. Improvements in information access, transport infrastructure and increased competition have reduced the cost of moving cereal from farmers to urban consumers. Higher real prices of coarse grains since 1994 have increased the cost of meeting cereal consumption needs for rural deficit households (those not producing sufficient quantities of MSMF) and urban consumers. The ability of these households to pay higher prices for cereal depends on availability of income from agricultural and non-agricultural sources.

Evidence on Income Trends and Food Security Impacts of Agricultural Growth: The analysis of the regional distribution of agricultural production is only a very rough indicator of the potential for regional differences in food availability. More detailed analysis of the availability and access to sufficient food is limited by the lack of disaggregated rural household data on general household characteristics, cereal transactions (e.g., purchases and sales) and income from agricultural and non-agricultural sources, particularly the livestock sector. Despite this limitation in national data bases, a review of a number of case studies conducted in Mali and other Sahelian countries provides some information that permits us to propose hypotheses on the linkages between income, production, and food security.

A review of selected studies conducted in the cotton- and rice-growing zones in Mali suggests that increased agricultural production has led to an increase in real farm income particularly after

the devaluation of the CFA franc in January 1994. These increases in income were greater for larger farms with more productive assets. Research by Dioné in the mid 1980s in the agricultural zones managed by the CMDT and Upper Niger River Valley Development Authority (OHV), and by the IER in 1994 and 1997 in the Sikasso region showed that better equipped farms (in terms of agricultural equipment and animal traction ownership) are the most productive and profitable farms in terms of both cotton and cereal production. IER survey results show that real average net income per hectare for cotton/maize farms in the Sikasso region increased respectively 14% and 30% between 1993/94 and 1997/98. This average hides the disparity between the more productive and profitable equipped farms from the lesser equipped and non-mechanized farms, for which real farm income actually declined after the devaluation (Kébé, Diakite, and Diawara 1998). In certain zones, Kébé, Diakite, and Diawara (1998) explain that for farms without a complete set of draft animals and equipment, the effect of increasing the area planted and minimal use of recommended cropping techniques contributed to low seed cotton yields and subsequently a loss of income.

For rice farmers in the ON, a comparison of net income per hectare before (1992/3 to 1993/4) and after devaluation (1995/6 to 1996/7) showed real increases ranging from a low of 8% for small farms with access to improved irrigation infrastructure to a high of 94% for those with medium size farms and improved irrigation. Returns to labor were also impressive for those with improved infrastructure (35% to 143%, depending on farm size), but for farms in the zones with unimproved irrigation the returns to labor were static for small and medium size farms and actually declined for large farms. This was due to the adoption of the more productive, but labor intensive, practice of starting rice seedlings in a nursery and then transplanting them.

These average increases in returns to rice production hide an important amount of inter-household variability in the income effects of the devaluation. This variability is illustrated to some extent by answers to qualitative questions about changes in food consumption patterns after the devaluation. When asked if they were eating about the same, better, or worse after the devaluation, two thirds of households reply that consumption was the same or better (e.g., more diversified diet with increased consumption of meat, fish and other products) while one third indicated they were worse off. Among the latter group, small farms predominated – they were the ones with the smallest increases in income per hectare or large production debts that had not yet been paid off.

Higher levels of equipment ownership clearly have a positive impact on grain production. Dioné (1989) found that 89% of the equipped farms' cereal production exceeded household consumption needs while only 43% of the farms who cultivated manually produced sufficient quantities. Data collected on farm household sales, purchases and gifts of cereal showed that 90% of the total quantity of net sales came from only 28% of the farms, primarily the better equipped ones (Dioné 1989).[5]

[5] Forty three percent of farm households were net grain buyers and only 53% of the farms were net grain sellers in the CMDT/OHV zones.

Information on farm households' cereal production and net sales situation are not however an adequate indicator of food security. Additional research by Sundberg on Dione's sample of households in the OHV zone showed that estimates of households' net grain sales may not accurately portray a household's cereal situation. In the southern part of the OHV zone, farm households "attempt to assure household food security through own production and tend to purchase grain only if this strategy fails. Northern OHV households, in contrast, develop more diverse income strategies that are less directly dependent on rainfall levels and use revenues from those activities to purchase food" (Staatz, D'Agostino, and Sundberg 1990). These strategies explain why short-term nutritional status was negatively correlated with coarse grain purchases in the south but positively in the north. Inversely, household grain sales in the northern zone may represent distress sales of grain to meet pressing cash needs and are not an indication of a surplus grain reserves.

The differences in income effects of the devaluation among different groups of farmers in both the CMDT and the ON, zones suggest the presence of net grain buyers (cereal deficit farms) even in the surplus production zones. For cereal deficit households throughout the country, particularly producers of sorghum and millet in the more arid regions, satisfying their cereal needs depends largely on their access to income through a variety of other agricultural (e.g., cotton, horticulture, livestock) and non-agricultural activities.

Two of the most important elements missing from the above synthesis of case study findings above are: (1) information on the distribution and growth rates in livestock production; and (2) distribution and growth rates in the non-farm income of agricultural households. Thus far we have not found a Malian data base or secondary sources of information helping us to shed light on these issues. For example, we know from national accounts data for 1994 to 1999 that there has been continuous growth in herd size for cattle (2% to 3% per year) and small ruminants (4% to 5% per year), but we have not yet been able to determine whether the distribution of the livestock herds (and income derived from them) is similar to that for crop production, thereby increasing the income and assets of those already benefitting from high productivity in crop production, or if it is concentrated in regions that have relatively low crop production per capita. It may be possible to do this type of disaggregation with livestock data collected as part of the annual agricultural survey conducted by DNSI. It is much less likely that we will be able to determine the extent and distribution of non-farm income earned by farm households as this type of data is not collected in annual surveys.

This could prove to be a critical missing link in the analysis if non-farm income is as important in Mali as it is in neighboring Senegal and Niger. The Sundberg-OHV data mentioned above, suggests that at least in some zones of Mali this will be the case. Evidence from neighboring countries also supports the hypothesis that non-cropping income is an important determinant of household food security. Analysis of detailed data on all sources of income and expenditure for a two-year period in the late 1980s showed that the average share of non-farm income for Senegalese and Nigerian farm households ranged from 30% to 80% depending on zone and year. Net income from livestock transactions was also important (13% to 23% of total income in Senegal). Analyses also showed that both non-farm and livestock income played a significant

role in smoothing inter-annual fluctuations in cropping income. As the size of the household food deficit increased, the share of non-farm and/or livestock income also increased, suggesting that non-cropping income could play an important role in helping households to maintain acceptable consumption levels despite crop short-falls. Surprisingly, the higher potential production zones in Senegal (where cropping income represented 70% or more of total income) tended to have more households classified as 'at risk' (<2400 kcal/ae/day) than the lower potential zones during both a good and a poor harvest year. Less well developed transportation and market infrastructure in the high potential zone probably contributed to the farmers' inability to market agricultural products and earn non-farm incomes.

Results of Dione's and Sundberg's work in the OHV zone and information from Senegal and Niger show us the importance of collecting information on food production, sales and purchases and on other sources of income if we are to fully understand the links between agriculture and child nutrition. The situation in Senegal and Niger may not be the same as that in Mali. But given the absence of data on livestock and non-farm income for Mali, information from other Sahelian countries provides some input into our task of developing hypotheses to explain why malnutrition remains high in Mali – even in sectors and regions experiencing strong growth in agricultural productivity.

3.3. Summary of Trends in Agriculture and Nutritional Status

Initial analysis shows that while the agricultural sector as a whole has been growing faster than population levels, there is still considerable spatial and temporal variability in aggregate agricultural production and production per capita as well as some differences across sectors. Growth across all sectors has been generally favorable, with the rice and cotton sectors exhibiting high rates of growth, livestock doing relatively well and the coarse grains sector declining slightly (although maize grown primarily in the cotton farming systems has expanded due to the introduction of new, fertilizer-responsive varieties).

Spatial distribution of production is skewed. Sixty percent of agricultural value added is coming from two regions (Sikasso and Ségou) which represent only 35% of the Malian population. The bulk of both highly commercial crops (rice and cotton) and traditional cereals (MSMF) are produced primarily in these regions. It is not possible to accurately allocate livestock income to particular regions.

Temporal distribution of agricultural value added remains a problem for some regions but is not important in the aggregate. Inter-annual fluctuations in aggregate and per capita production of MSMF are smallest (CV = 13% to 21%) in the high productivity regions, keeping fluctuations in aggregate national production relatively low for a Sahelian country. These aggregate numbers, however, do not reflect the reality faced by farmers in the drier zones where MSMF are frequently the principal products. In these zones the coefficient of variation on MSMF production is in the 80% - 90% range, forcing farmers to adjust their food security strategies substantially from year to year.

Better equipped and more technologically advanced rice and cotton farmers appear to be better positioned to achieve household food security as they tend to produce cereals in excess of their own consumption needs more than other farm types and frequently have income from other crops. Animal traction and equipment ownership among cotton farmers and use of intensive production practices among both cotton and rice farmers are key factors affecting the profitability and productiveness of farms. Greater profitability increases household income, which then improves the capacity of the household to purchase food and health services. We conclude, therefore, that improving agricultural productivity and profitability provides rural households with a means to increase income. Whether this increased income leads to improved nutritional status depends on how the income is used by the household. This is a topic covered in the next section of this paper.

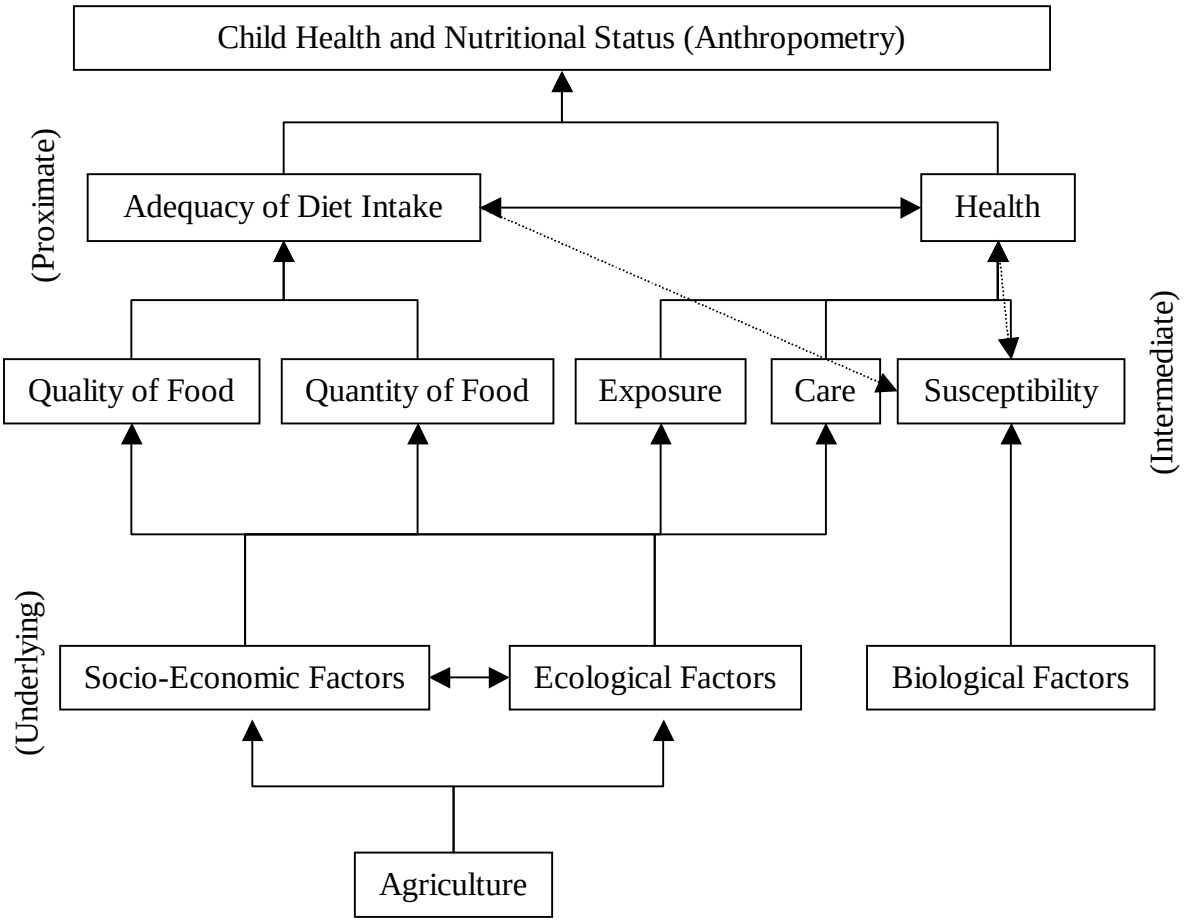
For most cereal deficit households (particularly, but not limited to, producers of sorghum and millet in the more arid regions) and some cereal surplus households, having the means to satisfy food consumption needs depends largely on their access to income through a variety of other agricultural (non-crop related) and non-agricultural activities and efficient markets. Hence, efforts to improve agricultural as well as rural non-agricultural revenues are required if all households are to attain income levels that put them in a position to satisfy food security and basic health needs.

Our discussion of the current nutrition situation in Mali concluded that there is not overwhelming evidence that rates of child malnutrition have increased over time. Rather, it appears that the differences in available "statistics" – average measures of child anthropometry – are more reflective of differences in the sample populations being studied. Regardless of any trend in these statistics over recent years, these surveys unequivocally indicate the widespread phenomenon of poor health and nutrition throughout Mali. High rates of child malnutrition across all regions of the country (grain surplus and grain deficit) and for all socio-economic classes of households, indicates that intra-household behavioral factors play an important role in influencing nutritional status.

4. LINKS BETWEEN AGRICULTURE AND CHILD NUTRITION

Models that identify the mechanisms through which nutritional status is determined are well-developed in the literature (see for example UNICEF 1996; Martorell 1995). Figure 1 presents the first three tiers of factors that affect the anthropometric measures used as indicators of the health and nutritional status of children. adaptation of the literature review. It is an adaptation of models developed by WHO (1995), UNICEF (1996), Mosley and Chen (1984), and Martorell (1995).

Figure 1. Proximate, Intermediate and Underlying Determinants of Child Health and Nutritional Status



Source: Adaptation of WHO and UNICEF models

The proximate determinants of nutritional status are health status (disease) and dietary intake (nutrition). Health and nutrition jointly affect each other, and these two factors, in addition to genetic traits, determine growth.[6] Nutrition is then simplified, outside of health, to be a function of the quantity and quality of the different foods consumed. Health, outside of nutrition, is a function of susceptibility to disease, exposure to the disease environment and any care received in this process.

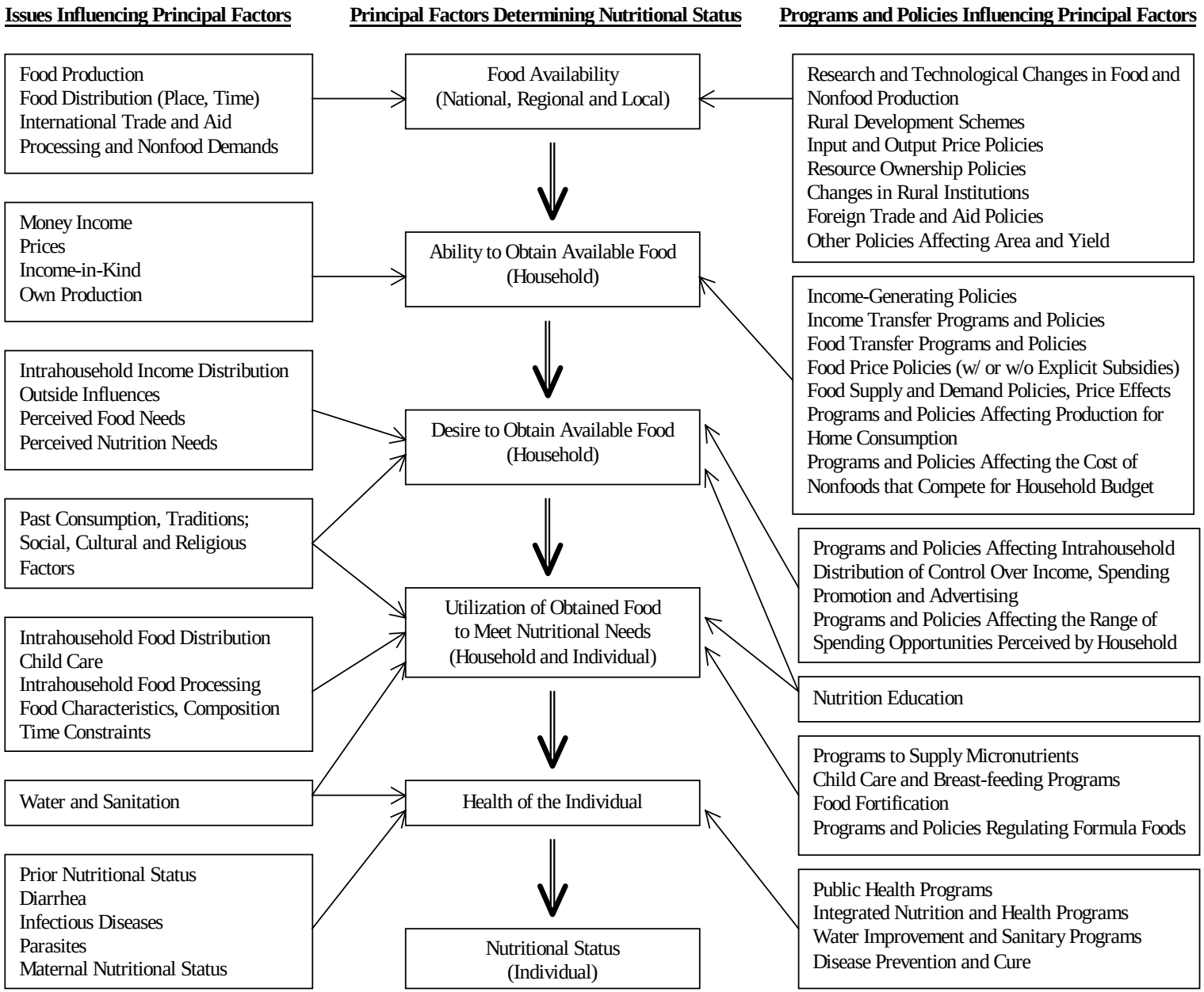
The five intermediate factors (quantity of food, quality of food, exposure to disease, susceptibility, and care) can be influenced by a variety of underlying socio-economic and ecological factors, such as income, education, feeding practices, hygienic practices, health services, government policies and the environment. Agricultural development influences nutritional status indirectly by acting through these underlying factors.

As part of their early 1980s review of the current state of knowledge on nutrition and identification of areas where nutrition-related policy research is needed, International Food Policy Research Institute (IFPRI) developed a conceptual framework linking the nature and causes of malnutrition to the approaches to its reduction or elimination. This framework presented in Figure 2 centers around five interrelated factors that determine nutritional status: food availability, ability to obtain available food, desire to obtain available food, utilization of obtained food to meet nutritional needs, and the health of the individual. While identifying many of the same factors outlined in the model presented in Figure 1, IFPRI's framework also emphasizes the importance of issues, programs and policies that influence these principal factors (Kennedy and Andersen 1983). The additional detail provided in IFPRI's schematic overview of nutrition allows us to more clearly see the multiple avenues by which agricultural growth can affect the nutritional status of Malian children.

For example, the income pathway operates through both household and community level factors. The hypothesis is that if agricultural productivity increases, reducing per unit production costs, and markets are functioning well (reducing the margin between consumer and producer prices of basic foods), rural households will have better access to goods and services that improve diets and health status. If household incomes increase, communities will also have more resources to invest in infrastructure that can further increase incomes (markets and roads for example) or that contribute to improved health (better sanitation, improved access to water, education, and health services).

[6] For children, genetic traits are not an important component of growth until after 5 years of age (WHO 1995). In this model, genetic traits are considered to have more impact on susceptibility to disease.

Figure 2. A Conceptual Framework for Nutrition (Source: IFPRI: Kennedy and Andersen 1983)



An analysis of Malian data bases and a review of literature for Mali as well as other countries make it clear that there are many factors that can diminish the potentially positive effects of increased rural incomes on nutritional status. Among the most important factors in the Malian context are:

- Intra-household distribution of assets and income;
- Household decisions concerning labor allocation and child care;
- Household food choices and feeding practices;
- Maternal education; and
- Illness and hygiene.

Although it appears that the income effects at the household and community level (and the mitigating factors listed above) are the most important paths through which agricultural development influences nutrition, there are two other areas that warrant attention – primarily with respect to the impact they may have on nutritional status in the future: (a) changes in the nutrient content of foods through diversification of crops produced or plant breeding; and (b) agriculture-induced disease and sanitation problems.

The rest of this discussion is divided into four sections that present the evidence on:

1. Household income links to nutritional status (including mitigating factors);
2. Community income links;
3. Changes in nutrient content of foods; and
4. Agriculture-induced problems.

4.1. The Relationship Between Household Income and Improved Child Nutritional Status

Higher incomes are a means of getting access to better nutrition. Higher incomes do not imply that households will necessarily choose to spend increases in income on goods and services that will improve health and nutrition. A variety of factors, including control over household resources, increased labor participation in agricultural activities, feeding practices, maternal education, and health and hygiene, can mitigate the impact of rising household income. However, it is expected that households who benefit from rising incomes, will, through increased access to and consumption of nutritionally adequate food, begin to show demonstrable improvements in health and nutrition over time.

4.1.1. Household Income and Child Nutrition

Household income can be derived from both agricultural and non-agricultural activities. Although improvements in agricultural productivity can directly increase agricultural income, they can also free up other resources within the household that enable the members to increase income from off-farm sources. It should be noted that increased food production, which raises food availability, is functionally the same as increasing household income, with an implicit

decision to repurchase the food. However, the effect of cash income versus increased food production on nutrition may differ depending on who controls the production and/or income within the household.

It is clear from the agricultural evidence presented in Section 3 that rural incomes are rising for many, but not all households. One important empirical question is to what extent will these higher incomes result in better health and nutrition, presumably through increased consumption of health goods and services and more nutritious foods.

National data available in Mali does not permit a conclusive determination of the effects of rising agricultural incomes on child health and nutrition. However, analysis of DHS I and II data (Penders 1999) finds that income, approximated by the ownership of various assets,[7] has a positive but statistically weak effect on weight-for-height and height-for-age Z scores in children. This finding is similar to evidence presented by many other studies throughout developing countries (for a review see Behrman and Deolalikar 1988). Table 10 presents the average weight-for-height and height-for-age Z score according to asset ownership for households in the DHS I, II and EMCES studies. From this table, it is clear that households classified as "poor" relative to other families in Mali have a lower probability of better health and nutritional status. However, the table does not show a substantial reduction in the probability of relatively wealthier households having children with poor health and nutrition.

Table 10. Percent of Household Owning None or One Asset by WHZ Score

Weight-for-Height Z score	EMCES	DHS II
Less than -3 std. dev.	41%	47%
-2 to -3 std. dev.	35%	43%
-1 to -2 std. dev.	35%	41%
-1 to 0 std. dev.	37%	41%
0 to 1 std. dev.	32%	34%
Greater than 1 std. dev.	34%	40%

Source: Enquete Malienne de Conjoncture Economique et Sociale 1994; Demographic and Health Survey 1995-96
Base = All children 6 to 35 months

[7] Ownership of household assets (radios, bicycles, motorcycles, televisions, refrigerators, and cars) may be a poor proxy for income in any given year, since they reflect the consumption of durable goods. Also, households that choose to consume more health services rather than purchasing a bicycle will confound the relationship between the "asset ownership" and nutrition – these households would appear to be less wealthy, yet may have better health and nutrition.

Sundberg (1988) provides an example of the positive correlation between household grain production and agricultural and non-agricultural income on child nutritional status. In her analysis of farm households in two areas in the OHV zone, Sundberg found that more diverse income sources in the northern, lower rainfall OHV zone generate revenues that allow households to purchase food (making up for lower grain production) and maintain food consumption security at similar levels of households in the more agriculturally-productive southern zone. Results of anthropometric measurements confirmed these findings showing that there was no significant difference in the prevalence of wasting between the north and south. The prevalence of stunting was higher in the south. Despite the important role played by non-crop income in assuring household food security in the north, long term nutritional status was positively correlated with grain production (Staatz, D'Agostino, and Sundberg 1990). However, this correlation may also stem, in part, from other factors within these households that are related to higher grain production, such as higher incomes and better education.

4.1.2. Factors that Influence the Strength of the Income-Child Nutrition Relationship

Analysis of DHS data shows that wealthier households, those with better access to infrastructure, and those with higher levels of education do not necessarily have children with better health and nutrition (Penders 1999). Access to resources within the household, including disposable income as well as productive resources, feeding practices, maternal education, sanitation, and hygienic practices are, as mentioned previously, fundamental factors that determine, in part, nutritional outcomes.

Access to Disposable Income: Some studies in other developing countries suggest that women's income may contribute more to household food security and child nutrition than income controlled by men – the IFPRI model (Kennedy and Andersen 1983). The rules governing distribution, control and use of farm household's productive assets (land, labor, inputs) among different household members (particularly between men and women) and the income and production derived from their use, may be important factors affecting child nutrition.

Research in the Bougouni district of the Sikasso region found that season in which income is generated and the gender of the provider are two important factors determining the impact of household income on nutritional status. In particular, women's non-agricultural income was found to have a significant effect on child nutrition in the pre-harvest season (De Groote 1997).

Access to Land and Food Provisioning Responsibilities: The manner in which a farm household's land assets are designated for household (family fields) and individual use, and allocated among members determines each adult's access to and control of agricultural production and income (associated with crops produced on individual fields). The productivity of individual fields is in turn influenced by access to equipment, labor and inputs used in production, which in most cases is determined by the senior adult male in the farm household.

Analysis from the farming systems research conducted in Sikasso by the IER found that ethnicity of the household and the age and gender of household members determine whether

individuals have access to private fields and control of crops produced on them (De Groote and Coulibaly 1998).

Although household staple food needs are in principle satisfied by cereal produced in communal household fields generally controlled by the senior adult male, detailed information is lacking on household strategies and individual members' responsibilities and roles in satisfying grain needs in cereal deficit households or in bad agricultural years. There is also little information on members' responsibilities for supplying condiments and how the production and income from individual members' fields affect the quality and quantity of condiments at different times of the year. Food security and child nutrition will be affected by the manner in which food provisioning responsibilities are shared among household members, productive resources are allocated to individual members and the final product is used.

Staatz, citing Sundberg's (1988) finding that children were more likely to be wasted in households in the OHV zone where women sold a greater part of their products from their individual fields, posits that women who retain their own production for home consumption increase the diversity of their children's diet, thus contributing to a better nutritional outcome (Staatz, D'Agostino, and Sundberg 1990).

Agricultural Labor Participation: Individual household members' agricultural labor requirements and energy expenditures are dictated by the way land is allocated between communal and individual use, by the decisions over what crops are grown on the different fields, and by individual members' labor roles for each crop and each type of field. For example, what has been the labor impact of the increase in area planted to cotton (primarily in communal fields) in the CMDT zone since the 1994 devaluation of the CFA franc? Has it diminished women's time available for work on individual fields or their productivity? Although no specific information exists to answer this question, research in other countries has shown that high seasonal agricultural labor demands can have adverse consequences on both children and mothers. A study on the effects of maize production on child nutrition in Zambia found that weight-for-height Z scores in children under 5 years were worse during the month of February, when fields were weeded by women (Kumar and Siandwazi 1994). High seasonal labor demands may therefore affect the time available for mothers to carry out other activities (child care and meal preparation) critical to child nutrition.

The effect of increased female agricultural labor demands on child nutrition (primarily for those older than 6 months who require additional foods to complement breast milk) depends largely on the way child care responsibilities are shared within the household. Little is known regarding the delegation of food preparation and care-giving activities to other household members and their resultant effects on the quality of foods and care provided. A study in the Douentza area found that although a weaned child "only spent 25% of their time in the presence of their biological mothers," non-maternal care did not a priori negatively affect children's health and well-being (Castle 1995). Given the important role of siblings and grandparents in child care in Mali, efforts to ensure use of correct child feeding practices would logically need to be broader in scope than simple focus on mothers.

Evidence from the Bougouni district suggests that high seasonal agricultural labor requirements affect women's nutritional status. The average adult women's body mass index (weight/height^2) – a standard indicator for adult nutrition status – dropped below 18.5 indicating that on average women were malnourished during the month of September when agricultural labor demands were at their peak (De Groote 1997). Although it is unclear exactly how pregnant or lactating mother's physical energy expenditures and nutritional status affect child nutrition and birth weight, if seasonal periods of malnutrition correspond to critical periods of fetus development, one might anticipate negative impacts on birth weight. Since numerous studies have determined that birth weight is the single, most important factor associated with child survival (Newman 1987) and that low-birth-weight babies, defined as weighing less than 2.5 kilograms at birth (WHO 1995), are more likely to suffer from stunting and other illnesses than are other infants (UNICEF 1996), additional clarification of this relationship appears necessary.

The small number of rural children with known birth weights in the DHS II sample did not allow for conclusive testing of the relationship between increased rates of stunting and agricultural work associated with weeding and harvesting by mothers during the second and third trimester of gestation (Penders 1999).

Ascertaining the overall effect of changes in cropping patterns and labor allocation on food security and nutrition requires detailed surveys in order to determine how changes in agricultural income are used within the household. In Rwanda, Blaken, von Braun, and de Haen (1994) find a negative effect of increased male control of household resources from cash cropping on child nutrition. However, this was outweighed by the positive affects on nutrition from increasing household incomes.

Foods and Feeding Practices: Several reasons may explain why food availability may be a poor measure of actual food consumption for children: insufficient feeding frequency; insufficient time spent by the caregiver actively encouraging children to eat; poor food quality; low nutrient and caloric density; and beliefs and cultural norms regarding child feeding practices that are contrary to recommended practices (Engle 1995).

The majority of Malian women do not follow breast feeding practices recommended by the Ministry of Health (Moore 1998). The process of weaning a child, from the introduction of solid foods to the end of breast feeding, is a critical element, if not the single most important factor, in determining the nutritional status of a child (Martorell 1995). UNICEF (1996) recommends that all infants be exclusively breast-fed until four to six months of age, after which solid foods, in addition to breast milk, should be introduced into the diet. Breast-feeding should continue through 24 months of age. DHS II reports that only 12% of Malian children are exclusively breast fed for the first four months (Haggerty et al. 1998). Research in the Dogon area shows that children are often given water and other liquids, such as juice or tea, before 6 months of age, and the solid foods introduced into the diet are most often a watery millet or sorghum porridge (Dettwyler 1992). A 1992 UNICEF report indicated that 31% of Malian children no longer received breast milk after 12 months of age (Treche 1999).

Growth faltering is associated with the introduction solid foods too early or too late in a child's life, the types of solid foods introduced, how much supplemental breast feeding occurs, and whether breast feeding stops too early or too late. Weaning practices in Mali vary both by region and by ethnicity (Treche 1999). The only study that represents all of the different ethnic groups and regions is the DHS II, but there is not enough detailed information on weaning to analyze these issues. There are a variety of food taboos in Mali as well. For example, Bambara children do not generally eat meat or eggs at a young age, even though their nutritional requirements for these foods are much greater than adults (Sundberg 1988).

Weaning children need frequent feedings which require time and energy from the caregiver. Studies such as Dettwyler (1992) demonstrate a positive association between the child's nutritional status and the active role of caregivers in feeding. She describes the cultural norm as the perception that children know how hungry they are; consequently, food is not forced upon them (Dettwyler 1991).

Integration of young children into family meals (i.e., common bowl) also presents feeding challenges to caregivers to assure that a sufficient quantity and quality of food is consumed. To the extent that household size and composition, in particular the number of children vis a vis adults, affects the competition for resources among family members, special efforts must be taken so that children receive necessary protein, vitamins and minerals even if grain quantity and sauce ingredients are stretched thinner over a larger number of household members (Staatz, D'Agostino, and Sundberg 1990; De Groote 1997).

Anemia and vitamin A deficiency appear to be a major problem for the children surveyed in the Kolondieba district of Mali (Institut National de Recherche en Stante Publique, and Save the Children USA 1999). Other studies from the 1980s in Mali find significant problems with vitamins A and C and iodine deficiency, anemia and protein-energy malnutrition (see Sundberg 1988 for a review). Given the abundance of mangoes in Mali, one topic for research may be to examine whether young children under two to three years of age consume mangoes and store Vitamin A.

Increased agricultural productivity can also improve the diversity of the diet for young children, primarily by raising effective demand. In particular, if men and women have different propensities to consume different goods and services, additional income in the hands of women may help directly increase dietary diversity. To the extent that households and women are directly involved in the production of more nutritionally diverse foods, such as gardening, own consumption may increase, particularly if the disparity between producer and consumer prices is high.

Table 11 presents results from the DHS II showing that there is no substantial difference in wasting (WHZ scores) for children 7 months and older who have consumed meat and eggs, fish or poultry within the past week with those who were not fed meat, fish poultry or eggs. The table also shows that only 7% of the children under 7 months of age are being exclusively breast-fed. Although these children have a somewhat higher average WHZ score, this may be attributable to the small number of children (n = 85) in this category.

Table 11. Selected Z Scores by Feeding Practices

Feeding Practices	WHZ	% of Women
Under 7 Months		
Total	-0.61	100%
No other liquids	-0.78	7%
Water	-0.60	90%
Fresh milk	-1.06	5%
Cereals	-1.19	5%
Eggs, fish and poultry	-0.88	1%
7 Months and Over		
No meat or eggs	-1.63	44%
Eggs, fish and poultry	-1.53	58%
Meats	-1.53	52%

Source: Demographic and Health Survey 1995-96
Base = All children measured, ages 0 to 35 months

Maternal Education: Maternal education is widely recognized as an important factor in determining the health and nutritional status of young children (Behrman and Deolalikar 1988). Although maternal education operates through better hygiene, health care and feeding practices, it is given special attention here because of the important role paid to it by researchers and policy makers alike.

Table 12. Selected Z Scores by Maternal Education

Maternal Education	WHZ	HAZ	% of Women
None	-1.15	-1.28	84%
Incomplete Primary	-0.91	-1.01	10%
Complete Primary	-0.96	-1.20	1%
Incomplete Secondary	-0.96	-0.72	5%
Higher	-0.21	0.29	0%
Rural Women with No Education			91%
Urban Women with No Education			70%

Source: Demographic and Health Survey 1995-96
Base = All children measured, ages 0 to 35 months

Table 12 shows a substantial improvement in Z scores from women with no education to those with some primary schooling. These trends continue as education increases; however, the number of women within these strata is relatively small. Rates of schooling for mothers of children in rural areas in the DHS I and II studies are very low.

There is considerable speculation over how maternal education influences nutrition. Some researchers believe that higher education increases household income. Others note that more education for women may provide them more control over household resources. Still others feel that education lowers the cost of acquiring and processing information on better health, hygiene and feeding practices. With the vast majority of child health care occurring away from health centers, women's ability to diagnose and treat daily child health needs would seem to improve with greater education.

Penders (1999) finds mixed results from the effects of maternal education on weight-for-height and height-for-age Z scores. Overall, the effects of maternal education on weight-for-height Z scores was more robust than the effects on height-for-age. To some observers, this may seem to be a counterintuitive result, as one would expect to find a greater relationship between the long-term measure of health and nutrition, HAZ, and less association with WHZ. However, better educated mothers could mean less exposure to illness due to mosquitos or poor sanitation.

Engle (1995) observes that it is not clear how a few years of schooling would make considerable difference in the mother's caregiving behavior. Better understanding the role of maternal education with respect to feeding practices, health care, hygiene and control over resources is one area of research that would improve our understanding of child health and nutrition and potentially be very beneficial to policy makers.

Illness and Hygienic Practices: Evidence from around the world shows that clean water and better sanitation are associated with decreased morbidity from diarrhea, ascariasis, shistosamiasis, guniea worm and trachoma, as well as lower rates of child mortality and better nutrition (UNICEF 1996; Burger and Esrey 1995). However, water collection can be a very time intensive activity for women in developing countries (UNICEF 1996), an effort that varies according to season. Although community water supplies may be clean, contamination, usually fecal, occurs somewhere between collection and ingestion.

A study in the Kolondieba district in Mali noted a lack of latrines and potable water at community schools and concluded that parasites, endemic to the region (e.g., ankylostomias) posed substantial health problems (Institut National de Recherche en Sante Publique, and Save the Children 1999). The report also advocated improvements in basic personal hygiene. A study in the ON zone identified other sanitary problems, particularly with shistosomiasis. Roughly two-thirds of the children in the study reported urinating and defecating in the water, despite nearly all of the households having latrines (Institut National de Recherche en Sante Publique 1998).

In the DHS II, mothers were asked if their children had suffered from diarrhea, fever or cough with the past two weeks. Table 13 indicates the average weight-for-height and height-for-age Z

Table 13. WHZ and HAZ Scores by Incidence of Illness

Illness	Mean WHZ	Mean HAZ	Incidence
All Children	-1.11	-1.22	
Diarrhea	-1.41	-1.55	27%
Fever	-1.30	-1.37	42%
Cough	-1.21	-1.24	30%

Source: Demographic and Health Survey 1995-96
Base = All children measured, ages 0 to 35 months

score by three different types of illnesses. Children who had suffered from a fever and particularly diarrhea are substantially worse off than the average for the entire study. In some ways, the incidence of illness may be approximating the quality of their environment and care received by these children. Thus, children who had an illness within the past two weeks may be more likely to suffer from illness in general.

Research on feeding practices and illness suggest that feeding may be more of an issue when the child is sick and not very important when the child is healthy (Haaga and Mason 1987). Apparently, children do not respond much in terms of growth to increases in calorie consumption unless they are below 60% to 70% of recommended daily allowances (RDA); otherwise, children who obtain 70% or more of the RDA may simply reduce activity and still grow reasonably well. This conclusion implies that much of the growth retardation observed could stem from poor feeding practices for sick children. If applicable to Mali, this could have profound impact on policy. Rather than concentrating on general messages relating to feeding practices, specific messages regarding how to improve the nutritional intake of sick children could contribute to significant improvements in growth. More research is clearly necessary before any conclusions or actions are recommended.

Analysis from the DHS studies (see Penders 1999) finds the effects of better sanitation, approximated by improved toilet facilities, and safer water on children's weight-for-height to be mixed. All of these factors are positively related to WHZ scores in the DHS II sample, but not statistically significant – although combining the effects of water and improved latrines are significant ($p < .05$). However, in the DHS I sample, most of these factors were negatively associated with WHZ scores. Without consistent results from both DHS I and II studies, it is difficult to draw any firm conclusions.

Estimating the effects of cleaner water and sanitation on child height-for-age are also ambiguous. Flush toilets are positively and significantly related to better Z scores in the DHS I samples, but negative (although not significant) in the DHS II study. In fact, the magnitude of having a flush toilet in the first DHS study is expected to increase child Z scores by more than 2 standard deviations! Such effects may be accounting for a variety of unobserved characteristics, in particular income and other behavior, which may be responsible for increasing height-for-age.

4.2. The Role of Agricultural Income in Financing Community Infrastructure

Raising rural incomes through agricultural development not only allows households to purchase more food and health-related goods and services, but also permits villages to make investments in community infrastructure. In the cotton zone, fees paid to village associations by the CMDT for services rendered in the assembly of seed cotton have been used to finance investment in community infrastructure (schools, CSCOM, wells). Some villages in the Kolondiéba district have even levied taxes on the sale of seed cotton in order to generate revenues for community investment.

Regression analysis of weight-for-height and height-for-age Z scores in Mali[8] finds the presence of community health facilities to be positively associated with height-for-age Z scores, but more ambiguously related to weight-for-height (see Penders 1999). These results are consistent with the types of poor health and nutrition represented by the two indicators of child nutrition status. Low weight-for-height may reflect a sudden illness, such as diarrhea, that is not necessarily preventable simply by living near a health facility. However, over time, it is expected that the frequencies of these incidents would decrease, consequently height-for-age should improve.

As a condition for building a CSCOM, villages are required to contribute at least 15% of the total cost of construction. Consequently, agriculturally-rich rural areas may have a financial advantage to make these investments in community infrastructure and thus have a real impact on improving the health and nutritional status of all the villagers - including children. In recent years, however, the large amount of government, donor, NGO and local population investment in extending health care coverage seems to have equalized investment in CSCOM and average population per CSCOM across regions. This may explain why the percentage of villages with social infrastructure is not necessarily higher in the agriculturally rich zones of Sikasso and Segou relative to the other regions (Table 14).

Table 14. Access to Infrastructure by Region

% of Villages with:	Kayes	Koulikoro	Sikasso	Segou	Mopti	Timbuktu	Gao-Kidal
Pumps	39%	50%	55%	42%	7%	3%	2%
Pharmacy	4%	5%	4%	3%	3%	1%	1%
Health clinic	7%	12%	8%	5%	5%	2%	3%
Primary school	10%	17%	11%	7%	7%	4%	6%
Population per CSCOM	8,444	19,070	14,296	13,013	11,535	14,745	11,173

Source: Bureau Central de Recensement, Direction Nationale de la Statistique et de l'Informatique

[8] The data analyzed were collected by the Demographic and Health Survey 1995-96.

Perhaps more important than its role in financing initial investment in CSCOM (construction costs), agricultural income will be a decisive factor in: 1) determining access to health centers by the local population and thus the financial sustainability of their operations; and 2) allowing CSCOM to improve and expand their health activities. Given women's predominant role in child care and higher relative need for health care services (e.g., reproduction, child care), using CSCOM depends on them having sufficient income to pay for medical care. A 1994 *Institut National de Recherche sur la Sante Publique, Mali* (INRSP) study on women's role in CSCOM found that low individual income was one of the biggest obstacles to women's greater use of health care services (Maiga et al. 1995). Augmenting women's income from agricultural activities can increase their effective demand for health care services, thus, improving the financial ability of CSCOM in their efforts to offer a complete package of health care services.

Access to health infrastructure assumes a certain quality in the level of services. To the extent that sustainable mechanisms can be found for communities to channel agricultural income into financing expanded and improved CSCOM services, agriculture can have a significant positive effect on health care quality and ultimately improved child nutrition status. Additional income could help finance hiring additional health personnel or expanded activities of the mobile health teams that are associated with CSCOM, two actions that may comprise a strategy to improve nutritional outreach activities or to more closely monitor the growth of malnourished children.

Further development of synergies between agriculture income and improved health sector may require greater collaboration between district health personnel and local representatives of the Chamber of Agriculture and newly elected communes in order to coordinate financing arrangements.

4.3. Nutrient Composition

Another major pathway between agriculture and health and nutrition is the nutritional quality of the food which can be improved in processing through nutrient fortification, in breeding through genetic modification of crops, or in extension systems through the introduction of nutritionally superior crops like soy. (Please note that information pertaining to the effects of dietary diversity are contained in Section 4.1.2 under *Foods and Feeding Practices*.)

Although genetic engineering research is in its infancy, efforts to enrich grains with micronutrients, such as recent efforts in developing "golden rice" (high in beta carotene), should be monitored for potential transferability in the future. In the more immediate future, nutrient fortification of processed foods offers opportunities to produce protein and micronutrient rich high caloric density weaning foods. Numerous efforts by the Food Technology Laboratory of IER, most recently in association with the Novartis/Point-Sud Foundation, have developed test formulas for weaning foods. While successful development of low cost, commercially-viable weaning products by a nascent food processing sector presents many challenges, their potential impact on child nutrition status will be limited by low purchasing power of Malian households, not to mention issues of taste, acceptability and consumption patterns. Of more immediate

relevance may be efforts by certain NGOs to improve the nutritional content of local weaning foods by use of other locally available and nutrient rich products.

4.4. Agricultural Effects on Exposure to Disease and Sanitation

The use of fertilizers, pesticides and herbicides can expose communities to certain disease-causing agents that are not found in the local environment.[9] Some of these inputs can have a negative impact on health, particularly if they infiltrate the water system. Policies that help promote the proper storage, transport, application and disposal of fertilizers, pesticides and herbicides may help prevent some of these agents from affecting water sources. Given the paucity of information available on this topic in Mali, this issue was not a major focus of first phase investigations.

Another area of concern is the increase of water-borne disease associated with irrigation projects. Malaria and shistosomiasis are two of the more common diseases that have been affected by expanded irrigation in Mali (Institut National de Recherche en Sante Publique 1998). Such projects may also contribute to higher rates of diarrhea among children.

4.5. Summarizing the Links Between Agriculture and Nutrition

Raising rural incomes through increases in agricultural productivity can improve access to better health and nutrition but the direct measurable impact is small because many of the effects of agriculture on health and nutrition are indirect and are conditioned by household behavior. Higher incomes are a means to improving welfare, but require conscious decisions by household members. Along with positive benefits, there is the potential for adverse consequences as well. Agricultural development may increase the time women spend working in the fields, which in turn may affect the quality of food prepared at home or diminish the care provided by the mother. High seasonal labor demands (e.g., weeding) may also negatively affect adult nutrition and could in the case of pregnant women have a negative effect on child birth weights.

Through village associations, profits from agricultural production can be invested back into the village. Health facilities, schools and clean water are the foundation for future improvements in health and nutrition. Providing community infrastructure does not guarantee that members of the village will make use of the facility, nor that schools and health centers offer effective nutrition-related services and education to the local population. There is still much to learn about the links between agriculture and malnutrition and their relationship with household behavior.

[9] Issues concerning hygienic practices and the ability of communities to improve water supply are not directly affected by agriculture; these issues are dealt with separately, in Section 5.

5. CONCLUSIONS

The conclusions presented in this section, as well as many of the hypotheses, results and identification of gaps in our understanding of these problems, are an attempt by the authors to facilitate discussion among the participants at the Workshop on the Links between Rising Agricultural Productivity and Child Nutrition (Bamako, February 10 and 11, 2000). Workshop participants, as part of a steering committee, are helping to define objectives and plan future research and activities concerning Phase II of the project to examine the links between agricultural productivity and child nutrition. Efforts have been made to incorporate, wherever possible, comments from the workshop into the final version of this report.

5.1. Summary of the Links Between Agricultural Growth and Improved Nutrition

Lowering average per unit costs of production is the principal means through which rising agricultural productivity permits households to raise incomes and allocate resources to other productive activities. This process of agricultural transformation is predicated on well-functioning markets. Lower margins between producer and consumer prices, combined with rising productivity, allows households with surplus production to increase income while simultaneously lowering real food prices for both urban households and rural households with insufficient food production. This process allows resources to be re-allocated to other sectors of the economy with higher long-run profitability.

When markets function well, households do not need to be self-sufficient to be food secure. Rather, households need to have the ability to purchase enough food ("effective demand") to lead an "active and healthy life." As with households, regions of Mali do not need to be self-sufficient, and, as the data reveal, many are not. Households in deficit food production areas compensate by increasing effective demand through livestock production and off-farm income. At the national level, Mali has been self-sufficient in grain production in 11 of the last 14 years. Even when aggregate production falls below requisite levels, Mali has the ability to import food from other countries, both within West Africa and from other nations as well. It is hoped that the National Grain Stock will ensure that Mali, in times of drought, has sufficient grain reserves to meet shortfalls, particularly in areas where there is little effective demand.

Rising agricultural productivity can lead to higher effective demand. However, higher real incomes (effective demand) are only a means to improving health and nutrition. Households may not necessarily choose to consume more foods and health services in the short run. Rather, they may choose to make other expenditures, including investments in productive assets that raise productivity and increase income. Over time, Bennett's Law states that households will diminish the share of calories from cereals and replace them with increased consumption of fresh fruits and vegetables, meats, fish and dairy products which ultimately will improve nutrition (i.e., there is a positive correlation between income and consumption of more nutritious foods but the effect is often not immediate).

Many other factors play a fundamental role in the process of improving health and nutrition. The diverse manner in which households across Mali allocate productive resources (land, labor, inputs) for different activities and use the benefits (production, income) is one factor affecting food security and child nutrition. Feeding practices for young children, hygiene and sanitation are other behavioral factors that intervene between the consumption of foods by young children and their ability to process these nutrients. Maternal education and access to infrastructure are examples of other important factors that have been shown to influence the health and nutritional status of children. The minimum package of health services (PMA), offered by community health centers, is one vehicle through which government health policies can have a positive impact on nutrition.

In Mali, results from the 1995-96 EDS II suggested that rates of malnutrition were increasing, despite growth in agricultural production. Further analysis reveals that measures of nutrition are not comparable between the EDS I (1987) and EDS II; consequently, it is not clear that child nutrition is deteriorating. However, evidence indicates unequivocally poor health and nutrition to be a serious problem for many young children in Mali.

Aggregate production is increasing in Mali, and has accelerated since the recent devaluation in 1994. While growth in the cotton sector is due primarily to large increases in area planted, rice farmers have increased production through improvements in yields. Much of this growth is concentrated in the regions of Sikasso and Segou. Buttressed by the devaluation, a period of good rainfall and liberalized trade policies, households with greater levels of productive assets are driving this increase in production and benefitting from increased productivity. In other areas in Mali, primarily those where coarse grain production predominates, results have been less favorable.

The hypothesis of this analysis, that agricultural growth that increases real farm income leads to better health and nutrition, was examined with regard to several key factors: (a) household income; (b) community investment of agricultural profits; (c) labor allocation, particularly by women; and (d) market performance.

The findings of the first phase research suggest that growth in agriculture has contributed to raising rural incomes for some but not all producers. The improved efficiency of markets in Mali has reduced the margin between producer and consumer prices, making cereals less expensive for consumers. The analysis of existing data bases and review of past studies suggest that increases in household income are positively but weakly associated with improved nutritional status of children. Agricultural-led growth can also have an impact on the community by increasing the ability of a village to invest profits from agriculture into needed infrastructure. Higher rural incomes do not necessarily imply more money from agriculture; gains in agricultural productivity may free up resources within the household to increase income through other activities, in order to diversify risk. In some instances, the distribution of resources, particularly cash income, among household members may affect the decisions on how to allocate these resources. These decisions may, in some ways, relate to the different responsibilities assured by family members.

Many of the aspects of the overall hypothesis – the relationship between rising agricultural productivity and child nutrition – were tested indirectly, and do not represent a conclusive test of either the general hypothesis or its components. One of the major obstacles to conducting this research was the lack of data combining health and nutrition with agricultural productivity at the household level. Improved coordination of data collection and dissemination among Malian government ministries, donor agencies, and non-governmental organizations is necessary to improve the understanding of the underlying factors that contribute to better health and nutrition. More than just agricultural productivity, information is needed linking child nutrition with the ability of households to consume adequate levels of food, whether this stems from own production or purchased foods from non-food and off-farm production. Rising agricultural productivity is concerned with increasing both supply and effective demand that enables all households to lead an active and healthy life.

One gap in our understanding of the links between rising agricultural productivity and improved child nutrition is the ability of households, and individuals within these households, to meet consumption requirements throughout the year. It is not understood how different households, through own production of food, production of non-food crops, and off-farm income are able to ensure adequate consumption throughout the year. Nor is it clear how the responsibilities among household members and their control over income affects the provisioning of food. Seasonal demands on labor may affect the energy level or "effort" of these members, which will change the minimum level of required food consumption. The timing of purchase and sales decisions, especially for cereals, may even change the household's position in the market. For example, liquidity constraints may require seemingly self-sufficient households to sell immediately following the harvest, when prices are low, and be forced to repurchase inadequate supplies at higher prices later in the season.

The influence of seasonal factors on health and nutrition, clearly documented in studies from other countries, is still not well understood in Mali. Examining the impact of seasonal fluctuations in food availability on nutritional status of children requires monitoring child growth and consumption patterns throughout the year. This would permit researchers to examine whether growth retardation is associated with specific seasonal factors, such as periods during the year when households have inadequate food consumption, and issues associated with increased agricultural labor participation (particularly by women), as well as examining seasonal changes in the incidence of diseases and parasites. Moreover, this research can also investigate feeding and hygienic practices and the use of health infrastructure in more detail than studies that only interview households at a particular point in time.

5.2. Policy Implications

Results from this research show that community infrastructure is positively related to health and nutrition, thus investment in CSCOMs and other infrastructure will play a pivotal role in future health interventions and improvements to sanitation. To the extent that profits from rising agricultural production can be reinvested in building CSCOMs, increasing their financial

viability, improving the quality of their services, as well as developing water and sanitation infrastructure, the agricultural links to health and nutritional status will be strengthened.

There has been some evidence of infrastructure development occurring in the CMDT zone, via revenues from seed cotton marketing services provided by village associations representing cotton producers. More information is needed to more fully document the income sources villages throughout Mali use to help finance infrastructure development. If other areas have been successful in this regard, it is important to learn how these groups have organized themselves and whether their model is replicable in other areas. Could the approach used in cotton areas be replicated by producers of other "cash" crops, such as rice and horticulture? Are there other organizations, notably farmer associations such as local chambers of agriculture, which can assist in organizing similar actions in other areas? Are there other sets of incentives that can be used to encourage this investment in other areas of Mali? Finally, aside from financing infrastructure development, can further incentives be established to encourage use of agricultural revenues to finance greater access and improvements to health services (e.g., promotional activities)? Given limited human and financial resources at the local level, finding sustainable financing solutions for health care and other community development activities will need to be coordinated with decentralized health and commune policies.

Another area of consideration is education. Although the process by which maternal education improves child health and nutrition is not clearly understood, the two are positively correlated with one another – a finding consistent with numerous studies. Thus, reinforcing current efforts to encourage education, particularly increasing schooling rates for girls – an objective in and of itself – may help improve child health and nutrition, particularly over the long run. More immediately, increasing teacher training and improving curricula in health, hygiene, and nutrition may help contribute to improved behaviors.

Policies that seek to help finance social development through higher incomes hinge on continued progress in improving agricultural productivity, and on the ability of markets to coordinate exchange, both domestically and internationally, and reduce marketing margins between producer and consumer prices. Without functioning markets, raising agricultural productivity may not lead to greater effective demand for urban and rural households, be they net buyers or sellers. Consequently, Mali must continue to engage in activities that facilitate trade, such as building roads and reducing barriers to trade.

A final concern is the ability of Mali to develop both human and institutional capacity to address these problems. Mali has a cadre of highly qualified professionals, but there is still a need to strengthen skills through training and education in order to face new challenges in designing and coordinating policy and improving child nutrition interventions at the village level. Without qualified medical, public health, and nutrition personnel trained in community nutrition, no solution can be sustainable. The need for greater human resources is necessary at all levels of the health and agricultural system from the ministry all the way to the agents working in the remotest of locations. Current plans to provide on-the-job training in nutrition education to health and agricultural field personnel appear well-founded if these agents will be called on to more effectively diagnose and monitor child nutritional status and promote improved behaviors

at the village level. Plans to finance degree training in nutrition and food systems is also justified in order to increase the critical mass of trained analysts in these fields. The challenge of designing sustainable health care financing options would also suggest training in health care economics.

5.3. Suggestions for Future Research

Further research is necessary to strengthen our understanding and ability to increase the positive links between agricultural growth and improved child health and nutrition. However, before moving forward with any new research projects, the first objective should be to improve the coordination of ongoing (and planned) research efforts among Malian institutions and donor agencies. Given the current institutional structure in Mali, the newly created DSSAN appears to be the appropriate mechanism through which second phase research activities, which are currently being planned by the steering committee, are coordinated across institutions.

The design of future research activities will need to carefully consider issues related to the size and scope, which may depend, at least in part, on the objectives of the study. Some research topics require broad, nationally representative surveys to identify areas where problems arise. Other, often smaller studies may focus on collecting detailed information that investigates causal relationships and the manner in which underlying factors affect these processes. Still other research may focus on a specific topic or a particular geographic area, depending again on the objectives.

Collecting disaggregated data on both agricultural- and nutrition-related variables at the household level will require an innovative research design and use of existing national data collection efforts. Coordinating future research with up-coming national surveys, so that the same sample or subsample is used, could result in an extremely rich data set that would allow detailed analysis of the links between agricultural growth and child nutrition status. For example, the households identified could be a subset from those studied during the DHS III, being conducted during the spring of 2000. An upcoming study on micronutrients, funded by the World Bank, could also select these children as an additional part of the sample. Another upcoming study on household budget and expenditures, may provide additional insight. These studies could then be supplemented by monthly monitoring of child growth and interviews of other household issues not covered by the larger studies.

While this is one suggestion that would allow researchers to look at a variety of important factors, other issues need further research as well. One area of research may be to examine ways in which the effectiveness of nutritional messages can be improved. Other research could seek to develop low-cost methods of monitoring feeding practices within households, which would be of potential use to health professionals in the field (CSCOMs) and for government and donor institutions to monitor the effectiveness of health interventions.

The objectives of presenting results from initial analysis conducted in the first phase of this project is to solicit feedback from the many actors involved. Not only do the conclusions, policy

recommendations and suggestions for future research depend upon this process, but the objectives and orientation of the second phase will reflect this discourse and participation. The proposed actions presented here are simply that, and represent an effort on the part of the authors to stimulate discussion.

REFERENCES

Behrman, Jere R., and Anil B. Deolalikar. 1988. Health and Nutrition. In *Handbook of Development Economics*, B. V. Elsevier Science Publishers. Amsterdam, The Netherlands 1: 631-711.

Blaken, Jurgen, Joachim von Braun, and Hartwig de Haen. 1994. The Triple Role of Potatoes as a Source of Cash, Food and Employment: Effects on Nutritional Improvement in Rwanda. In *Agricultural Commercialization, Economic Development and Nutrition*, ed. Joachim von Braun, Howarth Bouis, and Eileen Kennedy. Baltimore: Johns Hopkins University Press.

Burger, Susan E., and Steven A. Esrey. 1995. Water and Sanitation: Health and Nutrition Benefits to Children. In *Child Growth and Nutrition in Developing Countries*, ed. Per Pinstrup Anderson, David Pelletier, and Harold Alderman. Ithaca: Cornell University Press.

Castle, Sarah. 1995. Child Fostering and Children's Nutritional Outcomes in Rural Mali: The Role of Female Status in Directing Child Transfers. *Social Science Medicine* 40.5: 679-93.

Cole, T.J. 1993. Seasonal Effects on Physical Growth and Development. In *Seasonality and Human Ecology*, eds. S. Ulijaszek and S. Strickland. Cambridge: Cambridge University Press.

De Groote, Hugo. 1997. Women's Income Versus Family Income as a Determinant for Food Security, an Example from Southern Mali. In *Issues in Agricultural Competitiveness: Markets and Policies, Proceedings of the 22nd Conference of Agricultural Economists Held in Harare, Zimbabwe, 22-29 August 1994*, ed. R. Rose, C. Tanner, and M. Bellam. Dartmouth, Aldershot, England: International Association of Agricultural Economists.

De Groote, Hugo, and Ngolo Coulibaly. 1998. Gender and Generation: An Intra-Household Analysis on Access to Resources in Southern Mali. *African Crop Science Journal* 6.1: 79-95.

Dembélé, Niama Nango, and John M. Staatz. 1999. The Impact of Market Reform on Agricultural Transformation in Mali. Paper presented at the Workshop on Agricultural Transformation in Kenya, 27-30 June, Nairobi, Kenya.

Demographic and Health Survey, Mali. 1995-96.

Dettwyler, Katherine A. 1991. Growth Status of Children in Rural Mali: Implications for Nutrition Education Programs. *American Journal of Human Biology* 3: 447-62.

Dettwyler, Katherine A. 1992. The Biocultural Approach in Nutritional Anthropology: Case Studies of Malnutrition in Mali. *Medical Anthology* 15: 17-39.

Dioné, Josue. 1989. Informing Food Security Policy in Mali: Interactions between Technology, Institutions and Market Reforms. Ph.D. dissertation, Michigan State University.

DNSI. 1999. Macroeconomic and Price Data Bases.

Engle, Patrice L. 1995. Child Caregiving and Infant and Preschool Nutrition. In *Child Growth and Nutrition in Developing Countries,* ed. Per Pinstrup Anderson, David Pelletier, and Harold Alderman. Ithaca: Cornell University Press.

Enquête Malienne de Conjoncture Economique et Sociale. 1994.

Haaga, John G., and John B. Mason. 1987. Food Distribution within the Family Evidence and Implications for Research and Programs. *Food Policy* 12.2: 146-160.

Haggerty, Patricia, Rohini Pande, Ana Sanchez, N'Faly Dembele, Modibo Diarra, Ousmane Sidibe, and Kagnassy Dado Sy. 1998. Nutrition et santé des jeunes enfants et de leur mère au Mali. Résultats de l'Enquête Démographique et de Santé au Mali 1995-96. Calverton, MD: Macro International Inc.

Institut National de Recherche en Sante Publique. 1998. Etude Environnementale de la Zone de l'Office du Niger: Etude sur les Aspects Lies a la Sante Humaine.

Institut National de Recherche en Sante Publique, and Save the Children (USA). 1999. Evaluation de l'Etat de Sante et le Statut Nutritionnel des Enfants Scolarises des Ecoles Communautaires du Cercle de Kolondieba.

Kébé, Demba, Lamissa Diakite, and Hamady Diawara. 1998. Impact de la dévaluation du FCFA sur la Productivité, la Rentabilité et les Performances de la filière coton (Cas du Mali). PRISAS/INSAH-ECOFIL/IER.

Kelly, Valerie, T. Reardon, A. Fall, B. Diagana, and L. McNeilly. 1993. Final Report for the IFPRI/ISRA Study of Consumption and Supply Impacts of Agricultural Price policies in the Peanut Basin and Senegal Oriental. Washington, D.C.: International Food Policy Research Institute (unpublished project report).

Kennedy, Eileen T., and P. Pinstrup Andersen. 1983. *Nutritional-related Policies and Programs: Past Performances and Research Needs.* IFPRI.

Kumar, Shubh K., and Catherine Siandwazi. 1994. Maize in Zambia: Effects of Technological Change on Food Consumption and Nutrition. In *Agricultural Commercialization, Economic Development and Nutrition,* ed. Joachim von Braun, Howarth Bouis, and Eileen Kennedy. Baltimore: Johns Hopkins University Press.

Maiga, Mariam D., Sissoko Assanatou Doucoure, Adégné Niangaly, and Nianguiry Kante. 1995. Quel rôle joue la femme dans la création et la gestion des associations de santé communautaires (ASACO) et des centres de santé communautaires (CSCOM) au Mali? Etude de cas dans le district de Bamako et les régions de Ségou, Koulikoro et Mopti. INRSP/CNIECS/ MSSPAS.

Martorell, Reynaldo. 1995. Promoting Healthy Growth: Rationale and Benefits. In *Child Growth and Nutrition in Developing Countries*, ed. Per Pinstrup Anderson, David Pelletier, and Harold Alderman. Ithaca: Cornell University Press.

Ministere de la Sante des Personnes Agees et de la Solidarite. 1998 Programme de Développement Sanitaire et Social (PRODESS), 1998 - 2002.

Moore, Emily, with Claude Théophin. 1998. Etude qualitative, conceptions des populations face à la malnutrition. Groupe ad hoc santé, MS.

Mosley, W. Henry. 1984. Child Survival: Research and Policy. In *Child Survival Strategies for Research*, ed. W. Henry Mosley and Lincoln C. Chen. Cambridge: Cambridge University Press.

Mosley, W. Henry, and Lincoln C. Chen. 1984. Framework for the Study of Child Survival. In *Child Survival Strategies for Research*, ed. W. Henry Mosley and Lincoln C. Chen. Cambridge: Cambridge University Press.

Newman, Lucile F. 1987. Fitness and Survival. In *Child Survival*, ed. Nancy Scheper-Hughes. Dordrecht, The Netherlands: D. Reidel Publishing Company.

Penders, Christopher L. 1999. Examining the Links between Agriculture and Child Malnutrition in Mali. Masters thesis, Michigan State University.

Schofield, Sue. 1973. Seasonal Factors Affecting Nutrition in Different Age Groups and Especially Preschool Children. *Journal of Development Studies* 11.1: 22-40.

Simondon, Kirsten B., Eric Benefice, Francois Simondon, Valerie Delaunay, and Anouch Chahnazarian. 1993. Seasonal Variation in Nutritional Status of Adults and Children in Rural Senegal. In *Seasonality and Human Ecology*, ed. S. Ulijaszek and S. Strickland. Cambridge: Cambridge University Press.

Staatz, John M., Victoire C. D'Agostino, and Shelly Sundberg. 1990. Measuring Food Security in Africa: Conceptual, Empirical, and Policy Issues. *American Journal of Agricultural Economics* 72.5: 1311-17.

Sundberg, Shelly. 1988. An Overview of the Food Consumption and Nutrition Situation in Mali. Report submitted to USAID/Mali/Agricultural Development Office.

Thompson, Barbara, and A.K. Rahman. 1967. Infant Feeding and Child Care in a West African Village. *The Journal of Pediatriacs* 13.3: 124-138.

Treche, Serge. 1999. Rapport Technique de Mission en Republique du Mali. World Health Organization.

UNICEF. 1996. *Food, Health and Care: The UNICEF Vision for a World Free from Hunger and Malnutrition*. New York: United Nations Children's Education Fund.

WHO Expert Committee on Physical Status. 1995. *The Use and Interpretation of Anthropometry*. Geneva: World Health Organization.

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