Measuring the Programme Mali-Nord's Impact :

An Analysis of Poverty and Food Security in Northern Mali

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List of Abbreviations

CSCOM	Centre de Santé Communautaire (Community Health Center)
CSLP	Cadre Stratégique de Lutte contre la Pauvreté
FAO	Food and Agricultural Organisation
FCFA	Franc de la Communauté Financière Africaine
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
IFAD/FIDA	International Fund for Agricultural Development / Fonds International pour le Développement Agricole
IFPRI	International Food Policy Research Institute
IIRPA	Institut International de Recherche sur la Politique Alimentaire
KfW	Kreditanstalt für Wiederbau
PDZL II	Projet de Développement Zone Lacustre - Phase II
PIV	Périmètre Irrigué Villageois (Village Irrigation Project)
PMN	Programme Mali-Nord
RNDH	Rapport National 2003 sur le développement humain durable au Mali
SAGA	Strategies and Analysis for Growth and Access
USAID	United States Agency for International Development

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All errors remain the exclusive responsibility of the author and do not necessarily reflect the opinions of the funding organizations or any of the above mentioned people.

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Executive Summary

1. This report uses a household economic survey to evaluate the impact of the Programme Mali-Nord's interventions on poverty reduction and agricultural production. The „Etude sur la Pauvreté et la Sécurité Alimentaire au Nord Mali 2006" interviewed men and women from households across northern Mali in 151 villages from February 2006 to October 2006 in seven cercles (Niafunké, Goundam, Diré, Tombouctou, Rharous, Bourem, and Kidal). The communes in the full sample include Kidal city in the cercle of Kidal ; Bourem, Bamba and Temera in the cercle of Bourem; Séréré, Rharous, Hamzakona, and Banikane in the cercle of Gourma Rharous; Lafia, Bourem-Inaly, Ber, Tombouctou city and Alafia in the cercle of Tombouctou; Tonka, Hangabera, M'Bouna, Essakane, Douékiré, Bintagoungou and Goundam city in the cercle of Goundam ; Arham, Binga, Bourem Sidi Amar, Dangha, Diré city, Garbakoïra, Haïbongo, Kondi, Sareyamou, and Tienkour in the cercle of Diré; and Soboundou, Léré, Banikane Narhawa, Dianké, Fittouga, Koumaïra, N'Gorkou, and Soumpi in the cercle of Niafunké. Of the 2 658 households in the sample, 245 households in the commune of Soboundou, Niafunké that were originally surveyed in a similar study conducted in 1997-98, were resurveyed twice in 2006.

2. The objective of the 1997-98 survey was to understand and develop food security indicators for the International Fund for Agricultural Development (IFAD) by implementing a four round household survey in 10 villages of the commune of Soboundou in the Niafunké district (*cercle*). This 1997-98 survey was collaboration among the International Food Policy Research Institute (IFPRI), IFAD, and the United States Agency for International Development (USAID) and Cornell University to develop food security indicators.

3. The Programme initially became interested in this study after the survey began and preliminary results from the initial stage of data collection were presented at a March 2006 meeting. Capitalizing on the ongoing study, the Programme Mali-Nord and the study explored together the possibility of expanding the survey area to the full Programme Mali-Nord intervention zone and undertaking a thorough evaluation of irrigation interventions on agricultural production and poverty reduction. The number of Programme Mali-Nord households in the survey is 243, which compose about 11% of the full sample.

4. The specific research objectives of the study responded to the funders' interest in a study that could inform them on the impact of their investments. These included the study objectives to:

◊ Measure changes in household welfare with poverty and food security indicators that are attributable to household participation in the Programme Mali-Nord's development interventions using the evaluation technique of propensity score matching.

◊ Measure the direct effects of irrigation investments (PIVs) and lake barrage systems in increasing mean agricultural production and reducing the variance of agricultural returns.

◊ Analyze the dynamics of poverty and food security over the past nine years in the Zone Lacustre regions using comparisons from the 1997 data with the newly collected 2006 data. Why have some households improved and others declined or remained in poverty?

5. To implement this economic survey in the entire survey area described in the first paragraph, coordination of all data collection activities were assured by the Coordinator, a Research Assistant and a Field Supervisor/Trainer. 28 survey enumerators administered the survey throughout the different cercles by working in two person teams. Field work to collect this data was conducted from February to October 2006.

6. Descriptive statistics from the survey indicate that the mean number of people in the households surveyed was 6.24 persons. Rural households have .5 more persons than urban households. 31% of the households in the sample come from urban areas while 69% of the households are from rural areas. Men composed 50.55% of those surveyed, while women made up the other 49.45%. Mean weekly food expenditures were 18 671 FCFA with more than a 5 000 FCFA increase in food expenditures among urban than rural households. These figures roughly correspond to a daily expenditure of a little less than 3 000 FCFA per day. Mean values of durable assets between men and women differ by almost 85 000 FCFA with men owning more durable assets then women.

7. The mean consumption per capita per year for households in the survey is 340 318 FCFA. In the urban sector, the mean consumption per capita per year is 443 141 FCFA. In the rural sector, mean consumption per capita per year is 272 937 FCFA. Mean consumption per capita per year statistics differ between rural and urban sectors with a difference of 170 204 FCFA per capita per year. Poverty measures for the full sample indicate about 39% of the population are considered poor using a one Euro per person per day poverty line. However, using this same standard, almost 53 % of the rural population is considered poor. These statistics reflect the stark underdevelopment of rural populations in northern Mali.

8. Agriculture remains a dominant livelihood system in northern Mali. The composition of crops planted remains predominantly cereals when compared with the 1997-98 period. However, the number of farmers planting irrigated rice has greatly increased with smaller reductions in the number of households planting millet and sorghum. The composition of crops planted by farmers has changed when compared to the 1997-98 agricultural season. This is primarily caused by agricultural investment which has increased the availability of irrigation. 29.6% of households have switched to irrigation since 1997 in the

commune of Soboundou, Niafunké. Overall, the percentage of households who have access to irrigation is 21.7% in the full sample of data from 2006. Households with access to Programme Mali-Nord irrigation compose 17% of the population in the cercle of Niafunké, 7% in cercle of Goundam, 21% in the cercle of Diré, 1% in the cercle of Tombouctou, and 11% in the cercle of Rharous.

9. Production per hectare has increased by 3.8 tons in the past 8 years. Households continue to hold multiple plots farming multiple types of crops. The mean household area cultivated is 1.55 hectares. Estimates of production per hectare across the districts (*cercles*) for 2006 range from the highest estimates of 2.5 tons per hectare in Diré and Niafunké to 1.3 tons per hectare in Rharous and Bourem. In addition to finding significant returns to irrigation investment overall, we find an approximately fourfold difference between small and large irrigation projects with smaller irrigation projects contributing 2.8 additional tons to production per hectare, while larger irrigation projects contribute 0.7 additional tons of production per hectare.

10. After analysis of the data, we find that the significant program evaluation results include:

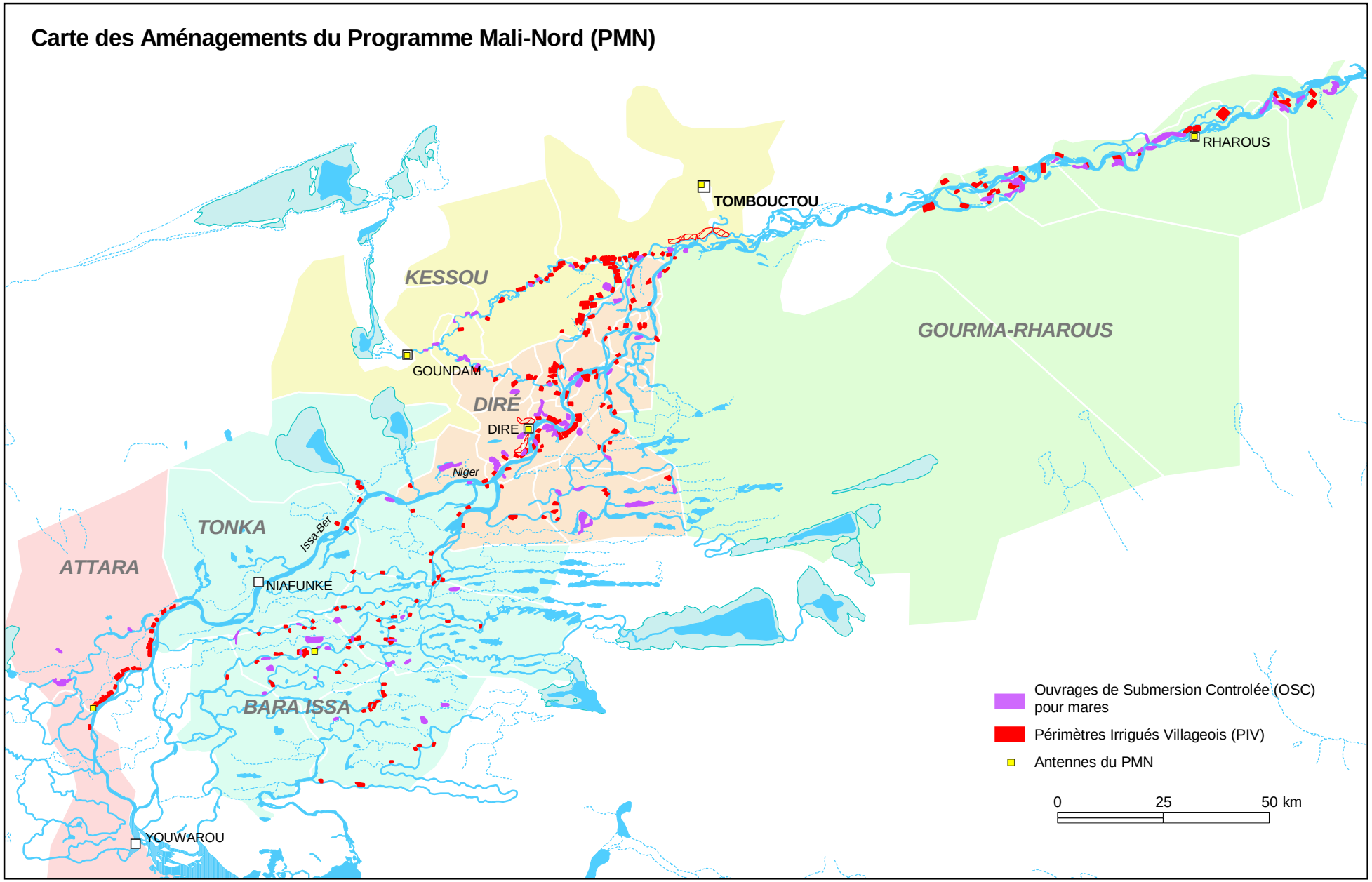
◊ Households that have access to the Programme Mali-Nord's irrigation investments (PIVs) add 2.4 additional tons of agricultural production per hectare than households that do not have access to these interventions.

◊ Per capita consumption per year is higher in households that participate in the Programme Mali-Nord's programs by 47 778 FCFA than households who do not.

◊ There is a reduction of poverty of 14% linked to the Programme Mali-Nord's interventions after controlling for other factors that also reduce or increase poverty.

11. In summary, this report details the economic survey and methodology through which we have come to the above program evaluation conclusions. The Programme Mali-Nord has had a significant impact on rural farmers in their intervention zone. Our study clearly illustrates the stark differences between rural and urban residents. Hence, efforts to increase access to irrigation for rural farmers using strategies developed by the Programme Mali-Nord are likely to have impacts such as those measured in this report.

Carte des Aménagements du Programme Mali-Nord (PMN)



1. *Part I : measuring the Programme Mali-Nord's Impact*

1.1 Introduction

The purpose of this report is to evaluate the impact of the Programme Mali-Nord's development interventions, specifically small scale (20-40 hectare), village level irrigation projects (Périmètres Irrigués Villageois), on household welfare in its intervention zone. To quantify the impact of the Programme Mali-Nord's interventions, a representative household survey, the *Etude sur la Pauvreté et la Sécurité Alimentaire au Nord Mali 2006,* was undertaken to link welfare indicators to households who both benefited and did not benefit directly from the project. Differences between these two groups are examined using statistical evaluation techniques. If development interventions are effective in their targeting and implementation, there should be measurable reductions in poverty and measurable increases in food security and agricultural production.

Theoretically and empirically, there are many reasons to believe that irrigation projects have positive impacts on agricultural production and the reduction of poverty. Access to irrigation provides farmers a reliable water source at critical times in the crop's life cycle, removing the dependence and inherent uncertainty of rain-fed and lake based agricultural systems. This reduction in risk faced by farmers is likely not only to increase mean agricultural returns, but also reduce the variability of these returns. This is important not only because farmers produce more on average, but their production is also more certain. When farmers have sources of revenue that are more certain, households that farm have more consistent and less variable consumption, which allows them to build asset bases to move out of poverty. When basic consumption needs are not met, households are often forced to sell off assets to avoid poverty and malnutrition.

However, there are important debates concerning agricultural investment and village level irrigation projects in Mali. Access to irrigation is not without increased cost for the farmer, community and donors who finance the projects. Do these increased costs outweigh the benefits of the investment? The debate about the effectiveness of irrigation projects focuses primarily on the optimal scale of investment and the sustainability of these investments over time. Large scale (over 100 hectares), larger budget irrigation projects (upwards of 7 million FCFA per hectare) differ from small scale (30-50 hectares), reduced cost village level projects (1 million FCFA per hectare) in cost, size, management costs, community coordination, lifetime of the motor pump, and the quality of the principal and secondary canals that bring water to each parcel. Given these differences in project design, is there a statistical difference in rates of poverty reduction for larger, more expensive investments than smaller, less expensive investments? Critics of village irrigation projects (PIVs) also question the sustainability of village-based management systems, the emergence of a rice monoculture on dietary diversity, and the technical knowledge of farmers to use

and gain access to complementary inputs such as fertilizer to increase production[1]. Are these valid critiques of the village level irrigation investments?

This report attempts to respond to these questions using rigorous statistical analysis to measure the differences in household welfare and agricultural production between households with and without irrigation. The objective is not simply to provide descriptive statistics of agricultural production and household welfare, but to establish causality between the welfare indicators and access to irrigation using statistical regression techniques. This methodology allows the estimation of the effect of having access to irrigation on poverty. To establish if the Programme Mali-Nord's interventions reduce poverty, we analyze households that do and do not have access to irrigation from a representative household economic survey conducted in northern Mali from February to October 2006. This survey interviewed 2.675 households in the *cercles* of Niafunké, Goundam, Diré, Tombouctou, Rharous, Bourem and Kidal. The geographic breadth and sample size of the survey allow for two distinct sub-samples of households with varying characteristics that have access and do not have access to irrigation.

The report is organized as follows: the second section presents the Programme Mali-Nord's intervention zone, the third section briefly describes our research methodology and the survey's objectives[2], the fourth section describes the principles of program evaluation that the report uses to measure the impact of the Programme Mali-Nord's interventions, the fifth section provides general economic comparisons between the Programme Mali-Nord's zones of concentration and other zones, as well as the results of the statistical analysis with interpretation and the last section provides conclusions and recommendations of the report. A Bibliography and Technical Appendix are also included.

1.2 Presentation of Project Zone

The Programme Mali-Nord has intervened in northern Mali since 1994 by providing humanitarian and development assistance after the civil conflict that began in 1990. Interventions by the program focused on resettlement of refugees after the conflict, reconstruction of schools and public infrastructure destroyed during the conflict, and agricultural investment in PIVs to support the return of peace and economic development. The project zone covers the *cercles* of Niafunké, Goundam, Diré, and four *communes* located along the Niger River in the *cercle* of Rharous. Village level irrigation interventions began formally in 1995 with two PIVs in the villages of Dofana and Tin Telout. The objective of village level irrigation projects in the post conflict environment of northern Mali was to

[1] A recent study by Kouyaté and Haidara (2006) summarize some of these arguments.

[2] A more complete and extensive description of the research project is contained in Vol. 1 of this report which includes basic summary statistics of the data.

assure displaced populations that the economic needs of their families could be assured upon their return and promote general economic development in the north, the primary grievance of the conflict.

The survey area of the *Etude sur la Pauvreté et la Sécurité Alimentaire au Nord Mali 2006* is composed of 3 regions (Tombouctou, Gao, Kidal) from which 151 villages, nomadic *fractions* or towns in 7 *cercles* (Niafunké, Goundam, Diré, Tombouctou, Rharous, Bourem and Kidal) were randomly selected to participate in the study. Northern Mali has an estimated population of 809.111 people that live in an area bordered to the north by the Sahara Desert (Cartographie du Mali 2001). The Saharan zone (desert or arid region) receives less than 150 mm of rainfall par annum. This varies starkly with the Sahelien zone (grassland or semi-arid region) which receives 200-600 mm par annum and the south of Mali which can receive between 600-1200 mm par annum (FIDA 1996). The dominant ecological resource in the region is the Niger River that serves as a source of water for agriculture and animal husbandry. The inner Niger Delta is a rich agricultural resource in which flooding from the Niger augments water levels in temporary and permanent lakes and ponds, as well as smaller streams and tributaries. This diversity of water resources is harnessed by farmers through motorized pump irrigation, water-recession agriculture around the lakes and streams and in the Niger River itself. Rain-fed agriculture which does not depend on the water levels of the Niger River is also extensively practiced. Herders benefit greatly from the temporary and permanent lakes, which provide water and pasture land for cattle and sheep. Fishing is also an important economic activity that capitalizes on the Niger River and its tributaries to supplement the income and diets of households along its banks.

Capitalizing on the vast potential of the Niger River, which flows through Northern Mali and floods a multitude of streams, lakes and ponds in the inner Niger delta, the Programme Mali-Nord has invested in approximately 350 irrigated perimeters and 100 lakes and ponds by improving water control through small dams.

1.3 Survey Objectives and Research Methodology

The primary goal of this research program is to establish a representative economic survey of households to investigate poverty and food security in northern Mali. This data set will have multiple uses enabling a comprehensive understanding of the economics of households in northern Mali, the economic mechanisms through which project interventions work to improve household welfare, and an understanding of poverty dynamics and economic development since 1997. To achieve these goals, specific objectives include :

- Measure changes in household welfare with poverty and food security indicators that are attributable to household participation in the Programme Mali-Nord's development interventions using the evaluation technique of propensity score matching.
- Measure the direct effects of PIVs and lake barrage systems in increasing mean agricultural production and reducing the variance of agricultural returns.
- Analyze the dynamics of poverty and food security over the past nine years in the Zone Lacustre regions using comparisons from the 1997 data with the newly collected 2006 data. Why have some households improved and others declined or remained in poverty?

The survey is designed as a representative two-stage cluster sample of households in the *cercles* of Niafunké, Goundam, Diré, Tombouctou, Rharous, Bourem and Kidal. Villages, in the rural strata, or quartiers in the urban strata (the clusters) of the sample were randomly selected in the first stage and their population fully enumerated based on households actually residing in the village or quartier during the period of enumeration. The second stage used the lists generated from the first stage to randomly select a list of households to be interviewed. This sample design is commonly used in household surveys and is fully described in Deaton (1997).

In addition to producing a large data set of households across northern Mali, a second objective of the study was to follow up with households originally surveyed in 1997-98 by IFAD, IFPRI, Cornell University and USAID/Mali. The objective of that survey was to understand and develop food security indicators for IFAD by implementing a four round household survey in 10 villages of the Commune of Soboundou in the Niafunké *cercle*. Christiaensen (1998) provides a full description of the sample design and selection of households from the 1997-98 data. By resurveying these 245 households found in 2006 from the 1997-98 survey, a better understanding of regional change and poverty dynamics is possible. Information regarding sample attrition and the feasibility study undertaken to conduct this resurvey project is found in Dillon (2005).

The data set is composed of a village questionnaire and a household questionnaire. The village questionnaire was administered to the village leaders in each village or town concerned by the study. The household questionnaire is decomposed into men's, women's and children's sections and was addressed to the head of household, the head of household's wife and children.

1.4 Principles of Project Impact Evaluation

The idea of project evaluation is simple enough : do certain development interventions help to increase the welfare of the targeted groups ? Can we isolate from all other factors influencing household welfare (i.e.differences in macroeconomic growth or shocks across regions, differences in household composition, regional rainfall differences, etc.) a project effect on household welfare? The basic problem seeks to compare differences in outcome indicators between households with identical characteristics who have access to the project (the treatment group) and those who do not (the control group). However, is simply comparing different indicators across the two groups good practice?

To make a valid comparison between treatment and control groups, ideally we would like to observe identical households with and without access to the program intervention. Practically, this is impossible because households either have access or they do not. The data for the state in which we do not observe the household is missing, i.e. if a household has irrigation, we cannot observe the outcome indicators for the same household who does not have irrigation. A simple comparison of outcome indicators between participants and non participants in the project requires the assumption that participants arrived in their groups completely at random. Otherwise, there may be factors that affect the selection of certain participants to their respective groups and simultaneously the program impact. For most programs, random selection of participants is untenable because development interventions are often explicitly or implicitly targeted and participation is usually voluntary. If this is the case, then the mean outcome indicators between the two groups may already be biased in favor of one of the groups for reasons unrelated to the program's impact.

This can cause gross under or over-estimation of the effects of the program. For example, if programs are targeted at the poor than the treatment group will automatically be less well-off than the control group to begin with. Any gains in welfare caused by the program will be underestimated relative to the control group because the treatment group will have to, in effect, "catch-up" to the control group who started off better. To the contrary, program effects can also be overestimated. If those with more resources, education or motivation are able to better attract interventions to their communities, these groups are likely to be better off to begin with. Additionally, they can better utilize program interventions because they learn how to use new technologies or assimilate new ideas more quickly. For these reasons, it is not sufficient to assert a positive program effect simply by observing that certain indicators are of larger magnitude in program villages than those in non-program villages[3]. There may be causes unrelated to the program that explain the correlation, such as those noted above.

[3] Several papers that demonstrate evidence of these reversals in program impact estimates include Behrman and Hoddinott 2005, Wooldridge (2002), and Strauss and Thomas (1995).

There are several statistical methods to overcome this fundamental problem that participants and non-participants are not randomly assigned to their respective groups. The first method, propensity score matching[4], first estimates the probability that a household will be allocated to either the treatment or control groups. This estimation is based on observable household and village characteristics. Then this estimate is used to control in the regression for the differences across households of being in either of the two groups before estimating the program impact. This serves to "correct" for the non-random allocation of participants to the treatment and control groups.

The second technique, differencing, uses panel data[5] to compare households before and after program interventions. This method measures the change in outcome indicators over the course of a specified time period between treatment and control groups. If households in the treatment group indicate larger increases in welfare than those increases in the control group, the changes between the participants and non-participants can be attributed to the program.

Given the data available and the implementation of the Programme Mali-Nord's interventions, using propensity score matching and differencing are the most rigorous statistical methods available to measure program impact. However, each of these methods is founded on assumptions that can be criticized. The benefits of propensity score matching include the possibility to overcome the significant bias of non-random program access. It also has the advantage of being feasible to implement even when a baseline survey of the program intervention zone is not available. However, propensity score matching is based on the assumption that differences between treatment and control groups are solely due to observable characteristics that are measurable. If unobservable characteristics of villages or individuals influence differences in the control and treatment groups, then our estimates will equally be biased. The technique also requires a large sample size, which for our purposes does not pose an immediate problem, but does require investments by organizations in data collection projects.

Differencing assumes that trends between treatment and control groups over time are the same. That is that one group does not change at a different rate than the other. It also requires a baseline survey and a follow up survey that require resources and planning from program inception. In our case, we have benefited from a survey conducted in 1997-98 in the Zone Lacustre to provide some comparisons between villages with and without access to PIVs. However, the villages that were resurveyed are not located within the Programme Mali-Nord's intervention zone. The estimates of the impact of irrigation in these villages can be used to better understand the evolution of welfare in the region

[4] For the theoretical formulation of this technique, the seminal articles include Rosenblum and Rubin (1986) and Heckman et al. (1995)

[5] Panel data is data that has repeated observations on the same household over several periods of time.

generally and can provide an alternate methodology to verify the results from impact estimates based on propensity score matching.

This report uses these two different evaluation methodologies, matching and differencing, to ensure that regardless of methodology, we can be confident of the significance of program impacts and their magnitudes. It is important to remember that no methodology is without faults, but that the benefits of using a variety of well-established methodologies allows us to measure potential biases and evaluate whether the results merit confidence.

1.5 Analysis and Quantitative Program Evaluation Results

Despite persistent poverty, it is important to note that the agricultural sector has not remained static over the past 10 years. It is this poverty that inhibits farmers from investing in agricultural technology and capital that could increase their returns. As a result, production is highly labor intensive with low levels of agricultural capital available to households. Mean agricultural capital is approximately 65 000 FCFA per household. The factors that the farmer can control that contribute to higher agricultural productivity are the supply of labor (which partly explains high household size), crop and plot choice. One of the most important plot characteristics is how the farmer controls water to his or her crops. Table 1 shows the different water control systems used by farmers in northern Mali and how the agricultural sector has shifted towards irrigated agriculture since 1997[6]. These data come from a subsample of 10 villages and approximately 245 households in the *cercle* of Niafunké.

Table 1: Utilization of Different Agricultural Production Systems[7]
(% of farmers who use the different systems)

	1997 - 1998	2005 – 2006
Irrigation	0.4%	30%
Lake	6.8%	18.50%
Rain-fed	35.0%	33%
Irrigation+Lake	0.0%	1%
Irrigation+Rain-fed	9.4%	10%
Lake+Rain-fed	41.9%	6%
Irrigation+Lake+ Rain-fed	6.4%	2%

Due to this fundamental shift in production systems, agricultural productivity has also increased. Table 2 illustrates that in productivity measured by production per hectare has increased by 3.8 tons in the past 8 years. This is surely in part due to the resettlement of the population after the civil conflict from 1990-1996, but is

[6] Description of the survey methodology is contained in Volume 1 of this report.
[7] The different agricultural systems are defined relative to the system that the farmer uses to water his plot. These include a strictly irrigated system, a lake system, rain-fed agriculture and combinations between these three.

also partly attributable to the change in agricultural technology available to households.

Table 2: Agricultural Production

	1997 – 1998			**2005 – 2006**			**Change**		
	Men	Women	Household	Men	Women	Household	Men	Women	Household
Surface Cultivated (ha)	2.0	0.2	2.2	1.1	0.1	1.2	-0.9	-0.1	-1.0
Total Production (kg)	112	3	115	806	24	830	693.7	-0.1	715.0
Production per Hectare (kg/ha)			201			4045			3844.1

Increases in agricultural production have been coupled with increases in consumption since 1997. Table 3 displays total consumption and consumption per capita statistics for the 10 villages subsample in the *cercle* of Niafunké[8]. Both total consumption and per capita consumption have greatly increased in the past eight years by 842 520 FCFA and 161 796 FCFA respectively.

Table 3: Consumption

	1998 (Value FCFA)	2006 (Value FCFA)	Change in Total Value (FCFA)	% Change
Total Household Consumption	467698	1310219	842520	180%
Consumption per Capita	87097	248893	161796	186%

Though there seems to be a correlation between irrigation and consumption, does irrigation explain these welfare differences over time and across households who have access to irrigation? To answer this question, we begin by looking at data from the 2006 round of the *Etude sur la Pauvreté et la Sécurité Alimentaire au Nord Mali 2006*. Table 4 illustrates the urban and rural breakdown of households included in the sample. The number of Programme Mali-Nord households compose about 11% of the sample. Reference to Volume 1 of this report describes the sampling procedure to create a sample representative of the population of northern Mali.

Table 4: Sample Decomposition

Urban Sub-sample	664
Rural Sub-sample	1504
Total Cross Section	2168
Programme Mali-Nord Households in Cross Section	243

We first note the productivity differences across the *cercles.* Niafunké and Diré have agricultural yields which near 2.5 tons per hectare. Tombouctou and

[8] Nominal consumption values have been adjusted with a Paasche price index based on cereal prices to account for price changes over the period. This allows for real, as opposed to nominal, comparisons between the two periods.

Goundam exhibit yields around 2 tons per hectare, while Rharous and Bourem have mean yields of 1.3 tons per hectare. There are a variety of reasons for these regional patterns. Soil quality decreases as the geographic location of the *cercle* moves north away from the inner Niger delta and into more arid areas. Poor soil quality decreases yields. In addition, project interventions are located primarily in the *cercle*s in the inner Niger delta, so these farmers have more technical assistance and better soil quality. Lastly, poverty is more extreme in the *cercles* of Rharous and Bourem which limits disposable agricultural investment capital and limits the markets available to farmers in which to sell their products.

Table 5.1: Mean Agricultural Production (Kg per Hectare) by Cercle

Niafunké	Goundam	Diré	Tombouctou	Rharous	Bourem
2504	1907	2538	1999	1374	1360

When we look at a subsample of the data composed only of Programme Mali-Nord households (Table 5), we find significant differences between the agricultural production of Programme Mali-Nord investments across *cercles*. Taking the data from Table 4 and Table 5, we find that the difference in agricultural production within the *cercle* between Programme Mali-Nord households and other households is approximately 2.1 tons in Niafunké, in Diré approximately 1.4 tons, and in Rharous .9 tons. Though the mean agricultural production between the two *cercles* of Niafunké and Diré are essentially the same, there is a larger increase in mean production in the *cercle* of Niafunké than in Diré within the subsample of Programme Mali-Nord households.

Table 5.2: Mean Agricultural Production in Programme Mali-Nord households across Cercles (Kg per hectare)

Niafunké	Diré	Rharous
4613	3944	2294

Table 6 presents data that confirms that at least one of the reasons that there are significant productivity differences is due to access to irrigation through the Programme Mali-Nord's investments. There is a difference in mean productivity between Programme Mali-Nord farmers and other farmers of almost 2.3 tons per hectare when we simply compare mean productivity statistics.

Table 6: Mean Production Differences between Programme Mali-Nord farmers and other farmers (Kg per Hectare)

Programme Mali-Nord	Other Farmers
4399	2071

To estimate the returns to irrigation and specifically the Programme Mali-Nord's interventions, we need to determine, controlling for other factors (soil quality, labor supply, fertilizer usage, etc.) how much of this difference in mean

productivity is due to access to irrigation. To answer this question, we estimate two agricultural production functions. The first production function measures the overall returns to irrigation on mean agricultural productivity of all farmers who use irrigation. The second production function estimates the returns to the Programme Mali-Nord's irrigation interventions on agricultural production. The results of these regressions are displayed in Appendix 1.

We find that access to irrigation increases mean agricultural production by approximately 2 tons per hectare. This result is statistically significant which indicates that the trend in the data is strong. Equally important in increasing mean agricultural production are the number of days the farmer spends in his field and fertilizer usage. For each additional day of labor supplied in the field, mean agricultural production increases by 3.7 kilograms per hectare. In comparison, a day of additional non family labor on the plot only increases mean production by 2.3 kilograms per hectare. For each additional 1 000 FCFA of fertilizer purchased, mean agricultural production increases by 4.8 kilograms per hectare.

When we estimate the agricultural production function focusing on the returns to the Programme Mali-Nord's beneficiaries, we find that these interventions yield higher returns with a 2.4 ton per hectare increase in mean productivity for the farmer. The returns to fertilizer usage are also more pronounced with a return of 7.6 kilograms per hectare per 1 000 FCFA used.

The last agricultural production function that we consider estimates the difference in returns from large-sized irrigation projects and smaller-sized irrigation projects. Table 7 summarizes the estimates of the returns to irrigation projects. We find an approximately fourfold difference between small and large irrigation projects with smaller irrigation projects contributing 2.8 additional tons to production per hectare, while larger irrigation projects contribute 0.7 additional tons of production per hectare.

Table 7: Returns to Irrigation (Kg per Hectare)

All Irrigation Projects	1987
Large Irrigation	716
Small Irrigation	2806

While there are significant increases in agricultural production tied to access to irrigation, do these increases in production lead to changes in increased consumption and poverty reduction? To answer these questions, we employ the statistical technique of propensity score matching to evaluate the impact of the Programme Mali-Nord on consumption per capita and poverty reduction. Table 8 presents the results of propensity score matching. Controlling for selection between program and non-program participants was critical in obtaining accurate assessments of the Programme Mali-Nord impact. This is because Programme Mali-Nord interventions are targeted in primarily rural areas where poverty is high and consumption per capita is low. After controlling for selection into a

Programme Mali-Nord irrigation project, we find that differences in per capita consumption that are attributable to the irrigation intervention are 47 778 FCFA. Each member is better off by approximately this amount because of access to irrigation.

Table 8: The Programme Mali-Nord Impact on Consumption per Capita and Poverty

Consumption per capita (FCFA)	47 778
Headcount Poverty Measure	-14.41%

In addition to increases in consumption per capita, there are also significant decreases in poverty. There is approximately 14.4% less poverty between the Programme Mali-Nord group and the control group that is explained by access to irrigation. With the results of the agricultural production functions, it is clear that the increases in agricultural production induced by irrigation are causing increases in consumption per capita and reductions in poverty.

To confirm these tendencies, we present evidence from the sub-sample of 10 villages outside of the intervention zone of the Programme Mali-Nord for which we have tracked 245 households since 1998. Using the technique of differencing, we estimate the percentage of changes in consumption since 1998 due to access to irrigation. These regressions results are reported in Appendix 1. Households that have access to irrigation have had increases in real total consumption of 340 725 FCFA. Considering the total change in real total consumption since 1998, approximately 40% of the change in consumption is attributable to access to irrigation. This confirms the tendencies found in the data using the methodology of propensity score matching.

1.6 Conclusions

The Programme Mali-Nord has invested in northern Mali through irrigation projects since 1995. These investments have provided a significant increase in the welfare of households who have had access to these interventions in terms of increased agricultural production and consumption per capita, as well as reductions in the numbers of households who fall below the poverty line. The estimates presented in this report have attempted to control for additional influences on mean agricultural production and household per capita consumption, so that the estimates of the Programme Mali-Nord's effect on its beneficiaries can be precisely measured. Our estimates also indicate that there are significant differences between small and large-scale irrigation interventions. Small scale irrigation projects provide households in northern Mali with access to an agricultural technology that not only significantly increases production per hectare, but increases consumption per capita reducing poverty.

1.7 Technical Appendix: Regression Results

Agricultural production functions

agprod_men	Coef.	Std.	T	P>|t|	95% Conf.	Interval		
Irrigation	1987.646	92.42396	21.51	0	1806.391	2168.9		
Fpivv	0.005693	0.001227	4.64	0	0.003288	0.008099		
Fov	0.000252	0.010942	0.02	0.982	-0.02121	0.02171		
Pestv	-0.01317	0.061443	-0.21	0.83	-0.13366	0.107331		
Engv	0.004838	0.001214	3.99	0	0.002457	0.007219	Number of observations	2071
htravh1	3.717912	0.519378	7.16	0	2.699351	4.736473	F =	67.55
Ftravh1	-1.83521	0.969342	-1.89	0.058	-3.7362	0.065784		
etravh1	-0.06266	0.802639	-0.08	0.938	-1.63673	1.511408	R-squared	.2826
auttravh1	2.289014	1.227392	1.86	0.062	-0.11805	4.696074		
Exph1	0.90252	0.317338	2.84	0.004	0.280184	1.524857		
attpredh1	-0.69141	1.208086	-0.57	0.567	-3.06061	1.677785		
Ferth1	26.06866	53.41625	0.49	0.626	-78.6869	130.8242		
_cons	433.801	97.73915	4.44	0	242.1231	625.479		

agprod_men	Coef.	Std.	Err.	t	P>|t|	95% Conf.	Interval	
Programme Mali-Nord	2448.238	131.0096	18.69	0	2191.313	2705.163		
Fpivv	0.00613	0.001255	4.88	0	0.003669	0.008592		
Fov	0.003278	0.011192	0.29	0.77	-0.01867	0.025227	Observations =	2071
Pestv	-0.07292	0.062711	-1.16	0.245	-0.1959	0.050064	F =	56.8
Engv	0.007562	0.001221	6.19	0	0.005168	0.009956	R-squared	0.2444
htravh1	3.472816	0.531051	6.54	0	2.431363	4.514268		
ftravh1	-0.84451	0.991786	-0.85	0.395	-2.78952	1.100495		
etravh1	-0.0892	0.821638	-0.11	0.914	-1.70053	1.522129		
auttravh1	6.17073	1.255267	4.92	0	3.709005	8.632456		
Exph1	0.697497	0.325292	2.14	0.032	0.059562	1.335433		
attpredh1	-1.06923	1.235893	-0.87	0.387	-3.49296	1.3545		
Ferth1	-46.175	54.32175	-0.85	0.395	-152.706	60.35628		
_cons	785.2053	95.84787	8.19	0	597.2364	973.1742		

Agricultural production functions continued

Source	SS	Df	MS	Number of obs =	2071	
Model	2.24E+09	13	172279662	Prob > F	0	
Residual	6.96E+09	2057	3381599.74	R-squared	0.2436	
Total	9.20E+09	2070	4442312.21	Root MSE	1838.9	
agprod_men	Coef.	Std.	t	P>|t|	[95%	Conf.
Small	2806.138	155.3036	18.07	0	2501.57	3110.707
Big	715.678	169.0517	4.23	0	384.1477	1047.208
Fpivv	0.0052532	0.0012707	4.13	0	0.002761	0.0077452
Fov	-0.0017855	0.0112528	-0.16	0.874	-0.02385	0.0202824
Pestv	-0.0743093	0.063001	-1.18	0.238	-0.19786	0.0492431
Engv	0.0076189	0.0012279	6.2	0	0.005211	0.0100269
htravh1	3.51696	0.5333179	6.59	0	2.471061	4.562859
ftravh1	0.2890745	0.9989327	0.29	0.772	-1.66995	2.248099
etravh1	-0.438661	0.826337	-0.53	0.596	-2.05921	1.181883
auttravh1	6.06286	1.260363	4.81	0	3.59114	8.534581
exph1	0.5666004	0.3274338	1.73	0.084	-0.07554	1.208737
attpredh1	-1.225179	1.24076	-0.99	0.324	-3.65846	1.208098
ferth1	-40.65585	54.63717	-0.74	0.457	-147.806	66.49409
_cons	769.9739	97.46175	7.9	0	578.8399	961.1079

Matching

First Stage Results: Estimating the propensity score

				obs	2005			
				R2	0.1286			
Programme Mali-Nord		Coef.	Std.	z	P>|z|	[95%	Conf.	Interval]
Consag		7.34E-08	2.78E-08	2.64	0.008	1.89E-08	1.28E-07	
Hhsize		0.0171	0.009431	1.81	0.07	-0.00138	0.035584	
Niaf		4.529789	0.149988	30.2	0	4.235819	4.82376	
Goun		3.532759	0.204265	17.29	0	3.132407	3.93311	
Diré		3.928009	0.193818	20.27	0	3.548133	4.307885	
Rhar		4.335311	0.197441	21.96	0	3.948333	4.722289	
Songrai		0.651632	0.105403	6.18	0	0.445047	0.858217	
Tamasheq		0.710796	0.162627	4.37	0	0.392053	1.02954	
Peulh		0.479791	0.130133	3.69	0	0.224735	0.734848	
Bozo		0.533973	0.318057	1.68	0.093	-0.08941	1.157353	
Bambara		-0.05187	0.183005	-0.28	0.777	-0.41056	0.306811	
Agehh		-0.00355	0.002294	-1.55	0.122	-0.00804	0.00095	
rural_urban		-1.2865	0.157486	-8.17	0	-1.59517	-0.97784	
_cons		-5.60357	.	.	.	.	.	

Second Stage Results:
Impact of Program Participation on Household Consumption per Capita

						Observations	871	
						F	22.61	
						R-squared	0.0495	
consagperc~a		Coef.	Std.	t	P>|t|	[95%	Conf.	Interval]
Programme Mali-Nord		47778.06	21969.27	2.17	0.03	4658.969	90897.16	
propscore		-298039	44332.5	-6.72	0	-385050	-211027	
_cons		38440.32	30023.81	1.28	0.201	-20487.4	97368.08	

Impact of Program Participation on the Headcount Poverty Measure

						Observations	871	
						F	20.57	
						R-squared	0.0453	
headcount06		Coef.	Std.	t	P>|t|	[95%	Conf.	Interval]
Programme Mali-Nord		-0.14406	0.037052	-3.89	0	-0.21678	-0.07134	
propscore		0.451235	0.074769	6.04	0	0.304487	0.597983	
_cons		0.980635	0.050636	19.37	0	0.881251	1.080019	

Differencing

Impact of Access to Irrigation on Changes in Consumption between 1998 and 2006

Ch Consommation	Coef.	Std.	t	P>|t|	[95% Conf.	Interval]
ChMigRemit	1.291717	0.495695	2.61	0.01	0.315055	2.268378
chMembresMénage	29971.93	20523.29	1.46	0.146	-10464.8	70408.69
ChRevHom	1.296843	0.701786	1.85	0.066	-0.08588	2.679562
ChRevFem	4.4246	1.196912	3.7	0	2.066341	6.782859
ChIrrigation	340725	162670.9	2.09	0.037	20216.69	661233.3
_cons	806761.6	79536.49	10.14	0	650051.9	963471.3
	N	237				
	F	8.7				
	R2	0.158				

2. Methodology and Descriptive Statistics

2.1 Introduction

The *Etude sur la Pauvreté et la Sécurité Alimentaire au Nord Mali 2006* is an economic survey designed to improve understanding of the development challenges facing households in northern Mali. A representative household survey of 2 658 households was undertaken from February 2006 to October 2006 in seven *cercles*[9] in the regions of Tombouctou, Gao and Kidal. Of the 2 658 households in the sample, 245 households in the *commune* of Soboundou, Niafunké that were originally surveyed in a similar study conducted in 1997-98, were resurveyed twice in 2006. These households were resurveyed in Feburary/March and August/September to correspond with the periods under which the 1997-98 survey was undertaken. In this sense, there is both a panel (repeated observation) and a cross section (single observation) component of the data set. Panel data enables analysis of economic changes over time because the same households are followed over time. Analysis of poverty dynamics, the evolution of agricultural production and food security between 1997 and 2006 are possible with these data. The cross section component allows for regional comparisons to be made concerning poverty and household welfare. Both types of data permit the evaluation of development interventions on poverty reduction.

The primary funders of this research project had similar, but specific objectives in financing this study. The Projet de Développement Zone Lacustre - Phase II (FIDA) was primarily interested in the evaluation of its irrigation and health interventions which it has undertaken in the region of Tombouctou from 1996 to 2006. The Programme Mali-Nord (GTZ/KfW) was interested in the impact of its irrigation investments on poverty reduction, as well as a better understanding of the differences between large and small scale agricultural investments. In addition to understanding the returns to irrigation, the *Strategies and Analysis for Growth and Access* (SAGA) program and the Einaudi Center at Cornell University supported the research to examine the evolution and importance of human capital formation including health, education and child labor in northern Mali in relation to agricultural risk.

This report has two primary objectives. The first objective is to adequately describe the survey methodology and the program of research undertaken. Section II of this report describes the survey objectives, survey area, the survey design and sample selection, as well as the survey implementation. The second objective is to outline some of the basic findings and descriptive statistics that the survey has produced. This will provide a platform on which other analyses can

[9] Administratively, Mali is divided into eight regions that are composed of several cercles each. A cercle contains multiple communes. The cercle is analogous to a state or province, while the commune is analogous to a county or district.

build. Sections III-V provide basic analysis of household demographics, consumption, income and livelihood activities, agricultural production and poverty analysis. Volume 2 of this report undertakes a rigorous impact evaluation of the program interventions of the specific funding institutions.

2.2 Methodology

This economic household survey is designed to measure household consumption, production and revenue generating activities using the theoretical model of the household formalized by Singh et al. (1986). This model has been implemented in household surveys throughout the 1980's and 1990's through initiatives such as the World Bank's Living Standards Measurement Surveys and multiple other initiatives by international organizations and research economists[10]. More practically this survey builds on an economic household survey conducted in 1997-98 which was a collaboration among the International Food Policy Research Institute (IFPRI), the International Fund for Agricultural Development (IFAD), the United States Agency for International Development (USAID) and Cornell University to develop food security indicators[11].

Survey Objectives

The primary goal of this research program is to establish a representative economic survey of households to investigate poverty and food security in northern Mali. This data set will have multiple uses enabling a comprehensive understanding of the economics of households in northern Mali, the economic mechanisms through which project interventions work to improve household welfare, and an understanding of poverty dynamics and economic development since 1997. To achieve these goals, specific objectives include the following:

1. Measure poverty using expenditure information on household consumption, assets including livestock, migrant remittances, and agricultural production.

2. Measure poverty across multiple dimensions including children's health and education.

[10] Grosh and Glewwe (2000) provide a summary of some of this work as well as an extensive development of questionnaire modules that have been developed.

[11] These data, originally collected by Luc Christiaensen with support from John Hoddinott have been made available by the International Food Policy Research Institute. Funding for data collection was provided by the International Fund for Agricultural Development (TA Grant No. 301-IFPRI) and USAID/Mali (TA Grant No. 301-IFPRI). Neither IFAD nor USAID are responsible for any errors in these data or in their interpretation. These data could not have been collected without the substantial assistance of Sidi Guindo, Abdourhamane Maiga and Mamadou Nadio, and the helpful cooperation of the residents of the Zone Lacustre.

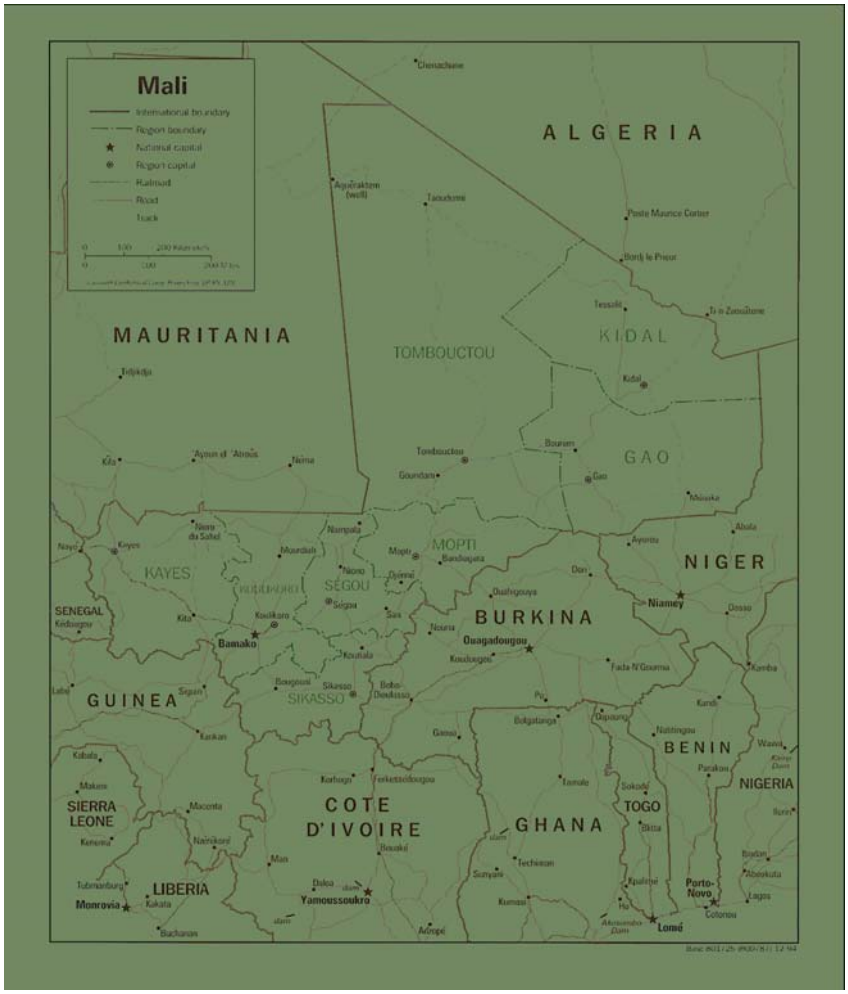
3. Decompose poverty measures across livelihood systems, ethnicity, gender, age, proximity to water, and exposure to previous natural shocks.

4. Investigate community needs, retrospective histories on regional conflict and perceptions of poverty.

5. Maximize opportunities for informal exchanges and dialogues with villagers about regional poverty.

Survey Area Description

The survey area of the *Etude sur la Pauvreté et la Sécurité Alimentaire au Nord Mali 2006* is composed of 3 regions (Tombouctou, Gao, Kidal) from which 151 villages, nomadic *fractions* or towns in 7 *cercles* (Niafunké, Goundam, Diré, Tombouctou, Rharous, Bourem and Kidal) were randomly selected to participate in the study. Northern Mali has an estimated population of 809,111 people that live in an area bordered to the north by the Sahara Desert (Cartographie du Mali 2001). The Saharan zone (desert or arid region) receives less than 150 mm of rainfall par annum. This varies starkly with the Sahelien zone (grassland or semi-arid region) which receives 200-600 mm par annum and the south of Mali which can receive between 600-1200 mm par annum (FIDA 1996). The dominant ecological resource in the region is the Niger River that serves as a source of water for agriculture and animal husbandry. The inner Niger Delta is a rich agricultural resource in which flooding from the Niger augments water levels in temporary and permanent lakes and ponds, as well as smaller streams and tributaries. This diversity of water resources is harnessed by farmers through motorized pump irrigation, water-recession agriculture around the lakes and streams and in the Niger River itself. Rain-fed agriculture which does not depend on the water levels of the Niger River is also extensively practiced. Herders benefit greatly from the temporary and permanent lakes which provide water and pasture land for cattle and sheep. Fishing is also an important economic activity which capitalizes on the Niger River and its tributaries to supplement the income and diets of households along its banks.



Source: Public Domain

The population in northern Mali is highly clustered around water sources, but sparsely distributed over the actual land mass that is northern Mali. Population density is increasingly concentrated around these water resources, so that regional population density statistics may be deceptive indicators of natural resource pressure from the population. Statistics for northern Mali indicate 1.5 people per km^2, while in the south of Mali, the density reaches 17 people per km^2 (FIDA 1996). In 1998, the administrative population for the regions of Kidal, Gao and Tombouctou were 27 521, 335 976, 445 614, respectively (Cartographie du Mali 2001).

The population of northern Mali is ethnically diverse. Sedentary ethnic groups that primarily practice agriculture include the Songray, Bambara, and the Soninkés. The Peulh, Tamasheq, Berabich and Maures are traditionally transhumant pastoralists, though increasingly are becoming sedentarized, especially in the region of Tombouctou. Lastly, the Sorko, Korongoy, and Bozo derive their livelihood from fishing and transport activities along the Niger River.

Poverty is a widespread phenomenon in Mali in general, but specifically in the rural regions of northern Mali. The region has known several significant economic shocks including widespread drought and famine in 1914, 1973 and 1984, as well as a civil conflict which destabilized the region from 1990-1996. The Government of Mali's *Poverty Reduction Strategy Paper 2002* reports a national poverty rate of 63.8% with severe poverty in the country at the 21% level. Indicators from the *Rapport National 2003 sur le développement humain durable au Mali* (RNDH 2003) illustrate at the commune level the entrenchment of rural poverty in the north as compared to other regions of Mali.

Table 1.1 decomposes poverty according to quantiles in urban and rural communes across the eight regions of Mali and the capital, Bamako. Communes were classified as rich or poor and then aggregated across regions. The rural entrenchment of poverty at the commune level in the regions of Kidal, Gao, and Tombouctou are often twice those found in Mali's other regions with poverty rates of 67%, 40%, 48% for the three regions.

Figure 1.1: Regional Poverty. Statistics from the RNDH 2003

	Q1		Q2		Q3		Q4		Q5	
	N	%cumulé	N	%cumulé	N	%cumulé	N	%cumulé	N	%cumulé
Kayes	16	12%	29	35%	24	53%	25	73%	35	100%
❑ Urbain	1	5%	6	35%	1	40%	1	45%	11	100%
❑ Rural	15	14%	23	35%	23	56%	24	78%	24	100%
Koulikoro	4	4%	18	20%	17	36%	22	56%	47	100%
❑ Urbain		0%		0%	3	18%	1	24%	13	100%
❑ Rural	4	4%	18	24%	14	40%	21	63%	34	100%
Sikasso	26	18%	28	37%	31	58%	24	74%	38	100%
❑ Urbain		0%		0%	1	7%	1	13%	13	100%
❑ Rural	26	20%	28	41%	30	64%	23	81%	25	100%
Ségou	22	19%	22	37%	28	61%	17	75%	29	100%
❑ Urbain		0%		0%		0%	1	8%	11	100%
❑ Rural	22	21%	22	42%	28	68%	16	83%	18	100%
Mopti	20	19%	18	35%	21	55%	24	77%	25	100%
❑ Urbain		0%		0%	2	15%		15%	11	100%
❑ Rural	20	21%	18	40%	19	60%	24	85%	14	100%
Tombouctou	22	42%	9	60%	4	67%	8	83%	9	100%
❑ Urbain		0%		0%		0%	1	17%	5	100%
❑ Rural	22	48%	9	67%	4	76%	7	91%	4	100%
Gao	8	35%	2	43%	2	52%	6	78%	5	100%
❑ Urbain		0%		0%		0%		0%	3	100%
❑ Rural	8	40%	2	50%	2	60%	6	90%	2	100%
Kidal	5	50%	2	70%	1	80%	2	100%		100%
❑ Urbain	1	25%	1	50%		50%	2	100%		100%
❑ Rural	4	67%	1	83%	1	100%		100%		100%
Bamako	0	0%	0	0%	0	0%	0	0%	6	100%
❑ Urbain		0%		0%		0%		0%	6	100%
❑ Rural		0%		0%		0%		0%	0	100%
Pays	123	18%	128	36%	128	54%	128	72%	194	100%
❑ Urbain	2	2%	7	9%	7	17%	7	24%	73	100%
❑ Rural	121	20%	121	40%	121	60%	121	80%	121	100%

Source: RNDH 2003

Human capital indicators for the regions of Tombouctou, Gao and Kidal also illustrate the lack of public infrastructure in the education and health sectors. According to the *Rapport National 2003 sur le développement humain durable au Mali*, 33 % of communes in Tombouctou, 30% in Kidal and 35% of communes in Gao had no access to primary schools in 1998, whereas the percentages for the regions of Kayes (13%) , Koulikoro (1%), Sikasso (6%), Ségou (4%), and Mopti

(7%) were significantly lower indicating better access to primary schools. The population also had little access to health services through community health centers (CSCOMs) in 1998. 94% of communes in Tombouctou, 100% of the communes in Kidal and 91% of the communes of Gao had no access to these community health centers. This compares to the regions of Kayes (73%), Koulikoro (59%), Sikasso (74%), Ségou (73%) and Mopti (78%) who also had poor, but slightly lower rates of inaccessibility to CSCOMs by commune.

In addition to differences between the north and south of Mali, there are significant differences between the *cercles* included in the survey.

Niafunké (Region of Tombouctou)

The *cercle* of Niafunké is the westernmost *cercle* in the region of Tombouctou. It borders the regions of Segou to the west and Mopti to its south. Its three major towns (Niafunké, Léré, and Attara) and smaller villages are scattered around the Niger River and various lakes and streams. Four broad systems of cultivation are practiced in this area which rely on diverse water sources. These include motor pump irrigation (rice), lake recession agriculture (sorghum, corn), rain-fed agriculture (millet), and stream based agriculture (sorghum). The area of lakes concentrated around Niafunké, often called Zone Lacustre, provides residents arable land for cultivation, but also a rich zone for pastoralists. The *cercle* of Niafunké has a high concentration of population relative to the other *cercles* mainly because the water resources of the inner Niger delta supports multiple livelihood systems and diverse economic activities.

Goundam (Region of Tombouctou)

During the colonial period, the *cercle* of Goundam was a cultural and economic center of importance in northern Mali. However, the majority of Goundam's villages lack access to the Niger River and the complete drying up of Lake Faguibine has caused serious constraints on the *cercle's* agricultural potential. Lake agriculture around the lakes Fati, Horo, and Tele are the primary sources of agricultural production which due to their size permit several crop cycles throughout the year. Pastoralists benefit from the pasture land that is enriched by the major lakes in the *cercle* and seasonal rains. Agricultural villages around Lake Horo, like Guinda Gatta and Echelle, attracted economic and social refugees from Lake Faguibine and other villages affected by the civil conflict in the early 1990s. In addition to agriculture and herding, the town of Tonka has emerged as an important commercial center which is situated strategically between Goundam, Niafunké, and Diré.

Diré (Region of Tombouctou)

The *cercle* of Diré is bordered by Goundam and Tomboctou to its north, Rharous to its east and Niafunké to its west. Diré, like Niafunké, is a *cercle* with incredible agricultural potential since the Niger River and its tributaries extend throughout the communes in the *cercle* when the river levels increase, usually in July/August. Agriculture, fishing and pastoralism are the primary economic activities. Agricultural production is focused on irrigated or floating rice, but wheat has emerged as an important counter season crop. The city of Diré is a vital commercial center and an important stop for interfluvial commerce.

Tombouctou (Region of Tombouctou)

The city of Tombouctou serves as the regional administrative and commercial center in the *cercle* of Tombouctou. Most government and non-governmental activity in the region is based in this city, as well as the region's most extensive selection of schools and medical facilities. Extensive commercial activity from trans-Saharian trade as well as a thriving tourist industry augments the traditional agricultural and pastorialist livelihood systems. Large irrigation projects just outside of the town of Tombouctou illustrate the region's rice production potential. However, outside the city of Tombouctou and away from the Niger, the landscape quickly becomes dry and uncultivable. These areas are comprised of transhumant pastorialists in various stages of sedentarization. Access to water remains a serious issue for these communities.

Rharous (Region of Tombouctou)

Rharous is a *cercle* that borders the regions of Tombouctou to its west and the *cercle* of Bourem to its east. It extends south all the way to the Burkina Faso border and finds its limit to the north by the region of Kidal. Primarily a zone of transhumant pastoralism, agriculture is practiced along and in the Niger River as well as several temporary lakes. Access is limited by sand dunes along the river front, so options for linking potentially cultivable land to the river for irrigation purposes are limited. Rharous, relative to other *cercles* in Tombouctou, lacks public infrastructure. Lack of electricity, potable water and passable roads are the *cercle*'s largest problems. Only since September 2006 did portable phone service ease the demand and high cost of telephone communication.

Bourem (Region of Gao)

The *cercle* of Bourem in the region of Gao is primarily an arid zone that borders the region of Kidal to its north. It is here that the Niger river reaches its

northernmost point before descending through Gao and out of Mali into Niger and Nigeria. Bourem shares many of the same problems as Rharous. Lack of electricity and passable roads are serious barriers to its development. Agricultural potential is limited by massive sand dunes that line the Niger River on either side of the river's path. The primary agricultural activities in the region focus on floating rice that is planted along the banks of the river. However, the recent proposal of a hydro-electric dam in the *cercle* may increase the region's agricultural potential and supply of electricity, as well as facilitate the construction of roads that will be needed to access the site for the dam. Seasonal male migration towards Ghana remains a survival strategy which significantly increased as a response to the droughts of the 1970s and 1980s as well as the civil conflict in 1990s.

Kidal (Region of Kidal)

The *cercle* of Kidal borders the regions of Gao to the south, Tombouctou to the west and Algeria to its north. Most of its land lies in the heart of the Sahara desert. Agriculture is very difficult in this region and is found only where gardening projects and wells have been created. Because of these environmental difficulties and a perceived lack of economic development, discontent in Kidal has become a national issue. In addition to being seriously affected by the civil conflict in the 1990s, attacks against government military positions in May 2006 resulted in another negotiated peace settlement, the Accords d'Alger, that complement the Pacte National which was signed in 1992. Currently, there is no armed conflict, but stability depends on the implementation of the signed agreements. Otherwise, Kidal is an area of trans-Saharan commerce primarily between Algeria and Gao, as well as other trade routes that traverse the desert from the west to east. The opening of a bridge in the city of Gao in September 2006 may increase trans-Saharan trade through Kidal from North Africa.

Survey Design and Sample Selection

The survey is designed as a representative two stage cluster sample of households in the *cercles* of Niafunké, Goundam, Diré, Tombouctou, Rharous, Bourem and Kidal. Villages, in the rural strata, or quartiers in the urban strata (the clusters) of the sample were randomly selected in the first stage and their population fully enumerated based on households actually residing in the village or quartier during the period of enumeration. The second stage used the lists generated from the first stage to randomly select a list of households to be interviewed[12]. This sample design is commonly used in household surveys and is fully described in Deaton (1997).

[12] See Appendix 2 for a list of communes included in the study and Appendix 3 for a decomposition of the sample.

In addition to producing a large data set of households across northern Mali, a second objective of the study was to follow up with households originally surveyed in 1997-98 by IFAD, IFPRI, Cornell University and USAID/Mali. The objective of that survey was to understand and develop food security indicators for IFAD by implementing a four round household survey in 10 villages of the commune of Soboundou in the Niafunké *cercle*. Christiaensen (1998) provides a full description of the sample design and selection of households from the 1997-98 data. By resurveying these 245 households found in 2006 from the 1997-98 survey, a better understanding of regional change and poverty dynamics is possible. Information regarding sample attrition and the feasibility study undertaken to conduct this resurvey project is found in Dillon (2005)[13].

The data set is composed of a village questionnaire and a household questionnaire. The village questionnaire was administered to village leaders in each village or town concerned by the study. The household questionnaire is decomposed into men's, women's and children's sections and was addressed to the head of household, the head of household's wife and children.

To ensure the representativity of the sample, sample weights are included in the data set to account for the different selection probabilities between urban and rural stratas. Following common practice, urban residents have a higher selection probability than rural residents[14], so to equalize their respective weights when conducting analysis, sample weights should be used. Additionally, incorporating resurveyed households in 2006 from the 1997-98 survey posed a technical challenge. It was necessary to account for population changes between the two surveys and the selection probabilities for the 2006 sample so that the appropriate weights could be assigned to the resurvey households. These weights are reported in the data set to facilitate data analysis.

Survey Implementation

The survey was conducted from February 2006 to October 2006 across northern Mali. Coordination of all data collection activities were assured by the Coordinator, a Research Assistant and a Field Supervisor/Trainer. 28 survey enumerators administered the survey throughout the different *cercles* by working in two person teams. These survey enumerators participated in a training and field test before beginning their work. This enabled the screening of enumerators

[13] Because of the multiple objectives in the survey design and sample attrition from the 1997-98 households, sample weights should be used when conducting data analysis.

[14] In the urban stratas, 33% of quartiers were selected in the first stage selection with 8% of the population in the quartiers selected. In the rural stratas, 15% of the villages or fractions were selected in the first stage with 8% of the population of the villages or fractions selected. Two exceptions to this rule were the urban strata of Tombouctou which used a second stage selection probability of 4% due to the high concentration of its urban population and the rural strata of Niafunke which used a 15 % second stage selection probability to assure an adequate sample size with which to conduct program evaluation in the primary intervention zone of the funding institutions.

and the selection of the best possible candidates as well as providing an opportunity to field test the questionnaire before its implementation. Survey questionnaires consisted of a village level questionnaire, a men's questionnaire, a women's questionnaire and a children's questionnaire administered independently.

Survey teams first visited the selected villages to explain the survey's objectives and obtain oral consent from village leaders. Then the village population would be fully enumerated and the village questionnaire administered. The population lists were checked against official population statistics and for other anomalies before a random sample was selected from the lists. Teams would then re-visit the village to conduct the household level component of the survey. Every effort was made to ensure that population lists were accurate, but the temporary displacement or refusal of a household to participate in the survey were occasionally encountered by the study. Replacement households were interviewed when it was determined that it was not feasible to interview the originally selected household. These households are clearly marked in the data set, so that researchers can use their discretion about their inclusion in their analyses. Households that were unable to be interviewed were replaced by their nearest neighbor as signified by the next household on the interviewer's list. Of the 2675 households interviewed in the survey, 20 were replacement households. This constitutes a refusal or absentee rate of less than 1 %.

After teams finished the household component of the questionnaire, the household surveys were checked for consistency, quality and household omissions by the survey coordination. Data entry was then conducted by a team of six data entry personnel who worked throughout the year. Entered data was routinely checked for errors.

The survey encountered no insurmountable problems in the field. Regional politics did create a difficulties in survey implementation in the Kidal region. Because of attacks on the Government of Mali's military installations in Kidal in May 2006, a significant displacement of the population occurred before the survey could be conducted in the region. After waiting several months to evaluate the security of the area, the Field Supervisor conducted the survey in the town of Kidal, but implementing the survey in rural regions around Kidal was considered too dangerous after consul from regional leaders. Although there was no ongoing physical violence in the town of Kidal, the urban population often came into town only during the day to buy food and provisions before dispersing into the desert at night. The displacement of the local population and the influx of military and government leaders to Kidal biases the data that was collected in that region. The difficulty in accurately constructing a complete population list during population movements lends doubt to the statistical principle that the random sample taken from that list can be considered representative of the town. There is a high probability that richer residents were less likely to be interviewed at the time of the survey because they had the means to hide or leave the region.

Additionally, a portion of the Kidal population was not included in the list because they were rebel or military personnel stationed outside the town and inaccessible due to the security situation. The Kidal data is reported in this document for comparison purposes to other regions only. These data should not be used in undertaking inference as they are statistically biased for the above reasons, but may be useful for descriptive purposes.

Data Collected

The four questionnaires administered in the field collected information from men, women, and children on the household level, and from village leaders on the community level. One of the key issues that was extensively discussed during enumerator training was the definition of a household. Following FAO and World Bank definitions, we assumed the following working definition of a household:

A household is composed of members of a family who live together under the same roof, eat together in common, conduct common economic activities together, and mix their incomes for the mutual benefit of the other members of the household.

This definition of the household, as opposed to the family, has clear analogues in the Sonrai language as *cousou* and *hyinka*. Based on this definition, a wide range of variables were collected to analyze the household's agricultural production, income generating activities, herding, assets, education, health, and demographic composition. Questions concerning the household's composition, education, primary activities, migratory status of household members and history of positive and negative economic shocks were addressed to the head of household, usually a man. Questions concerning the household's food consumption, health and dietary diversity were addressed to women. Sections concerning possessions, non-food expenditures, agricultural production, herding activities, credit, and time allocation were addressed to both men and women. The children's questionnaire solicited the child's (aged 10-17) perspective on their work, schooling and leisure activities. Additionally, children 0-5 years old were weighed and measured to facilitate the analysis of child health. The essential modules and the methodology of conducting men's and women's questionnaires were retained from the 1997-98 survey, so that analysis between the two data sets would not be biased by questionnaire design. A full outline of the questionnaires is contained in Appendix One.

2.3 Household Statistics

12 608 persons compose the 2.668 households that participated in the *Etude sur la Pauvreté et la Sécurité Alimentaire au Nord Mali 2006*. A full decomposition of the sample is included in Appendix Two which includes the 151 village surveyed and the number of households surveyed in each village. Table 1.1 provides a summary of the decomposition of the sample. 31% of the households in the sample come from urban areas while 69% of the households are from rural areas.

Table 1.1

Urban Sample	664
Rural Sample	1749
Total Cross Section	2413
2nd Round 1997 HH Follow up	245
Total Sample Households	2658

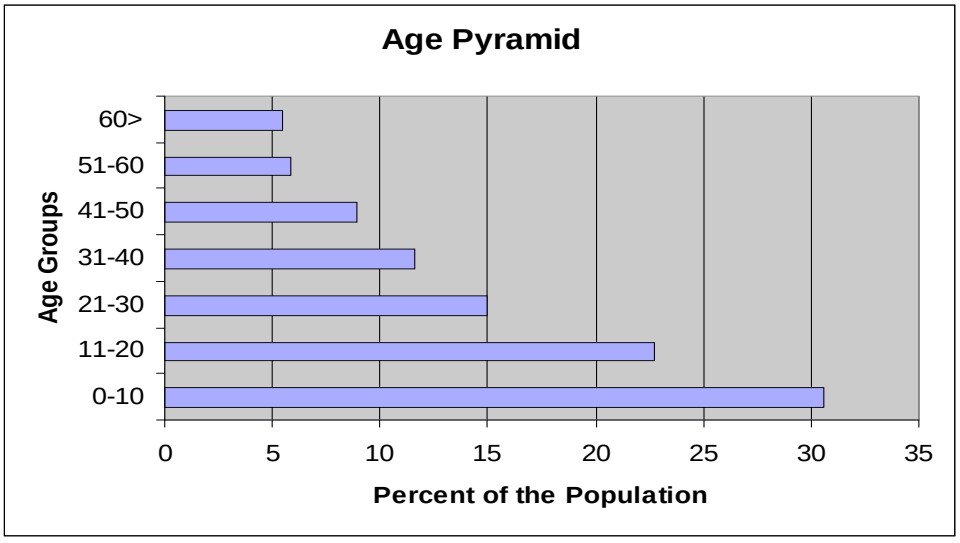
Men composed 50.55% of those surveyed, while women made up the other 49.45%. Statistics regarding household size and the age distribution of the population are presented in Table 1.2 and 1.3. The mean number of people in the households surveyed were 6.24 persons. There is a difference of almost .5 persons between urban and rural households.

Table 1.2 Mean Household Size

Total sample	Rural sample	Urban sample
6.24	6.44	5.94

The composition of the population is represented in the age pyramid reported in Table 1.3 which illustrates that the population is heavily weighted towards the young. This is consistent with high fertility and mortality rates that explain high percentages of young people in the population, but lower numbers of people in older generations.

Table 1.3



The migration of household members is a common strategy employed by households to spatially diversify risk and build networks to assure adequate resources for the household. Mean numbers of migrants associated with the household are reported in Table 1.4 along with migrant remittances decomposed for the full sample, the rural sector and the urban sectors. These data confirm that migration is predominantly a rural survival strategy. Rural households send one extra member on average to work than urban households. Migrants remitted an average of 28 480 FCFA in the three months prior to the survey interview. However, the amount of remittances to rural households is almost four times that for urban households.

Table 1.4

Mean Number of Migrants per Household			Mean Migrant Remittances (in FCFA)		
Full sample	Rural sub-sample	Urban sub-sample	Full Sample	Rural sub-sample	Urban sub-sample
0.79	1.25	0.14	28480	40042	11926

Table 1.5 displays the mean value of the household's durable assets in FCFA. The household's durable assets were solicited from both men and women. These assets include agricultural materials (hoes, *dabas*, donkey carts, etc.), household furniture (tables, chairs, televisions, etc.) and means of transport (*pirogue*, motorcycles, etc.). Men and women were asked to value their assets at their current resale value if sold at the time of the interview. Mean values of durable assets between men and women differ by almost 85 000 FCFA. These inequalities are less persistent in urban areas than they are in rural areas.

Table 1.5

Mean Value of Household's Durable Assets (FCFA)					
Full sample		Rural sub-sample		Urban sub-sample	
Men	Women	Men	Women	Men	Women
282710	198445	202600	128735	425728	358148

The household's expenditures on food and non-food items are described in tables 1.6 and 1.7. Women were asked to recount the household's food consumption expenditures over the previous seven days. Mean food weekly food expenditures were 18 671 FCFA with more than a 5 000 FCFA difference between urban and rural households. These figures roughly correspond to a daily expenditure of a little less than 3 000 FCFA per day.

Table 1.6

Household Weekly Food Expenditure (in FCFA)		
Full sample	Urban sub-sample	Rural sub-sample
18671	21686	16514

Non-food expenditure is reported from men's and women's interviews over the previous three month recall period. Mean non-food expenditures for men are 230 981 FCFA while women spent 93 078 FCFA. There are again substantial

differences between the urban and rural sectors in total non-food expenditures which are almost 40 % higher in urban than rural areas. Women assume much more responsibility in providing for family expenditures in rural areas than urban areas where the mean non-food expenditure for women in rural areas is actually higher than for women in urban areas. This may be because men account for approximately four times as many expenses in urban areas relative to rural areas, so that the distribution of expenses within the family changes according to the area.

Table 1.7

Mean Non-Food Expenditure (FCFA)					
Full sample		Rural sub-sample		Urban sub-sample	
Men	Women	Men	Women	Men	Women
230981	93078	112668	97891	450307	85701

The previous six tables briefly illustrate the important differences between urban and rural households in northern Mali across a variety of household statistics. The next section will describe how households finance these expenditures through agriculture, herding and non agricultural work.

2.4 Production and Livelihood Statistics

Agriculture, herding, and non-agricultural commercial activities (artisanal crafts, small business, manual labor, skilled trades, etc.) are three dominant production and livelihood systems in northern Mali. Households often engage at various points in the year in all three. This allows households to diversify against risk in any one sector as well as earn income throughout the year.

Agricultural production is a dominant primary activity for both urban and rural residents. The primary crops produced across northern Mali for commercial and auto-consumption are rice, sorghum and millet. Corn and wheat are of importance in certain *cercles* as are beans, onions and tomatoes. Various fruits and vegetables such as watermelons, okra, potatoes, and squash are also produced in gardens or on the periphery of irrigated fields.

Table 1.8 presents agricultural characteristics aggregated across the household's plots. The mean area cultivated by the household differs between the rural and urban sector with rural farmers cultivating approximately 150% more land than urban farmers. This may be because of few income generating options in rural areas. However, the productivity across rural and urban households is essentially equal with mean production (kg) per hectare equal to approximately two tons in both rural and urban sectors.

Table 1.8

Mean Household Area Cultivated (ha)			Mean Productivity (Kg per Hectare)		
Full sample	Rural sub-sample	Urban sub-sample	Full Sample	Rural sub-sample	Urban sub-sample
1.55	2.76	0.98	2071	2116	2049

Access to agricultural capital is a critical input into the production of the household's food needs. Men and women have differing access to agricultural capital. In general, this stark difference may be because women do not have access to their own plots, even though they contribute significant amounts of labor to their household's plots. Table 1.9 shows that rural men have higher actual amounts of agricultural capital than urban men. More hectares cultivated may be an important factor in explaining this difference. However, urban women have larger values of agricultural capital than rural women. This difference may be explained by the fact that community gardening projects targeted at women are primarily placed in urban areas.

Table 1.9

Mean Agricultural Capital (FCFA)					
Full sample		Rural sub-sample		Urban sub-sample	
Men	Women	Men	Women	Men	Women
59347	4403	61154	2651	56122	8417

Table 1.10 presents mean productivity (kg per hectare) decomposed by *cercle*. *Cercles* located along the river in the inner Niger delta (Niafunké and Diré) exhibit higher productivity yields than the other *cercles*. This may be because of inherent differences in soil quality between the *cercles*. Rharous and Bourem show the lowest productivity (approximately 1.3 tons per hectare) and in the most arid of the survey zone.

Table 1.10

Cercle Mean Productivity (Kg per Hectare)					
Niafunké	Goundam	Diré	Tombouctou	Rharous	Bourem
2504	1907	2538	1999	1374	1360

In addition to the importance of agricultural production as a livelihood system in northern Mali, pastoralism is a dominant primary or secondary activity of most households in northern Mali. As a primary livelihood system, pastorialists seek to live off their animal stocks to increase wealth and generate revenue. As a secondary activity for most households in northern Mali, owning animals serves as an important store of wealth in the absence of a well developed financial system. In our data women actually own more animals than men, but the value of these animals is considerably less than that of men's. This is primarily because women with fewer means own more chickens and goats, while men own cattle, sheep and goats. These trends are illustrated in Tables 1.11 and 1.12.

Table 1.11

Mean Herd Size					
Herd Size Full sample		Herd Size Rural sub-sample		Herd Size Urban sub-sample	
Men	Women	Men	Women	Men	Women
20	33	31	40	4	24

Table 1.12

Mean Herd Value (FCFA)					
Herd Value Full sample		Herd Value Rural sub-sample		Herd Value Urban sub-sample	
Men	Women	Men	Women	Men	Women
554366	179739	865787	249098	121399	74668

In addition to agriculture, households are engaged in various income generating activities outside of agriculture. These results are presented in Table 1.13. The net revenues of these activities were calculated from the survey data on gross revenues and expenses of the activity conducted in the previous month before the interview. Men gain consistently higher amounts of revenue across rural and urban sectors than women, but the differences in total net revenue gained between the sector is large. Men earn an mean net non-agricultural revenue of 107 143 FCFA while women earn only 31 372 FCFA.

Table 1.13

Mean Net Non Agricultural Revenue (FCFA)					
Full sample		Rural sub-sample		Urban sub-sample	
Men	Women	Men	Women	Men	Women
107143	31372	49631	20391	189298	47386

2.5 Poverty Analysis

Table 1.14 displays mean total consumption and consumption per capita the full sample, the rural sector and urban sector in northern Mali. Consumption aggregates were calculated to reflect the use value during the year of the household's possessions, its non-food expenditures and its food expenditures. Mean total consumption per household is 1 960 875 FCFA with a difference of almost 1 000 000 FCFA between urban and rural households. Mean consumption per capita statistics display similar differences between rural and urban sectors with a difference of almost 285 000 FCFA per person per household.

Table 1.14

Mean Consumption and Consumption per Capita (FCFA)					
Full sample		Rural sub-sample		Urban sub-sample	
Consumption	Consumption per capita	Consumption	Consumption per capita	Consumption	Consumption per capita
1960875	340318	1598450	272937	2513938	443141

Differences in total consumption are also distinct not only across rural and urban sectors, but also across the different *cercles* of the study. Tombouctou has the highest total consumption while Rharous has the lowest total consumption. Even though these two *cercles* border each other, these differences can be explained by the regional importance of the city of Tombouctou which serves as the region's commercial center and the isolation of Rharous as a *cercle* in which there is a significant lack of infrastructure and arable land.

Table 1.15

Cercle Mean Consumption Aggregates (FCFA)					
Niafunké	Goundam	Diré	Tombouctou	Rharous	Bourem
1619353	1982213	1829792	2527745	1280234	1467539

Headcount, poverty gap and severity measures are reported for the full sample, urban and rural sectors and across the *cercles*. Two poverty lines are used to measure poverty. The first poverty line is the government's poverty reduction monitoring body the *Cadre Stratégique de Lutte contre la Pauvreté* 2005 poverty line (CSLP 2005) based on the *Enquête Malienne d'Evaluation de la Pauvreté* 2001 poverty line adjusted for inflation and economic growth. The poverty statistics calculated with this poverty line of 153 310 FCFA are presented in Table 1.16. The second poverty line is based on a common international standard of 1 Euro per person per day to delineate extreme poverty. This poverty line represents a yearly per capita income of 365 Euros or 239 217 FCFA. The poverty statistics for this poverty line are reported in Table 1.17

Table 1.16

Poverty line--Government 2005 line (153310)			
	Headcount	Gap	Severity
Full Sample	0.1461393	0.0398883	0.0165348
Urban	0.0371275	0.0045527	0.0010896
Rural	0.2204332	0.0639703	0.027061
Niafunké	0.2194294	0.0637912	0.0270016
Goundam	0.0725057	0.0166719	0.0056012
Diré	0.0127989	0.0013497	0.0002203
Tombouctou	0.0345882	0.00343	0.0005986
Rharous	0.4246789	0.1232482	0.0486976
Bourem	0.1881142	0.0625688	0.029403

Table 1.17

Poverty line--1 Euro per day per person (239217 FCFA)			
	Headcount	Gap	Severity
Full Sample	0.388073	0.1203169	0.0533632
Urban	0.1814421	0.0381464	0.0119388
Rural	0.5288963	0.1763179	0.0815947
Niafunké	0.5264184	0.1755843	0.0812956
Goundam	0.3013419	0.0775588	0.0285207
Diré	0.0691143	0.0172196	0.0051482
Tombouctou	0.176592	0.0358085	0.0107052
Rharous	0.7802369	0.2926858	0.1455373
Bourem	0.5827813	0.177094	0.081305

There are significant differences between the poverty statistics presented using the two different poverty lines. The CSLP line generates a headcount poverty measure of approximately 15 % while the greater one Euro per day produces an estimate of poverty of almost 39%. The *cercles* of Rharous, Bourem and Niafunké are the poorest *cercles*, regardless of the poverty line used. Because of the high cost of living in northern Mali relative to the rest of the country, the higher one Euro per day poverty line might be a better reflection of the economic reality in the survey area. This second poverty line illustrates the persistent urban/rural economic differences. The urban poverty rate using the second poverty line is approximately 18% of the population while rural poverty rate is almost 53%. In addition, significant differences in the dispersion of poverty as measured by the poverty gap and severity measures exist between the urban and rural regions.

2.6 Conclusions

The objective of this report is to provide a description of the research methodology, sample design and a brief regional overview of the *Etude sur la Pauvreté et la Sécurité Alimentaire au Nord Mali 2006*. The study's objective is to provide detailed economic information on households in northern Mali and a better understanding of the poverty and food insecurity that face many of its residents. These summary statistics provide a general overview of differences between the *cercles* and the urban and rural sectors, so as to induce further discussion and analysis of these data.

Appendix 1: Questionnaire Organization

Community Characteristics

1. Meta-data
2. Health
3. Migration
4. School
5. Infrastructure
6. Agriculture
7. Physical and Demographic Characteristics

Household Questionnaires

Women's Questionnaires

1. Household Information
2. Possessions
3. Agricultural Exploitation
4. Herding
5. Non-Agricultural Revenue
6. Non-Food Expenditures
7. Credit/Savings
8. Food Consumption (together with HH Head)
9. Food Security Survival Strategies
10. Women's Time Allocation

Men's Questionnaires

1. Household Information
2. Household Composition (with female respondent)
3. Household Education
4. Household Activities
5. History of Household
6. Migration
7. Agricultural Exploitation
8. Herding
9. Fishing
11. Non-Agricultural Revenue
12. Non-Food Expenses
13. Credit/Savings
14. Men's Time Allocation
15. Economic Shocks

Children's Questionnaires

1. Child Work
2. Education
3. Child Health
4. Anthropometry

Appendix 2: Decomposition of the Sample

As described in the *Methodology* section of this report, a two stage representative sample was drawn to be representative of the population. This was implemented by first dividing the list of villages, towns, and fractions provided by the *Cartographie des infrastructures communales du Mali* into urban and rural subsectors based upon official population statistics. The *Cartographie des infrastructures communales du Mali* is a summary of data collected during the last governmental census of Mali in 2001. Cities and towns with populations of over 3000 people and distinct quartiers were considered urban. All other villages or fractions were considered rural. Using these lists a first stage random selection of quartiers in cities, villages or fractions were chosen. Then the population of households in these quartiers, villages or fractions were fully enumerated. Using this enumeration of households, a second stage random selection of households were chosen to be part of the sample. The cities, villages or fractions and the number of households selected from each are listed below. See footnote 6 for the different selection probabilities between the urban and rural sectors.

Urban

Name	Cercle	Commune	HH Selected
Tonka	Goundam	Tonka	158
Niafunké	Niafunké	Soboundou	100
Diré	Diré	Diré-ville	66
Tombouctou	Tombouctou	Tombouctou-ville	120
Bintagoungou	Goundam	Bintagoungou	23
M'Bouna	Goundam	M'Bouna	9
Goundam	Goundam	Goundam-ville	47
Gourma-Rharous	Gourma-Rharous	Rharous	13
Baria	Bourem	Bourem	20
Bourem Foghas	Bourem	Bourem	34
Kidal	Kidal	Kidal	13
Echell	Goundam	Tonka	34
Léré	Niafunké	Léré	27

Rural			
Name	Cercle	Commune	HH Selected
Morikoira	Diré	Arham	11
Babaga	Diré	Binga	4
Bangadria-Abba	Diré	Binga	2
Farabongo	Diré	Bourem Sidi Amar	18
Hara-Hara 1	Diré	Bourem Sidi Amar	4
Bara	Diré	Dangha	3
Koria	Diré	Dangha	3
Sakoïra	Diré	Dangha	5
Bingatane	Diré	Diré	3
Bani	Diré	Garbakoïra	4
Koïratao	Diré	Garbakoïra	5
Tofakoïra	Diré	Garbakoïra	3
Haïbongo	Diré	Haïbongo	12
Minessingué	Diré	Haïbongo	11
Dialoube	Diré	Kondi	4
Kondi	Diré	Kondi	19
Chirfiga	Diré	Sareyamou	13
Ciba Ouro Ali	Diré	Sareyamou	4
Gabongo Fadahit	Diré	Sareyamou	4
Koïto	Diré	Sareyamou	3
Sareyamou	Diré	Sareyamou	29
Tarfa	Diré	Tienkour	5
Tienkour	Diré	Tienkour	8
Alphahou Taraba	Goundam	Bintagoungou	5
Taxina	Goundam	Bintagoungou	3
Groupe Katoua	Goundam	Douékiré	11
Dangaye	Goundam	Douékiré	1
Ebagaou Beri	Goundam	Douékiré	3
Goussou Tjiré	Goundam	Douékiré	4
Kessou Bibi	Goundam	Douékiré	10
Niambourgou	Goundam	Douékiré	20
Essakane	Goundam	Essakane	4
Tinafaradji	Goundam	Essakane	5
Garbeye	Goundam	M'Bouna	3
Hangabera	Goundam	Hangabera	16
Atta	Goundam	Tonka	18
Guindi Gatta	Goundam	Tonka	34
Bancani-Camp	Goundam	Tonka	8
Debe-Yourmi	Goundam	Tonka	5
Karango	Goundam	Tonka	23
Kel-Haoussa	Goundam	Tonka	4
Saya	Goundam	Tonka	5
Tintafarak	Goundam	Tonka	2
Dag Hamzane	Tombouctou	Alafia	6
Hondoubomo Koïna	Tombouctou	Alafia	31

Name	Cercle	Commune	HH Selected
Iloa	Tombouctou	Alafia	16
Tassakane	Tombouctou	Alafia	14
Toya	Tombouctou	Alafia	17
Dag Bodel	Tombouctou	Alafia	2
Ber	Tombouctou	Ber	7
Kel Tafardest	Tombouctou	Ber	2
Idane	Tombouctou	Ber	2
Tinafewa	Tombouctou	Ber	6
Teherdje	Tombouctou	Ber	11
Houndoubomo Ababer	Tombouctou	Bourem-Inaly	12
Milala	Tombouctou	Bourem-Inaly	22
Kel Taborit	Tombouctou	Lafia	3
Gourzougueye	Gourma-Rharous	Banikane	14
Kel Anouchagrene	Gourma-Rharous	Banikane	2
Kiewa	Gourma-Rharous	Banikane	5
Kel Talatahit	Gourma-Rharous	Hamzakona	6
Cherifen Rhergo	Gourma-Rharous	Rharous	3
Djiri-Beragoungou	Gourma-Rharous	Rharous	7
Gaberi	Gourma-Rharous	Rharous	9
Salakoïra	Gourma-Rharous	Rharous	9
Goungouberi	Gourma-Rharous	Serere	7
Kano	Gourma-Rharous	Serere	10
Ouagaye-Sonraï	Bamba	Bourem	8
Bourem Djindo	Bourem	Bourem	46
Chabaria	Bourem	Bourem	40
Donghoï Bano	Bourem	Bourem	14
Karabassane	Bourem	Bourem	42
Kourmina	Bourem	Bourem	13
Abakoira Sonraï	Bourem	Bamba	6
Ahel Lawal	Bourem	Bamba	2
Bamba-Poste	Bourem	Bamba	5
Eguedech	Bourem	Bamba	7
Garbame-Sonraï	Bourem	Bamba	4
Tinafozo	Bourem	Bamba	4
Titilane	Bourem	Bamba	7
Bossolia	Bourem	Temera	12
Garaye Goungo	Bourem	Temera	16
Takamba	Bourem	Temera	14
Aldianabougou	Niafunké	Soboundou	15
Tomba	Niafunké	Soboundou	35
Mangourou	Niafunké	Soboundou	27
Gouaty	Niafunké	Soboundou	7
N'Goro	Niafunké	Soboundou	53
Tomi	Niafunké	Soboundou	12
Hamakoira	Niafunké	Soboundou	17
Goundam Touskel	Niafunké	Soboundou	12
Ouaki	Niafunké	Soboundou	45

Name	Cercle	Commune	HH Selected
Name	Cercle	Commune	HH Selected
Anguira	Niafunké	Soboundou	19
Ardiango	Niafunké	Banikane Narhawa	3
Ballal	Niafunké	Banikane Narhawa	6
Banikane	Niafunké	Banikane Narhawa	21
Debewel	Niafunké	Banikane Narhawa	3
Gounambougou	Niafunké	Banikane Narhawa	5
Guediou Gourma	Niafunké	Banikane Narhawa	7
Kondjibobo	Niafunké	Banikane Narhawa	8
Koyam	Niafunké	Banikane Narhawa	8
Madina	Niafunké	Banikane Narhawa	3
Toulal	Niafunké	Banikane Narhawa	1
Dari	Niafunké	Dianké	3
Dianké	Niafunké	Dianké	50
Dielimakan	Niafunké	Dianké	9
Boyo Ouro	Niafunké	Fittouga	6
Betou	Niafunké	Fittouga	3
Tounkararou	Niafunké	Fittouga	6
Sirfila	Niafunké	Fittouga	7
Dang	Niafunké	Fittouga	8
Salakoïra	Niafunké	Fittouga	4
Saraféré	Niafunké	Fittouga	38
Koumaïra	Niafunké	Koumaïra	17
Weldou	Niafunké	Koumaïra	8
Komogo	Niafunké	Koumaïra	9
Sandji	Niafunké	Koumaïra	8
Gagalati	Niafunké	Koumaïra	11
Soungalore	Niafunké	Koumaïra	7
Filanzan-Rimaibe	Niafunké	Koumaïra	5
Doumbou	Niafunké	Koumaïra	5
Kobe	Niafunké	Koumaïra	5
Niatie	Niafunké	Léré	8
N'Gorkou	Niafunké	N'Gorkou	24
Konkobougou	Niafunké	N'Gorkou	12
Toumpa	Niafunké	N'Gorkou	5
Djinango	Niafunké	N'Gorkou	6
Marsiré	Niafunké	N'Gorkou	6
Dara	Niafunké	N'Gorkou	6
Goye Ouro	Niafunké	N'Gorkou	4
Borou	Niafunké	N'Gorkou	5
Diabagui	Niafunké	N'Gorkou	6
Massatoumaré	Niafunké	N'Gorkou	2
Attara	Niafunké	Soumpi	34
Doua	Niafunké	Soumpi	13
Dofana	Niafunké	Soumpi	10
Soumpi	Niafunké	Soumpi	15
Kawantza	Niafunké	Soumpi	10

Appendix 3: Construction of the Consumption Aggregate

The consumption aggregate is composed of four main components of the men's and women's questionnaire: Possessions, Housing, Non-food expenditures and Food Expenditures. In equation form,

Consumption Aggregate = Men's Possessions*.20 +Women's Possessions*.20 + Women's Non-Food Expenditures*4 + Men's Non-Food Expenditures*4 + Food Expenditures*52

The standard practice for constructing consumption aggregates is reviewed concisely in Deaton and Zaidi (1998), as well as Deaton (1997), Ravallion (1994), and Grosh and Glewwe (2000).

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