Afrint II: Ghana

Draft Micro and Meso Study report

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Micro and Meso Study Report

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CHAPTER 1

BACKGROUND TO THE STUDY

1.1: Introduction

That the majority of Ghana's rural population rely on small-scale agriculture (less than 4 hectares) for their livelihoods has probably been overemphasised. How to get these households out of poverty has been at the centre of many research activities over the past decades. The fifth round of Ghana Living Standards Survey (GLSS5) suggests a significant decline in poverty — from 51.7% of the population living below the poverty line in 1992 to 28.5% in 2006. According to the UNDP, the figures suggest that goal 1 of the MDGs would be achieved by Ghana. There are however major concerns of food insecurity in many parts of the country, particularly the three northern regions with the most recent case being a result of floods in 2007. This calls for concerted effort, including micro-level research, to understand the scale and magnitude of the problems associated with food insecurity and other related issues such as changes in agricultural technology adoption and practices likely to impact the eradication of extreme hunger and poverty in some parts of Ghana. Longitudinal studies employing panel data is particularly useful for such purposes because it enables us to distinguish between 'the chronic poor and food insecure' and 'the transitory poor and food insecure'. Such studies are rare in the context of SSA and Ghana in particular. Most of the statistics available are from cross-sectional studies with the GLSS involving a survey of different households each round.

As part of the Afrint I project a survey of 416 households originally located in four districts in two administrative regions (the Eastern and Upper-East regions) was conducted in 2002 and focused mainly on four staple food crops (maize, cassava, rice and sorghum). The survey addressed a wide range of issues but was generally aimed at addressing the question as to whether there is the need for Ghana to learn from the Asian agricultural model (the Green Revolution) which was characterised by agricultural

intensification and if so how this could be achieved with any modifications if required. Given the role of the state in policy formulation and implementation, not only in the agricultural sector but also through other sectors which are linked directly and indirectly to the farm sector, the Afrint I Ghana study was conducted bearing in mind the SAP. In this vein retrospective questions were elicited to enable evaluation of policy on small holder production and welfare. These questions at the household survey level also made it possible to compare micro and macro level outcomes.

Results of the Afrint I survey showed a general increase in crop output and marketing during and after the SAP period. The farm economy also appeared to be more market-driven than state driven as the case was pre-SAP. The use of technology, albeit not advanced, appeared to have increased during and after the SAP period with the use of tractor and animal drawn implements for land preparation more common during these periods than before. Also, the use of improved and hybrid seeds had increased, particularly for maize with chemical fertiliser use experiencing a more than expected use in the sample than the macro data had indicated. It could be said from the Afrint I data that there has been increased agricultural intensification motivated by pressure on land and improved marketing channels but that substantial barriers to productivity still pertain. These constrains exist in the area of lack of credit for investment as well as making the requirements for intensification (adoption of modern technology and marketing) more accessible to more small holders.

With Afrint I serving as a baseline, an opportunity has arisen to investigate dipper some of the issues that emerged. Building up a panel would help deal with the long term observable changes in the small farm sector in a more comprehensive manner and allow the answering of questions relating to the relationships between agricultural development and the dynamics of farm intensification at the micro level over time and how this impacts upon food security and poverty. Undoubtedly, these issues would be better understood by studying the same households over a longer period (2002-2008). The micro study in 2008 therefore made a somewhat successful attempt at following households in the 2002 survey for the purposes outlined.

1.2: Research Questions and Objectives

Agricultural technology adoption has been the focus of many studies in Ghana (for example Opare 1980; Bakang 1998; Conley and Udry 2001; Doss and Morris 2001; Adeoti 2008). It is intuitive to hypothesis a bidirectional link between technology adoption and market participation. As recognised by Yilma *et al.* 2008, the relationship between markets and technology adoption can be quite complex. Hypothesizing a relationship between agricultural technology adoption, agricultural market participation (agricultural commercialization) and farm household welfare is not inexplicable. As important as this relationship could be there is paucity of empirical research to examine the dynamics of such a relationship and we are not aware of any study that has sought to understand such a relationship using long-term panel data in Ghana. At the household level it is difficult to distinguish between temporal and enduring changes in farm production, productivity and intensification by means of a single cross-section of data. Related to this is the challenge of identifying welfare changes and the drivers of such changes overtime. It is important to identify whether or not the observed changes are temporal or persist and what factors are responsible for such observed changes. The socio-economic and gender dimension is an aspect that was not mainstreamed in Afrint I but there is no overemphasizing the fact that such an exercise is important given the prominent role played particularly by women in the small scale staple crop sector in Ghana.

Given these issues it is important to explicitly ask questions such as: what precipitates changes in household and village level staple food crops farm productivity? Are farmers adopting new technologies? At what scale are new technologies being adopted if at all and for which crops and under what conditions? Are there significant observable changes in staple crop yields? Are these changes maintained over time? How erratic are these changes and what are the factors responsible for such instability if any? Are there significant observable changes in household welfare attributable to changes in technology adoption and productivity? Does the adoption of new technology lead to productivity at such a scale that enables households to escape poverty or is the change only temporal? Are there observable spill over effects of the above linkages to other sectors or the rural economy? And what are the implications for other socio-economic outcomes? It is thus generally important to examine the relationship between developments in the stable food crop sector in Ghana since Afrint I and how these have impacted food security and

poverty alleviation. With the aid of the available panel data it is possible to enhance our understanding of the driving forces behind the state of staple crop production in the small farm sector while investigating whether there have been any notable household welfare improvements as a result of changes in the sector. To answer the questions raised, the following specific objectives follow:

1) To understand the dynamics of staple food crop farm expansion or intensification based on available technology or the adoption of new ones; and to identify whether or not any observed changes are temporal or long-lasting.
2) To examine the relationship between, on the one hand, the nature (temporal or otherwise) of the changes in yields and technology adoption and the nature of the changes in household welfare.
3) To investigate the distributional effects of the above on gender and socio-economic outcomes, geography and household's agricultural production sector.

1.3: Method of Data Collection

The objective of building a household panel using the 2002 sample as a baseline meant that the households sampled in 2002 had to be traced and re-interviewed. Of course, there were the usual issues relating to building panels that needed to be addressed; dealing with the problem of attrition and selecting replacement households. Aside from these, there were attempts to correct some of the sampling challenges encountered during Afrint I. In November 2007 visits were made to all eight villages to access the chances of locating households sampled in 2002. This was even more critical given the 'convenient sampling' approach adopted in some of the villages during Afrint I which meant that specific household locations were not specified. This was because of the dispersed nature of the farming settlement in 7 of the 8 villages. All farmers were thus gathered at a central point and then a sample was drawn from the farmers present. In each of the eight villages the strategy was to contact the assembly man or an opinion leader in the community with whom we went through the sample list to find out whether they could identify the names on the household heads or farm managers. This was generally successful even though most of the names were wrongly spelt, particularly in the Upper East Region. A major challenge was identifying respondents of the villages named Winkongo in the Afrint I sample. None of the respondents on the Winkongo list could be identified. With the

assistance of the local people at Winkongo it tended out that the sample was actually taken from a village which is about 6 kilometres from Winkongo called Shia.

The Afrint II household survey and village level survey instruments were administered between 2nd January and 1st February 2008. Two groups of 5 research assistants were recruited and trained to administer the household survey instruments while the Afrint II Ghana team conducted the village level interviews with the assistance of the visiting Swedish team in the case of the Upper-East region village interviews. The team from Sweden also assisted in the training of the research assistants, which took place at the University of Ghana for the Eastern region team, and in Bolgatanga for the Upper East region team. Out of the 416 households interviewed during Afrint I, 358 (86%) were successfully contacted during the Afrint II survey. These were made up of 328 'original' Afrint I households and 30 descendants of Afrint I households.[1] Also, due to the potential bias that could have been introduced by the sample selection procedure during Afrint I the strategy was to draw a probability sample of 20 households from each village so as to enable same investigation of the nature and extent of bias that might have been introduced by the procedure adopted in 2002. In drawing the new sample priority was given to those parts of some villages that appeared to have been under represented during Afrint I. In all 161 new households were sampled and the distribution is shown in Table 1.1. Akatawia had 19 valid new samples because one of the questionnaires had to be dropped during data entry for incomplete information. On the other hand there were 21 new samples from Zenlerigu and Asitey instead of the 20 targeted. Thus in all a sample of 161 new households (including 10 immigrant households) were drawn. In addition to this, another 50 replacement households were drawn due to sample attrition – these households could not be traced. The attrition rate was particularly low for the villages in the Upper-East region. In Shia for example, all households were successfully traced; including two descendant households. In the other 3 villages – Gaane, Doba and Zanlerigu – only 7, 5 and 3 households, respectively, could not be located. It was relatively more problematic locating Afrint I households in the Eastern region, except for the case of Gyedi. The Gyedi case was peculiar because of its relatively small size and the

[1] Most of these households are made up of adult children of Afrint I households mostly living in the same dwelling but whose parents (head of households during Afrint I) had passed away.

fact that it is a settlement exclusively of a small religious group that is mainly engaged in farming. Here, only 3 households could not be traced because they had completely relocated. In the other villages the rate of attrition was quite high: 11 (25.6%), 8 (15.4%) and 13 (27.0%) for Akatawia, Asitey and Apaa, respectively.

Table 1.1: Sample of Afrint II households

Sample Category	Freq.	Percent
Re-interviewed Afrint I households	328	57.6
Descendents of Afrint I households	30	5.3
Replacement due to attrition	50	8.8
New sample (including 10 immigrant) households	161	28.3
Total	569	100.0

Source: Afrint II household survey, 2008

1.4: Structure of the Report

The descriptive analyses in this report are based on the implementation of two separate survey instruments employed to address the research issues raised. The instruments comprise of a meso (or village level) questionnaire and a micro (or household) questionnaires. The main objective of the village diagnostics questionnaire was to assess the state of agricultural intensification in the sampled villages and to get a good understanding of the issues that promote or limit the process. The approach adopted in this report is to combine the village level information with the household level data with the intention that the former would help explain some of the observations in the later. The report is presented in a logical manner following the structure of the questions in the household survey questionnaire where possible. The important ingredient is that where the variables permit we make comparisons with the 2002 data. The report is organized as follows: In chapter 2, an overview of the demographic and socio-economic characteristics of the sample villages as well as the state of agriculture and related activities are presented. In chapter 3 the report highlights the characteristics of households surveyed after which farm and crop management practices are examined. Included in this chapter are detailed descriptions of production, harvesting and disposal of the four main crops considered in the study – maize, cassava, rice and sorghum. Agricultural capital assets – natural capital (mainly land resources), human capital, and technology as well as the

institutional environment that facilitates or inhibits productivity of these assets are described in chapter 5. Finally, chapter 6 examines household and community economic welfare indicators as well as linkages between rural and urban areas in terms of staple crops and cash transfers.

CHAPTER 2

THE SURVEY VILLAGES AND FACTORS OF PRODUCTION

The report in this chapter is based on key informant and focused group interviews in the various villages. The respondents include village chiefs and elders, local government authorities, agricultural extension agents, and focused groups comprised of farmers and opinion leaders. The issues discussed cover a wide range of topics including the demography, infrastructure, land tenure, agricultural production and general socio-economic issues. These issues help in understanding the factors that hinder or promote agricultural intensification and commercialization at the village level as well as enable an assessment of any possible changes that might have occurred within the villages since the 2002.

2.1: Characteristics of the Villages in 2008

As mentioned in the first report in 2002 the 8 survey villages (Akatawia, Asitey, Gyedi, Apaa, Doba, Gaane, Zenlerigu and Shia) were located in 4 districts, namely Manya Krobo, Fanteakwa, Kassena-Nankana, and Bolgatanga districts. The first two districts are in the Eastern region whiles the later two can be found in the Upper-East region. Some of these designations have however changed due to the re-demarcation or creation of new districts in the country in 2007. The districts affected by the re-demarcation are the Manya Krobo and Bolgatanga districts. Manya Krobo has been split in two – Upper Manya Krobo and Lower Manya Krobo districts. Akatawia falls into Upper Manya Krobo while Asitey is in the Lower Manya Krobo district. In the Upper-East region Bolgatanga, the regional capital has now been given a municipal status and the two villages, Zanlerigu and Shia, are now part of the Talensi-Nabdam district.

Akatawia

The population estimate of Akatawia in the 2000 population census of Ghana was about 663. During the survey in 2008, the community leaders estimate the population of the

village as 864, representing an annual population growth rate of about 3.7% which is over and above the 2.4% growth rate estimate by the Ghana Statistical Service (GSS). The number of households in the village during the survey period was estimated at 133 with an average household size of 6.5. This represents a drop in average household size of about one person since the Afrint I survey. While in 2002 about 21% of households were female headed, in 2008 the estimate decreased slightly to about 19.5%. There are no child headed households in the village. The focused group discussion at the village estimated that about 90% of households could be classified as farming households while the other 10% were non-farm households. The sale of crop was ranked the most important source of income for most households in the village. Income from natural resources such as firewood, charcoal and non-traditional forest products (NTFPs) and animal sales were ranked 2nd and 3rd most important source of income for most households in Akatawia (Table 2.1).

The indigenous ethnic group in the Upper Manya Krobo district is the Krobos and hence it is not surprising that about 90% of the inhabitants of Akatawia are Krobos. Two other ethnic groups – the 'Northern'[2] group and the Fantes constitute the other 10% of the village population in equal proportion. The main livelihood activity of all these groups is food crop farming. The village is directly serviced by public transport several times a day with a tarred all-weather road passing through the village centre. The relatively easy access to transportation is partly due to the proximity of the village to the district capital Asasewa which is also a major food crop marketing centre. Mobile network coverage is however very poor even though there are few spots in the village where there is limited network coverage of two mobile phone companies (MTN Ghana and Scancom Ghana Limited).

Asitey

Estimates from local community leaders and the village unit committee suggests an average annual population growth rate of about 5.7% between 2000 and 2008 given the population figures reported by the 2000 population census. Thus the population estimate

[2] Here, Northern ethnic group referrers to any ethnic group that originates from the northern parts of Ghana. There are several ethnic groups in northern Ghana.

of the village for 2008 was 1,560 up from 1,070 in 2000. This appears an overestimation and there could be two possible sources of error. The first is the possibility of an error in the 2000 census figure while the second may be an error is the estimation by the unit committee of the village. In our own estimation we are inclined to believe the estimates from the unit committee because sometimes the demarcation of geographical boundaries by the Ghana Statistical Service does not necessarily coincide with the exact local boundaries. Average household size in 2008 was 5.2 compared to 9.7 in 2002. Members of the village estimated the proportion of female headed households at 30% in 2008 and there were no child headed households. About 80% of household were considered farming households and about 20% were categorised as non-farm households. Revenue from crop sales was considered the most important source of income in Asitey. Petty trading and animal sales were ranked 2nd and 3rd respectively in terms of importance in contributing to household income for most households in the village (Table 2.1).

The indigenous ethnic group is the Krobos and they make up about 70% of the village population while the rest of the village population are Ewes – an ethnic group from the neighbouring administrative regions. The main occupation of both groups is food crop farming. The village centre is less than a kilometre away from an all weather road and transportation appears not to be a constraint because the village is serviced by vehicles several times a day commuting to and from the district capital and surrounding towns. The village has access to mobile network coverage. The three leading mobile network providers offer services in the village.

Gyedi

In 2008 the population of Gyedi was 371. This is in sharp contrast to what was reported in Afrint I where the 2000 population figure of 860 was applied. The anomaly can be attributed to differences in demarcation boundary between the Ghana Statistical Service and the community. Gyedi is a very small suburb of Begoro – the district capital of the Fanteakwa district. It is a church settlement of about 65 households with an average household size of 5.7. About 12% of households in Gyedi are female headed with no child headed households. The population of Gyedi is quite diverse in terms of ethnic composition. It is composed of the Akyem group (60%), Asante (20%), Akwapem (10%), Krobo (5%), and Ewe (5%). The primary livelihood activity in Gyedi is staple crop farming

and this does not vary by ethnic group. Indeed all households were considered faming households by our focus group participants. According to the group the most important source of income for most households in Gyedi was revenue from crop sales. Revenue from petty trading and animal sales were ranked 2nd and 3rd respectively in order of importance in contributing to household income of most households in the village (Table 2.1).

Being a suburb of the district capital the village has access to transportation services any time of day. The village also has easy access to the district market at Begoro. Mobile telecommunication coverage is available in the village and people can choose between two mobile networks.

Apaa

The population of Apaa was about 400 persons in 2008 (estimates by village opinion leaders). The Afrint I reports states the population of the village as 657 persons according to the 2000 population census. There seeming error in the two estimates is for the same reasons explained earlier regarding the other villages. The settlements in Apaa are made up of several small hamlets and some of the contiguous hamlets are not considered part of Apaa by our focus group but might have been counted as part of Apaa during the population census. About 5% of the households in the village are female headed and there are no child headed households. The average household size of the village in 2008 was 4 persons. All households in the village were classified as farming households. Crop revenue was ranked as the most important source of income for most households while revenue from the sale of animals and natural resource income was ranked as 2nd and 3rd most important source of household income respectively (Table 2.1).

Apaa is predominantly a faming settlement made up of migrants from the Krobo districts that share boundary with the Fanteakwa district. Hence about 75% of the people of Apaa are Krobos. The other 25% are made up of 15% indigenes of the district – the Akyem ethnic group, while both the Akwapem and the Ewe ethnic group constitute 5% of the population respectively. The road from the district capital to Apaa is un-tarred but motorable during most parts of the year. Commercial vehicles from the district capital,

which is about 7 kilometres away, serve the village several times a day. There is very limited mobile telecommunication network coverage in some parts of the village.

Gaane

The total population of Gaane was estimated at 640 during the Afrint II survey in 2008. If the estimate presented from the 2000 census in the Afrint I report is accurate then the average annual population growth rate of the village over the period stands at about 6.8%. This is very unlikely because the Kassena/Nankana district where the village is located is noted for a very low population growth rate because of outmigration, among other factors. We are inclined to believe that the possible error might be due to demarcation discrepancies. The estimated total number of households in the village was 100. There were 25 and 10 female and child headed households respectively. On the average there were 6.4 persons per household. In this village all households were considered farming households during the 2008 survey. Revenue from crop sales, animal sales, and petty trading were ranked 1st, 2nd and 3rd respectively in terms of most important sources of household income for most households in Gaane (Table 2.1).

About 80% of the village population belong to the Nankana ethnic group while the other 20% are from the Kassena group. Both ethnic groups are mainly farmers. The village is located near an all weather road though un-tarred. Given the proximity of the village to the district capital, Navorongo, access to market is not considered a problem. There is also mobile telecommunication network coverage in many parts of the village.

Doba

The total population of Doba in 2008 was 1,770 (estimate of village opinion leaders). There was an estimated 300 households in the village with mean household size of 5.9 persons. About 40% of households (120 households) were headed by females while 2% were child headed households (6 households). While in Gaane a distinction was made between the Kassena and the Nankana ethnic groups, no such distinction is made in Doba which has 95% of the population being Kassena/Nankana. The 5% minority group are from the Bulli ethnic group. All these ethnic groups are indigenous groups from the region. There is thus very minimal or no migrants from other regions or districts in most of the survey villages in the Upper East region. The entire population of the village are predominantly small-

scale farmers. Indeed about 98% of households were described as farming households while the other 2% are considered non-farm households. From the focus group discussions, the most important source of income for the majority of households in the village was from the sale of crop output. This was followed by revenue from animal sales and petty trading in that order. Since the village is located on the main highway linking Bolgatanga (the regional capital) and Navorongo (the district capital) it has no problem with availability of transportation services. There is also access to GSM mobile telecommunication networks.

Zanlerigu

The estimated population of Zanlerigu during the 2008 survey was 3,850 persons. There were about 500 households made up of 350 (70%) male, 100 (20%) female and 50 (10%) child headed households. The average household size was estimated at 7.7. The village population is predominantly made up of the indigenous Zoliba ethnic group who are mainly farmers. All households in the village were described by focused group interview members as farming households. When asked to rank household income sources in the village revenue from the sale of crop output was ranked as the most important. This was followed by animal sales and petty trading respectively. Even though many households engaged in some non-farm activities these were minimal and seasonal in some instances. There are no indications of migrants in the village which is served by an un-tarred but motorable road and is less than 4 kilometres away from the major tarred road which links it to the regional capital. Mobile telecommunication network coverage is available in some parts of the village.

Shia

Shia has a population of 3,306 people (2008 estimate by opinion leaders during the survey). There were about 389 households during the survey. About 292 households, representing 75% of all households were male headed. The rest of the households are female and child headed in the proportion of 20% (78 households) and 5% (19 households) respectively. The average household size was 8.5 as compared to 7.8 in 2002. The entire village is inhabited by the Talensi ethnic group and their main livelihood activity is small scale staple crop farming. All households in the village are farming household. According to our focus group discussions in the village revenue obtained

from the sale of crop output was ranked as the most important source of income for the majority of households in Shia. Revenue from the sale of animals was ranked 2nd while petty trading was ranked 3rd.

Shia is rarely serviced by commercial vehicles but it is about 2 kilometres away from an un-tarred all weather road which is serviced by commercial transport more than once a day. Market activity in the village is limited and most and most farmers travel to the regional capital which is about 13 kilometres to sell their produce albeit there is a limited sale in the village market. There is very limited mobile telecommunication network coverage in some few spots in the village.

Table 2.1: Rank of three most important income sources

	Crop sales	Animal sales	Natural resources	Petty trade
Akatawia	1	3	2	0
Asitey	1	3	0	2
Gyedi	1	3	0	2
Apaa	1	2	3	0
Gaane	1	2	0	3
Doba	1	2	0	3
Zanlerigu	1	2	0	3
Shia	1	2	0	3

Source: *AFRINT II Village Diagnostics Survey*

2.2: Outmigration

Seasonal migration is common in all survey villages except Gyedi (Table 2.2). The youth in most of the villages migrate to urban centres during the period before the farming season when there is very little on-farm work. The estimated percentage of the population outmigrating seasonally in search of work is highest in Doba where 33.9% of village population is estimated to leave the village annually for this purpose. There Upper-East region of Ghana is generally noted for seasonal migration mainly because of the monomodal nature of the rainy season. Gaane also experiences a relatively high proportion of seasonal outmigration yearly (15.6% of estimated population of village). In the Eastern region villages the highest proportion of village population outmigrating in search of seasonal work occurs in Apaa where estimates by the focus group discussion

put the figure at 7.5% per annum. All the first most important destinations of choice in all the villages are either the national capital, Accra, or the second largest city, Kumasi. The relative proximity of Kumasi to the Upper-East region makes it the first choice for villages in that region while Accra is closer to the villages in the Eastern region. Females are well represented among the seasonal outmigrants. Indeed, about 90% of villagers leaving Zanlerigu are female and they usually go to Kumasi to work as potters. In fact, one of the most popular work for seasonal migrants from the Upper-East region is head pottering in Accra or Kumasi.

Another category of migrants are those that migrant permanently to work in urban areas outside the village. Most of these migrants are said to be relatively more skilled or educated and they often work as civil servants. While a large proportion of seasonal migrants return at the beginning of the farming season these relatively more skilled migrants often return upon retirement from their jobs. The proportion of such returning migrants has been observed to decline over the years. Their highest numbers returning are from the Upper-East region villages.

Table 2.2: Outmigration patterns in study villages

					3 most important destinations				
Village	Population estimates of village	No. of villages out for seasonal work	% of population	% female	1st	2nd	3rd	No. of permanent migrants re-turning in 2007	% female
Akatawia	865	10	1.2	50	Accra	Tema	Koforidua	2	0
Asitey	1,560	90	5.8	35	Accra	Koforidua	yes	4	0
Gyedi	371	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Apaa	400	30	7.5	0	Accra	Begro	Nsawam	n.a	n.a
Gaane	640	100	15.6	30	Kumasi	Navrongo	Bolgatanga	6	30
Doba	1,770	600	33.9	30	Kumasi	Accra	Techiman	10	50
Zanlerigu	3,850	150	3.9	90	Kumasi	Tamale	Bolgatanga	10	50
Shia	3,307	50	1.5	40	Kumasi	Accra	Takoradi	15	30

Source: *AFRINT II Village Diagnostics Survey*

2.3: Agricultural dynamism in survey villages

Agricultural expansion or intensification would be conditioned by both national and village level contextual factors. Households are likely to respond to changes in incentive structure resulting from policy and institutional changes at national and local (district or village) level given a set of constraints. Changes in these variables would no doubt impact farming and livelihood decisions in general. In this section we examine some village level factors that could enhance or inhibit agricultural intensification or expansion.

2.3.1: Land

Access to land is a major determinant of agricultural production. Most of the farmers in the villages are small scale staple crop farmers who produce on family or lineage lands and do not have 'formal registered titles' to the lands they cultivate. In three of the villages in the Eastern region (Asitey, Gyedi and Apaa) there were claims that some small-scale farmers hold formal registered title to land but others in the focus group disputed this claim. Landlessness is however not a constraint to agriculture in most of the survey villages. Indeed there are no landless households in any of the villages except Zanlerigu where about 10 households were considered landless – one of them being female headed. Landlessness of these households was attributed to the increasing scarcity of land in the village.

The acquisition of land depends largely on the inheritance system of a particular village. Patrilineal inheritance dominates in all the villages in the Upper-East region. In the Eastern region Akatawia and Asitey are also patrilineal villages while Gyedi is matrilineal and Apaa is both matrilineal and patrilineal. Whether a village is patrilineal or matrilineal depends on the land owning ethnic group in the village. For example the mixture of both matrilineal and patrilineal inheritance in Apaa is explained by the ethnic composition. Even though the Fanteakwa district within which Apaa and Gyedi are located is generally matrilineal because the dominant ethnic group in the District is Akan[3], Apaa can be

[3] The Akan ethnic group is the largest in Ghana and consists of many other sub-groups. They are generally matrilineal.

considered a 'settler villager' because the Krobo ethnic group which is originates from other districts in the Eastern region dominates in Apaa. This accounts for the inheritance system being both matrilineal and patrilineal.

Clearing of virgin land belonging to the household of the patrilineage (or matrilineage) is the major means by which farm size is increased by already established households in Akatawia, Asitey and Gyedi (Table 2.3). If the household in these villages are newly established ones then they are allocated family land. Even though land frontiers are open in Apaa and there is no acute pressure on land most already established households wishing to increase their farm sizes or newly formed households desiring to farm borrow or rent land from land owning individuals or families. This situation is Apaa is due to the fact that the majority of farmers are from the Krobo ethnic group who are not originally from Apaa and thus do not have complete ownership rights over land. In the Upper-East region villages the major means of acquiring land from farm expansion by already established households is either by the clearing of virgin land (in Gaane and Doba) or by borrowing/renting land (in Zanlerigu and Shia). It is important to note that in Doba most lands cleared are really not virgin in that they have been used and left fallow mostly because of declining fertility. Newly established households in Doba and Shia are allocated family land for farming while those in Gaane and Zanlerigu establish farms by using vacant community land and by borrowing/renting land respectively (Table 2.3).

Table 2.3: Mode of land acquisition in study villages

Village	System of inheritance	Availability of land for cultivation	Mode of expanding farm size by established households	Mode of farmland acquisition by newly formed households
Akatawia	Patrilineal	Land frontiers open but limited	Clearing virgin land	Use family land
Asitey	Patrilineal	Land frontiers open but limited	Clearing virgin land	Use family land
Gyedi	Matrilineal	Frontiers open, no acute pressure	Clearing virgin land	Use family land
Apaa	Patrilineal & Matrilineal	Frontiers open, no acute pressure	Renting or borrowing land	Renting or borrowing land
Gaane	Patrilineal	Frontiers open, no acute pressure	Clearing virgin land	Allocated vacant community land
Doba	Patrilineal	Land frontiers	Clearing vacant but	Use family land

		exhausted	not virgin land	
Zanlerigu	Patrilineal	Land frontiers open but limited	Renting or borrowing land	Renting or borrowing land
Shia	Patrilineal	Land frontiers open but limited	Renting or borrowing land	Use family land

Source: *AFRINT II Village Diagnostics Survey*

Most female heads of households in the villages are either widows or women whose husbands do not reside in the village. In all other villages other than Akatawia and Asitey where it is common for widows to inherit land from the deceased husbands, widow farmers are often allocated land from their maiden families. This situation explains the reason why the major means by which female headed households obtain land for farming is through the allocation of family land except for Akatawia and Asitey where they most inherit land which they are already cultivating. In all the villages women do not retain land on which they were farming upon divorce if the land belonged to the husband or the husband's family. Though not a common occurrence parents or even widows could inherit land from their late children in Gaane and Doba.

The relative scarcity of land in Zanlerigu is reflected in Table 2.4. The village has the lowest proportion of uncultivated or fallow land (30%). Also, only 10% of farmers regularly put land under fallow as compared to all the other villages where every farmer leaves some land uncultivated either as a measure of facilitating soil fertility rehabilitation or due to the unprofitability of cultivating such lands. Apart from deliberately leaving land to regain fertility, in all the villages some land is left uncultivated because households are unable to raise the necessary resources to put such land under cultivation. Particularly in Doba the focus group discussions revealed that declining soil productivity due to the over cultivation of land has compelled many farmers to leave some of their lands uncultivated because production on such land do not make economic sense. This is reflected in the general increase in the length of the fallow period in the village and not because there is overabundance of land. Increase in the length of fallow period in Apaa is for the same reason but they reckon that increasing the duration of fallow is the only feasible option given the expensive price of fertility enhancing inputs. In our own estimation Doba is the village where land frontiers have been exhausted and fields have been permanently cultivated to the point where farmers have had to stop cultivation because of the waste of effort in the absence of productivity enhancing inputs. In 4 of the villages (Akatawia, Asitey, Zanlerigu and Shia) our assessment is that even though land

frontiers remain open there is some pressure on land and these frontiers could become exhausted in the next 10 years if land productivity in not improved. There is however no acute pressure on land at Gyedi, Apaa and Gaane and land frontiers remain open especially in Gyedi and Apaa in the Eastern region.

Land and soil related environmental degradation problems were highlighted in all the villages. Soil mining, soil erosion and deforestation were mentioned as the main environmental problems in all the villages. Bush fires were also said to be rampant in Asitey, Apaa, Gaane, and Shia. The problem is much more severe in Asitey where the community has had to form a group to police forest and land areas which are known to experience bush fires during periods of the year particularly in January and February. There are two reasons for these fires – the first is for land preparation and the second is for hunting bushmeat.

Table 2.4: Land fallowing

Village	% of land under fallow	% of farmers leaving land fallow	Length of fallow period (months)	Change in length of fallow over a decade	Reason for leaving land fallow
Akatawia	60	100	48	Decrease	Soil fertility
Asitey	40	100	36	Decrease	Soil fertility
Gyedi	50	100	36	Decrease	Soil fertility
Apaa	70	100	60	Increased	Soil fertility
Gaane	60	100	24	Decrease	Soil fertility
Doba	40	100	49	Increased	Unprofitable
Zanlerigu	30	10	36	Decrease	Soil fertility
Shia	40	100	60	Decrease	Soil fertility

Source: *AFRINT II Village Diagnostics Survey*

With the exception of Asitey and Shia the survey villages have experienced some level of demand for land from residents outside the village since 2002. Most demand for land in these villages comes from the major urban areas nearby but in Akatawia other neighbouring villages come in search of land. Such demand for land is by migrants who have sources of income than the majority of residents in the survey villages. The purchasing power these migrants enable them to rent land but not to own land since in

most of the villages land is not sold outright. There is no difference in land quality between migrants who seek land and residents in the village. In all the villages where migrants have acquired land security of tenure is not a problem even though in most cases they cannot purchase land outright. The rented out lands are those not under cultivation belonging to families or individuals. In Doba however the focused group agreed it was relatively more difficult for a migrant to acquire land than for resident farmers.

Apart from Apaa and Gaane, there are individuals who reside in major urban centres but own land in the villages. In Akatawia some people live in nearby villages but own land in the village. Most of these persons are however citizens of the villages. Such lands in Akatawia and Asitey are used by the community on the condition that the owner retained the primary rights over the land. In Gyedi the relatives of the owner as well as other members of the community have access to the land with the owner's permission. In the Upper East region villages where residents outside the village own land most of it is used by their families.

2.3.2: Agricultural water supply

Ghana's agriculture is generally rain-fed and this has not changed significantly since 2002. Rainfall conditions are generally erratic. The situation over the past 3 seasons before the survey as described by the village diagnostic interviews are shown in Table 2.5. The overall situation appears better in the Eastern region villages than villages in the Upper-East region. Particularly in 2007, 3 of the 4 villages in the Upper-East region experienced flooding which affected production. All the 4 villages were forced to depend on public food relieve as a result of the food shortage that ensured.

There is relatively more food crop irrigation agriculture in the Upper-East region than in the Eastern region. This is somewhat reflected in Table 2.6 where 2 of the 4 villages in the Upper-East region (Gaane and Doba) have some land under irrigation. Land area under irrigation in this context essentially referrers to the proportion of cultivated land supplemented by water any source other than rainfall. In Gyedi some farmers who

cultivate land along water bodies cultivate some vegetables using watering canes and basins.

Table 2.5: Rainfall conditions in survey villages (2005-2007)

Village	2007	2006	2005
Akatawia	Average	Below average	Below average
Asitey	Above average	Below average	Average
Gyedi	Above average	Above average	Above average
Apaa	Above average	Average	Average
Gaane	Flooding	Drought	Average
Doba	Flooding	Average	Average
Zanlerigu	Above average	Average	Average
Shia	Flooding	Above average	Above average

Source: *AFRINT II Village Diagnostics Survey*

In Doba however there are large depressions created in some areas where water collects and famers cultivate land around these areas particularly during the dry season. Gaane however has a large scale irrigation facility (Dam) which was constructed by the state is managed by the Irrigation Company of the Upper Region (ICOUR). ICOUR is a Ghana Government organization established to promote the production of food crops by small scale farmers within organised and managed irrigation scheme. In spite of water scarcity during the dry season particularly in the Upper-East region where there is only one main cultivation season rain water harvesting is not practiced. The large depressions near Doba however collect some rain water which is used by farmers who cultivate land near the dams.

Table 2.6: Extent of irrigation is some survey villages

Village	% Land area under irrigation	Change since 2002	Highest level of management regulating irrigation
Gyedi	5	Decreased	Small-scale, farmer constructed, water control devices managed by individual

			households
Gaane	20	Decreased	Large-scale systems constructed and managed by supra-village organisations at district or state level.
Doba	2	Decreased	Small-scale, farmer constructed, water control devices managed by associations of households at local level

Source: *AFRINT II Village Diagnostics Survey*

2.3.3: Credit supply

The supply of credit is a major factor that constraints agricultural production in Ghana. Credit markets are not well developed and because agriculture is considered are risky venture many credit suppliers are reluctant to offer services to small scale staple producers. Half of the survey villages (Akatawia, Asitey, Gaane, and Zanlerigu) reported that some form of credit was available but not to staple crop production farmers. Even though none of these villages have a formal banking system some individuals access credit from some formal banking institutions in neighbouring towns where such facilities are available. In Gaane and Zanlerigu some NGOs provide credit facilities for participants of specialised NGO programmes such as food processing. There are also some private individual money lenders in Gaane. Even though it is common in for farmers and individuals to access credit from friends and family particularly in situations of imperfect credit markets the village diagnostic survey suggest such options are rarely available in recent times in the villages. Only Gaane reported family and friends as a source of credit albeit not for staple crop production. The main reason given by our informants for this situation is deteriorating social cohesion and 'we feeling'.

In some sense contract farming could serve as a means of overcoming agricultural credit constraints. Such schemes are however not available in any of the villages except Gaane where one scheme is in operation. The scheme involves mainly vegetables and no staple food crops. The major factor facilitating such a scheme in Gaane is the irrigation system managed by ICOUR. The contract farming scheme serves several other villages around the irrigation catchment area and only about 5% of farmers in Gaane are involved in the scheme – 20% of whom are female. The main factor responsible for the availability of credit to the few farmers (not staple crop farmers) in Gaane is the contract farming scheme. Among the services they provide is credit. They also provide improved seed, fertilizer and pesticides. The scheme also assists participating farmers with extension

services. The produce from these farms are usually marketed in the major urban town and cities within and outside the Upper-East region. The current scheme was available in 2002 and not much has changed in terms of the services they provide.

2.4: Staple Crops: availability, access to varieties and marketing

Availability and access to planting materials and marketing of output at village level for the four major staple crops – maize, cassava, rice and sorghum – is the focus of this section. Maize and cassava are known to be the major stables in the four villages in the Eastern region which rice and sorghum are cultivated mainly in the villages in the Upper-East region. Maize is also cultivated in the Upper-East region but on a smaller scale and is often regarded as a cash crop.

2.4.1: Maize

Planting materials

All survey villages in the Eastern region cultivated both hybrid and improved open pollinated variety (OPV) maize. Farmers in Doba and Zanlerigu also planted both varieties but in Gaane only the improved OPV is planted. The situation was not much different in all villages in 2002 except in the case of Doba and Shia. Hybrid maize was not cultivated in 2002 in Doba and in Shia even though OPV maize was cultivated in 2002 no maize was planted during the last season before the survey in 2008 due to unfavourable climatic conditions.

Farmers in the villages still acquire hybrid maize either from the open private market or are supplied by government agencies or representatives. On the other hand in the case of OPV most farmers in some villages use their own seed stock from previous harvest of OPV seed. Of the 7 villages where farmers were still acquiring hybrid maize seed during the survey period private local or district markets served as the main source of supply for 3 of the villages (Akatawia, Gyedi and Apaa – all in the Eastern region) while the Ministry of Food and Agriculture (MoFA) served as the main supply source for the other 4 villages (Gaane, Doba and Zanlerigu – all in the Upper-East region – and Asitey). It appears that the supply of seed by government agencies is more common in the Upper-East region

than in the Eastern region: probably because farming communities in the Upper-East region are generally considered to be more remote and less accessible to private traders due to transaction cost. In Asitey and Gaane OPV seeds are acquired by farmers mainly through purchase from the private open market while farmers in Doba and Zanlerigu often depend on other fellow farmers for their OPV seed stock. In 2008 OPV maize seed was being supplied by an agent of MoFA in Shia.

As shown in Tables 2.7 and Table 2.8 the main sources of supply of both hybrid and OPV seed have not changed in most of the villages. With respect to hybrid maize seed (Table 2.7) the only changes are in Asitey and Gyedi in the Eastern region where there is a shift from private market supply to government agency and from government agency to private market supply in Asitey and Gyedi respectively. In the case of OPV seed supply the only change observable was in Doba where there is a shift from government agency supply in 2002 to supply of seed mainly by fellow farmers in 2008 (Table 2.8).

Table 2.7: Main source of hybrid maize seed: 2002, 2008

Village	2002	2008
Akatawia	Private market	Private market
Asitey	Private market	Government agency (MoFA)
Gyedi	Government agency (MoFA)	Private market
Apaa	Private market	Private market
Gaane	Government agency (MoFA)	Government agency (MoFA)
Doba	Government agency (MoFA)	Government agency (MoFA)
Zanlerigu	Government agency (MoFA)	Government agency (MoFA)

Source: *AFRINT II Village Diagnostics Survey*

Table 2.8: Main source of OPV seed: 2002, 2008

Village	2002	2008
Akatawia	Own harvest	Own harvest
Asitey	Private market	Private market
Gyedi	Own harvest	Own harvest
Apaa	Own harvest	Own harvest
Gaane	Private market	Private market
Doba	Government agency (MoFA)	Other farmers

Zanlerigu	Other farmers	Other farmers
Shia	Government agency (MoFA)	Government agency (MoFA)

Source: *AFRINT II Village Diagnostics Survey*

It is also common for farmers in all the villages to recycle their hybrid maize seed as planting material for the next season. They set aside some quantity of seed from their hybrid maize harvest as planting material. The purity of such seed is thus questionable.

The availability of improved maize seeds is not a constraint in any of the villages. The required quantity and quality of improved maize seeds are available when needed. Some key informants in Apaa complained about the quality of improved maize seeds. According to them some of the outlets do not stock reliable improved maize seed.

Table 2.9: Availability and price of hybrid maize seed

Village	Distance to seed market (km)	Mean price (US$/kg)	Min price (US$/kg)	Max price (US$/kg)
Akatawia	8	0.90	0.80	1.00
Asitey	1	0.75	0.50	1.00
Gyedi	0	0.80	0.80	0.80
Apaa	8	0.90	0.90	0.90
Gaane	5	1.25	1.00	1.50
Doba	6	2.00	2.00	2.00
Zanlerigu	3	0.50	0.33	0.66
Shia	12	n.a	n.a	n.a

Source: *AFRINT II Village Diagnostics Survey*

Table 2.10: Availability and price of OPV maize seed

Village	Mean price (US$/kg)	Min price (US$/kg)	Max price (US$/kg)
Akatawia	n.a	n.a	n.a
Asitey	0.65	0.6	0.7
Gyedi	n.a	n.a	n.a
Apaa	n.a	n.a	n.a
Gaane	0.175	0.1	0.25
Doba	1.84	1.84	1.84
Zanlerigu	0.33	0.33	0.33

Shia	n.a	n.a	n.a

Source: *AFRINT II Village Diagnostics Survey*

Also in Gaane there were complains that improved maize seed providers sometimes run-out of stock for several weeks. Farmers in all the villages but Gyedi travel some distance ranging from only a kilometre in Asitey to 12 kilometres in Shia to buy improved maize seed. This was however not seen as prohibitive since access to the points of sale was not difficult. There were however complains in all the villages that improved maize seed has become more expensive and less affordable compared to 2002 and there are no subsidies on improved maize seed. The average price of hybrid maize seed at the time of the survey ranged between US$0.5/kg in Zanlerigu to US$2/kg in Doba (Table 2.9). The difference in price between Zanlerigu and Doba is quite surprising given the fact that they are both supplied through government agencies. This might be reflecting differences in distance to market but the difference seems too wide and warrants further investigation. In the Eastern region villages the differences in price are related to distance to maize seed markets. OPV seed markets do not exist in Akatawia, Gyedi and Apaa because farmers either recycled previously harvested OPV maize or they received seeds from other farmers (Table 2.10). In the 4 villages where OPV maize seed is purchased cost/kg is lower than that of hybrid maize seed by a factor of approximately 1.1, 7.1, 1.1 and 1.5 for Asitey, Gaane, Doba and Zanlerigu respectively.

Output marketing

There is some level of maize marketing in all the survey villages. The marketing channels are at the farm gate, in the village market and in markets outside the village (mostly in the nearest urban centre) (Table 2.11). Farmers in most of the villages typically sell at the farm gate on in markets outside the village. In villages where selling at the farm gate is the dominant marketing channel (Akatawia, Gyedi, Apaa and Zanlerigu) the product is purchased by traders outside the village. It appears that there is little trading of maize in among village members probably because households would usually consume their own product rather than buy from other farmers.

The mean price of maize ranged between US$22/100kg in Apaa in the Eastern region to UD$50.5/100kg in the Upper-East region (Table 2.12). The relatively high mean price of

maize in Zanlerigu is partly due to the high variance between the minimum and maximum price. The difference depends mainly on the time of year the maize is sold. In the villages where farmers transport their maize for sale in markets outside the village (Asitey, Apaa, Gaane and Doba) transportation cost ranged between US$0.5/100kg (Asitey and Doba) to US$2.2/100kg in Apaa. This is reasonable because among the 4 villages Apaa is the least served by vehicles.

Table 2.11: Maize marketing channels

Village	Maize marketing channels	Dominant maize marketing channel
Akatawia	Farm gate and market outside village	Farm gate
Asitey	Village market and market outside village	Market outside village
Gyedi	Farm gate and market outside village	Farm gate
Apaa	Farm gate and market outside village	Farm gate
Gaane	Village market and market outside village	Market outside village
Doba	Market outside village	Market outside village
Zanlerigu	Farm gate, village market, and market outside village	Farm gate
Shia	Farm gate	Farm gate

Source: *AFRINT II Village Diagnostics Survey*

Table 2.12: Maize output price and transportation cost

Village	Mean price (US$/100kg)	Min price (US$/100kg)	Max price (US$/100kg)	Distance to market outside village (km)	Cost of transport (US$/100kg)
Akatawia	27.0	18.0	36.0	8	n.a
Asitey	28.5	26.0	31.0	3	0.5
Gyedi	25.0	10.0	40.0	1	n.a
Apaa	22.0	8.0	36.0	8	2.2
Gaane	27.0	18.0	36.0	5	1.0
Doba	23.5	18.0	29.0	6	0.5
Zanlerigu	50.5	29.0	72.0	4	n.a
Shia	n.a	n.a	n.a	12	n.a

Source: *AFRINT II Village Diagnostics Survey*

2.4.2: Cassava

Planting material

In the 4 villages in the Eastern region where cassava is cultivated only the 'local variety' is planted. Cassava is also cultivated at Gaane in the Upper-East region on a very small scale by few farmers. The key informant interviews did not reveal any known improved variety cultivation in the villages. The main source of planting material is from own-farm cuttings. In Asitey however some farmers receive cuttings from fellow farmers' within the village. Planting materials are available and often come at no cost to the farmer. The only problem is that of cassava mosaic virus which is estimated to have affected about 50% of crops in Gyedi in the 2007/2008 crop season but not very severe in that it did not lead to major crop losses. In Akatawia and Asitey only 10% and 5% of crops were estimated to have been affected in the 2007/2008 crop season.

Marketing of output

Cassava is marketed by farmers in all the 4 villages through the farm gate, village market and in markets outside the village. In this regard the situation has not changed much since 2002. The only difference is that the market price of cassava has increased as expected. The situation has not changed Also because almost all households in the villages are said to cultivate cassava there is very little sale in the village market which is patronised mainly by residents within the village. Those who sell at the farm gate sell to traders who come from outside the village to buy. In the case of Gaane where cassava is cultivated by only a few farmers it is marketed mainly in the village market (Table 2.13).

Table 2.13: Cassava marketing channels

Village	Maize marketing channels	Dominant maize marketing channel
Akatawia	Farm gate and market outside village	Farm gate
Asitey	Farm gate, village market, and market outside village	Market outside village
Gyedi	Farm gate and market outside village	Market outside village

Apaa	Farm gate, village market, and market outside village	Farm gate
Gaane	Farm gate and village market	Village market

Source: *AFRINT II Village Diagnostics Survey*

As expected the mean market price of cassava in Gaane is highest at US$17.5/100kg due to very limited supply of the product (Table 2.14). In the Eastern region villages the mean price of the tubers ranged from US$5.5/100kg (in Apaa) to US$12/100kg (in Akatawia). The relatively high average cassava price in Akatawia may be due to the fact that there were many household level processing of the tubers into *'Gari'* a food commodity that stores extremely well (up to 2 years or more). Apart from seasonal differences the differences between the minimum and maximum prices were said to reflect the period of the year when the soil is very dry and makes the harvesting of cassava very difficult and labour intensive.

Table 2.14: Cassava output price and transportation cost

Village	Mean price (US$/100kg)	Min price (US$/100kg)	Max price (US$/100kg)	Distance to market outside village (km)	Cost of transport (US$/100kg)
Akatawia	12.0	9.0	15.0	8	3.0
Asitey	7.0	6.0	8.0	3	1.0
Gyedi	9.0	5.0	13.0	1	1.0
Apaa	5.5	5.0	6.0	8	2.0
Gaane	17.5	15.0	20.0	n.a	n.a

Source: *AFRINT II Village Diagnostics Survey*

2.4.3: Rice

Planting material

The use of improved rice varieties has increased in all 3 of the 4 survey villages in the Upper-East region that cultivate the crop. The only village reported to have experienced a decline in the cultivation of the improved varieties is Zanlerigu. The NERICA variety is however cultivated only in Gaane where it is provided by ICOUR. Improved rice varieties are acquired from MoFA and private seed sellers. The situation has not changed much in except in the case of Doba where in 2002 the main supplier of improved seed were MoFA

but in 2008 farmers were acquiring seeds mainly from the private market. Quality and availability of improved rice seed is guaranteed from all the sources when needed.

The average price of improved rice seed ranged between US$0.4/kg (in Zanlerigu) to US$0.61/kg (in Doba) in 2008. Prices of planting material do not vary substantially as shown in the minimum and maximum prices. There are no subsidies on improved rice seed and there is usually an increase in price every year. The withdrawal of subsidies on rice planting material is reflected in the similarity in price between seeds supplied by the government agency and that obtained from the private market.

Table 2.15: Main source of improved rice seed: 2002, 2008

Village	2002	2008
Gaane	ICOUR	ICOUR
Doba	Government agency (MoFA)	Private market
Zanlerigu	Private market	Private market
Shia	Government agency (MoFA)	Government agency (MoFA)

Source: *AFRINT II Village Diagnostics Survey*

Table 2.16: Availability and price of improved rice seed

Village	Distance to seed market (km)	Mean price (US$/kg)	Min price (US$/kg)	Max price (US$/kg)
Gaane	1.5	0.55	0.50	0.60
Doba	6	0.61	0.55	0.66
Zanlerigu	10	0.40	0.40	0.40
Shia	12	0.50	0.50	0.50

Source: *AFRINT II Village Diagnostics Survey*

Marketing of output

Aside from home consumption rice is seen as a cash crop in all the rice growing villages. This was the case in 2002. Markets outside the village provide the main channel of rice sales in all villages but Zanlerigu where selling in the village market dominates (Table 2.17). The average price of rice in 2008 varied from US$25/100kg in Gaane to US$45/100kg in Shia (Table 2.18). The relative abundance of rice in Gaane due to the irrigation facility is said to be responsible for the relatively lower prices of rice there.

During the harvest season of 2007 a 100kg bag of rice sold at about US$14 while the periods before the harvest saw prices rise to US$36 for the same measure of rice.

Table 2.17: Rice output marketing channels

Village	Maize marketing channels	Dominant maize marketing channel
Gaane	Farm gate, village market, and market outside village	Market outside village
Doba	Farm gate and market outside village	Market outside village
Zanlerigu	Village market, and market outside village	Village market
Shia	Market outside village	Market outside village

Source: *AFRINT II Village Diagnostics Survey*

Table 2.18: Rice output price and transportation cost

Village	Mean price (US$/100kg)	Min price (US$/100kg)	Max price (US$/100kg)	Distance to market outside village (km)	Cost of transport (US$/100kg)
Gaane	25	14	36	5	1.5
Doba	34.	38	30	6	1.0
Zanlerigu	32.5	29	36	4	n.a
Shia	45	40	50	3	n.a

Source: *AFRINT II Village Diagnostics Survey*

2.4.4: Sorghum

Planting material

Improved sorghum seeds are used in all the sorghum growing villages and farmers in these villages get their supplied mainly form MoFA. This was indeed the situation in 2002. There were some private market purchases of sorghum seeds in Gaane and Zanlerigu in 2008 but only few farmers got some of their supplies from this source. Key informants reckon that the use of improved sorghum varieties has increased in all the villages but Gaane. There were no complains about the availability and quality of improved seeds but in Gaane and Doba our interviews revealed that there were few occasions when the required amounts of improved seeds were not available. The highest average price of improved sorghum seed was at Zanlerigu at US$0.6/kg and the lowest

price was recorded at Gaane at US$0.32/kg. There are no subsides on sorghum seeds and prices are said to be on an upward trend in all the villages.

Table 2.19: Main source of improved sorghum seed: 2002, 2008

Village	2002	2008
Gaane	Government agency (MoFA)	Government agency (MoFA)
Doba	Government agency (MoFA)	Government agency (MoFA)
Zanlerigu	Government agency (MoFA)	Government agency (MoFA)
Shia	Government agency (MoFA)	Government agency (MoFA)

Source: *AFRINT II Village Diagnostics Survey*

Table 2.20: Availability and price of improved sorghum seed

Village	Distance to seed market (km)	Mean price (US$/kg)	Min price (US$/kg)	Max price (US$/kg)
Gaane	5	0.32	0.26	0.37
Doba	n.a	n.a	n.a	n.a
Zanlerigu	2.5	0.60	0.40	0.80
Shia	12	0.50	0.50	0.50

Source: *AFRINT II Village Diagnostics Survey*

Output marketing

Most farmers in the sorghum growing villages sell a fraction of their sorghum harvest for cash. Sorghum marketing was also common in all the villages in 2002. But while there reported increases in market price of sorghum in all villages the key informants in Doba argued that prices have generally remained unchanged in the village. In all the villages sorghum output is usually sold at the farm gate, in the village market or in markets outside the village. While farm gate sales dominate in Shia, farmers in Zanlerigu mostly market their sorghum at the village market. Marketing in markets outside the village dominate the marketing channel in Gaane while it is the only channel used by mostly used by farmers in Doba. The highest average sorghum price in 2007/2008 was US$48/100kg obtained in Shia while the lowest price was reported at Doba – US$23/100kg.

Table 2.21: Sorghum output marketing channels

Village	Maize marketing channels	Dominant maize marketing channel
Gaane	Farm gate, village market, and market outside village	Market outside village
Doba	Market outside village	Market outside village
Zanlerigu	Village market, and market outside village	Village market
Shia	Farm gate, village market, and market outside village	Farm gate

Source: *AFRINT II Village Diagnostics Survey*

Table 2.22: Sorghum output price and transportation cost

Village	Mean price (US$/100kg)	Min price (US$/100kg)	Max price (US$/100kg)	Distance to market outside village (km)
Gaane	33.0	26.0	40.0	5
Doba	23.0	18.0	28.0	6
Zanlerigu	36.5	33.0	40.0	4
Shia	48.0	48.0	48.0	3

Source: *AFRINT II Village Diagnostics Survey*

2.5: Non-staple Crops: availability and marketing

Apart from maize and cassava, the main food crops cultivated by farmers in the Eastern region villages are vegetables for the local market in the case of Akatawia and Gyedi. These were also cultivated and marketed in 2002. Cow pea is the main 'other crop' in Asitey while cocoyam is the most common in Apaa. All these crops are grown for both home consumption and for cash income. While cowpea was not sold by many farmers in Asitey in 2002 cocoyam was a source of cash income for farmers in Apaa during the period. The most important main 'other food crop' cultivated in all survey villages in the Upper-east region was groundnut. It is a very important source of cash income for many households in these villages. All these food crops are sold at the farm gate, in the village market and in markets outside the village. None of the market channels dominate for any of these food crops.

Apart from Akatawia and Apaa, some farmers in all other villages engage in some non-food cash crop activity. In the Upper-East region the main non-food cash crop is the shea nut which grows in the wild. Many households in the villages pick these nuts and it serves as an important source of cash income particularly during the lean season. The product is sold at the farm gate, in the village market or in markets outside the village. Those who sell at the farm gate sell the shea nuts to traders from outside the village and agents of some processing companies. At Gyedi a special oil producing seed is cultivated. An NGO has setup a small processing plant in the village from where seeds purchased from the community are processed. This is on a very small experimental scale. It is important to note that the marketing of most of these non-food cash crops was not carried out in 2002.

2.6: Agricultural inputs and techniques

This section presents results of key informant interviews on issues relating to agricultural input access, availability and prices as well as highlights of agricultural techniques that are applied in the villages. It also presents issues relating to agricultural extension as an input in the farm production process.

2.6.1: Access to and use of fertilizer

Chemical fertilizers are used by some farmers in all the survey villages. The availability of fertilizers was not considered a constraint. The major issue was about its affordability. According to the key informants most farmers are unable to purchase the input. Even though in Gaane and Shia MoFA and the district assembly respectively supplied some fertiliser for sale the main suppliers of chemical fertilizers in all the villages were market traders. The situation was no different in 2002 in terms of availability and supply channels of the input. The main complaint was that the input was becoming increasingly expensive and unaffordable. Urea, NPK and triple superphosphate (TSP) are the 3 types of fertilizers available and being used by farmers, the most common being NPK. TSP was not being used in Akatawia and Shia. NPK was marginally more expensive than urea and TSP in 5 of the villages. Prices of the fertilizers are usually the same but the relatively more

demand for NPK sometimes causes traders to set the price marginally above the other two types.

Table 2.23: Chemical fertilizer prices in survey villages

	Urea			NPK			TSP		
Village	Mean price ($/kg)	Min price ($/kg)	Max price ($/kg)	Mean price ($/kg)	Min price ($/kg)	Max price ($/kg)	Mean price ($/kg)	Min price ($/kg)	Max price ($/kg)
Akatawia	0.55	0.50	0.60	0.45	0.40	0.50	n.a	n.a	n.a
Asitey	0.35	0.30	0.40	0.35	0.30	0.40	0.55	0.50	0.60
Gyedi	0.55	0.50	0.60	0.50	0.50	0.50	0.40	0.40	0.40
Apaa	0.40	0.40	0.40	0.50	0.50	0.50	0.40	0.40	0.40
Gaane	0.30	0.30	0.30	0.40	0.40	0.40	0.30	0.30	0.30
Doba	0.30	0.30	0.30	0.40	0.40	0.40	0.30	0.30	0.30
Zanlerigu	0.30	0.30	0.30	0.40	0.40	0.40	0.30	0.30	0.30
Shia	0.35	0.30	0.40	0.40	0.40	0.40	n.a	n.a	n.a

Source: *AFRINT II Village Diagnostics Survey*

2.6.2: Agricultural techniques and equipment

Adoption of various agricultural techniques depends on ecological conditions and knowledge of techniques, among many other factors. The most common agricultural technique practiced by most farmers in all the villages is intercropping. This ranked highest among all techniques. Intercropping with legumes is however as common considering its overall ranking among all 8 villages. This is because while only on village (Gyedi) practices intercropping with legumes it is a common practice in all villages of the Upper-East region. This is probably because their soils are generally less fertile and require such intercropping. The only technology not practices in any of the villages is breaking the hard pan. The second most common techniques practiced are zero or minimum tillage, improved planting practices, and pesticide/herbicide application. These are practiced in all the villages except Shia where minimum or zero tillage and pesticide application are not common and in Zanlerigu where improved planting practices are not commonly practiced. Generally, it appears that the practice of agricultural techniques is more common in the Upper-East region villages than in the villages in the Eastern region. These are mostly related to soil and water conservation capacity differences in the two ecologies and the rainfall regimes that exist.

Table 2.24: Rank of common agricultural techniques

	Eastern Region	Upper-East region	All
		Ranks	
crop rotation	6	6	5
intercropping	1	1	1
intercropping with legumes	9	1	6
Fallowing	1	11	6
Improved fallowing	n.a	11	13
Animal manure	n.a	1	10
Zero or min. tillage	1	6	2
Breaking the hard pan	n.a	n.a	n.a
Green manure	9	1	6
Soil water conservation	9	1	6
Improved planting practices	1	6	2
Integrated (Soil) Nutrient Management	n.a	11	13
Integrated Pest Management	7	n.a	12
Agroforestry	7	10	10
Pesticides/herbicides	1	6	2

Source: *AFRINT II Village Diagnostics Survey*

For example, while soil and water conservation practices as well as green manuring is common in all villages in the Upper-East only one village observes this practice in the Eastern region. Animal manuring is not practiced in any of the villages in the Eastern region but practiced in all villages in Upper-East. This is also partly because cattle dung which is most commonly used is more common in the villages where animal manuring is practiced. Improved fallowing and integrated nutrient management systems are rarely practices in any of the villages. Only a few farmers in Gaane practice these techniques.

The general observation was that agricultural techniques that are soil and water conserving and do not require much cash expenditure albeit labour intensive are more likely practiced in the Upper-East region villages while pest, disease and forest related management practices are more common in the Eastern region villages.

The difference in ecology and terrain largely determines the use mechanised equipments like the tractor. The forest ecological nature of the Eastern region villages makes the use of

tractors prohibitive. A tractor is available for hiring at Asitey but very few farmers use the equipment. On the contrary tractors are available in all villages in the Upper-East except Shia but some farmers hire from the equipment from neighbouring towns. The land in Shia is very stony and inhibits to some extent the use of tractors. Drying floors are available in Gaane, Doba, Zanlerigu and Shia and is used by all farmers in these villages but for Shia where 95% of farmers are estimated to use the facility. Modern grain stores are available only at Gaane and are used by about 35% of farmers in the village. The most common processing equipment is the maize miller. This is available in all the villages. As expected rice mills are available only in the Upper-East where the crop is grown. Shia however does not have the facility and milling is often done using a traditional method but some individuals mill their rice in other neighbouring villages. Cassava grating machines are available only at Akatawia and Asitey but a simple traditional cassava grating equipment is available in all households in the Eastern region villages.

2.6.3: Agricultural Extension

Agricultural extension services are available in all the study villages. These services are directed towards all food crops, small-stock, fowl and cattle in all the villages where they are produced or raised. Extension delivery towards non-food crops is very limited in the Upper-East region but common in the Eastern region villages except Akatawia where non-food crops are rarely cultivated. In villages where beekeeping is undertaken (Akatawia, Gyedi, Gaane and Doba) extension services are provided. The extension service providers claim to target special groups of farmers. The target of extension services in Akatawia is mainly progressive farmers. All other categories of farmers are targeted in Asitey and Apaa except the youth and child headed households: child headed households do not exist in these villages. At Gyedi, Doba, Zanlerigu and Shia extension services claim to target all categories of farmers but child headed households. Other specialised groups are targeted: market women in Apaa, the disabled in Gaane, widows in Zanlerigu, and farmer groups in Shia.

The main provider of extension services in all the study villages is the state through the MoFA. This was also the case in 2002. The activities of several NGOs in the northern regions of Ghana – including the Upper-East region – are manifested in their contribution

towards extension delivery in Doba, Zanlerigu and Shia. NGO involvement in extension service delivery in the Eastern region was observed only at Gyedi. Some of the services provided by MoFA appear to differ from village to village depending on what is considered the most important needs are. Seeds and fertilisers are provided in Doba and Akatawia respectively but not for free. They are sold at the market rate. Veterinary services are provided is all villages except Akatawia and Gaane. Even though consultation with the extension agent is free of charge the farmers pay for the cost of medication when administered. The same applies to the treatment of pest or any other service that may involve a cost element other than the technical advice provided by the extension agent. It is interesting to note that while members of the focused group in Doba complained that the extension agent does not provide them with any services the interview with the agent revealed the contrary.

According to the MoFA extension agents a number of training programmes are provided in the various villages. These include training on integrated pest management (Akatawia, Asitey, Gyedi, Apaa and Gaane), zero or minimum tillage (all villages except Gaane and Doba), planting practices (all villages), processing (all villages except Apaa and Shia), animal fattening (Asitey, Gyedi, Apaa and Gaane), poultry rearing (all villages but Apaa and Zanlerigu), bee-keeping (Asitey, Gyedi, Gaane and Doba), business skills (all villages in the Upper-East region and Gyedi), production standards (Akatawia, Asitey, Gyedi and Shia). It is worth noting that the provision of such training does not necessarily imply that these skills or techniques are being practices in the respective villages. For example, even though integrated pest management training was claimed to be provided in 5 villages, only two villages were mentioned where some farmers were actually practicing the technique. There were also instances where a particular training was not provided but farmers were practicing the technique. An example is the case of zero or minimum tillage techniques in Gaane and Doba where it was being practices even though no training was provided on the technique.

2.7: Gender dynamics in relation to crops

In all survey villages, the categorisation of crops as "women's crops" and "men's crops" is not as strict as in the past. In some of the villages in the past, particularly the villages in the Upper-East region these categorisation was strict and almost a taboo for women to cultivate certain crops. Nevertheless, some crops are presently still considered "women's

crops" or "men's crops" because they are cultivated predominately by women or men. It does not however imply that these cannot be or are not cultivated by either sex. In general, vegetables are considered "women's crops" in all the villages while the major staples are considered "men's crops" (Table 2.25 and Table 2.26). The main exception is rice which is associated more with women than men. While the majority of "women's crops", except the non-vegetables such as groundnut and beans, are cultivated mainly for cash "men's crops" are equally for cash and subsistence. It is probably worth noting that most of the crops associated with women have higher market value than those associated with men. The main reason is because the "women's crops" are often cultivated on a smaller scale than the "men's crops". It is also common to find intercrops of "women's crops" and "men's crops" particularly in the Eastern region villages. The most common "women's crop" in the Upper-East region is groundnut while pepper, tomatoes and okro are considered "women's crops" in the Eastern region.

Table 2.25: "Women's crops" and main purpose for cultivation

Village	Crop 1	Purpose	Crop 2	Purpose	Crop 3	Purpose
Akatawia	Pepper	Mainly for Cash	Tomatoes	Mainly for Cash	n.a	n.a
Asitey	Pepper	Mainly for Cash	Beans	Equally for subsistence and cash	Tomato	Mainly for Cash
Gyedi	Okro	Mainly for Cash	Garden	Mainly for Cash	Pepper	Mainly for Cash
Apaa	Pepper	Mainly for Cash	Garden	Mainly for Cash	Beans	Mainly for Cash
Gaane	Groundnut	Equally for subsistence and cash	Rice	Equally for subsistence and cash	Okro	Equally for subsistence and cash
Doba	Groundnut	Equally for subsistence and cash	Soybean	Equally for subsistence and cash	Rice	Equally for subsistence and cash
Zanlerigu	Okro	Equally for subsistence and cash	Pepper	Equally for subsistence and cash	Groundnut	Equally for subsistence and cash
Shia	Groundnuts	Equally for subsistence and cash	Okra	Equally for subsistence and cash	Bambara	Equally for subsistence and cash

Source: *AFRINT II Village Diagnostics Survey*

Table 2.26: "Men's crops" and main purpose for cultivation

Village	Crop 1	Purpose	Crop 2	Purpose	Crop 3	Purpose
Akatawia	Maize	Mainly for cash	Cassava	Mainly for cash	Yam	Subsistence
Asitey	Cassava	Equally for cash and subsistence	Maize	Equally for cash and subsistence	Groundnut	Mainly for cash
Gyedi	Maize	Equally for cash and subsistence	Plantain	Equally for cash and subsistence	Cassava	Equally for cash and subsistence
Apaa	Plantain	Equally for cash and subsistence	Cocoyam	Equally for cash and subsistence	Cassava	Equally for cash and subsistence
Gaane	Millet	Equally for cash and subsistence	Maize	Equally for cash and subsistence	Vegetables	Mainly for cash
Doba	Millet	Equally for cash and subsistence	Maize	Equally for cash and subsistence	Tomato	Equally for cash and subsistence
Zanlerigu	Sorghum	Equally for cash and subsistence	Millet	Equally for cash and subsistence	Maize	Equally for cash and subsistence
Shia	Millet	Equally for cash and subsistence	Maize	Equally for cash and subsistence	n.a	n.a

Source: *AFRINT II Village Diagnostics Survey*

2.8: Village level food security indicators

The most important means of obtaining food in all the villages is through own production. Staple foods are rarely purchased except during the lean season in the Upper-East region villages of Gaane, Doba and Zanlerigu. Hunting, gathering or fishing is not common in any over the villages. A few households in Gaane however obtain some fish from the irrigation dam. Famine is rarely a problem in the Eastern region villages but in the Upper-East villages where the length of the lean season lasts almost half the year (5-6 months) this usually a problem. This period is usually during the period immediately before planting until the new harvest. The severity of the problem is manifested in the fact that during this period most households reduce the number of meals consumed in a day. The adults may for example eat only one meal a day. Early millet – so called because of its early maturation period (usually in early July while late millet and sorghum are

sometimes harvested in October) is considered an important famine in the Upper-East region.

The main food security threats to all the study villages are prolonged drought, unpredictable weather, natural hazards and crop pest/disease. The main natural hazard that threatens food security in the Eastern region is bush fires while floods and bushfires are the main threats in the Upper-East. From the focus group discussions in the Eastern region it appears that bush fires are the only real threat to food security. It is in this regard that fire squad volunteer groups are formed to prevent bush fires and to help prosecute people who start these fires. Another strategy for preventing or copping with the fire threat is the creation of fire belts and the planting of trees by some farmers in Asitey. The threat of prolonged drought is more severe in the Upper-East. Pest and diseases also threaten mostly villages in that region but not the Eastern region except in the case of Apaa. In Gyedi deforestation was also mentioned by the focus group as a threat to food security. They reckon that as forest cover is removed the soil surface is left bear which over time leaves the land less productive.

The sale of livestock and petty trading is considered a copping strategy against food insecurity in all the villages in the Upper-East region. The collection of shea nuts from the wild, particularly by women and children, is also a very important copping mechanism in Gaane, Doba and Shia. Family support – usually from family members, who have migrated out of the village – is also critical to the survival of some households in all villages in the Upper-East. The sale of assets as a means of copping with food security was mentioned only in Zanlerigu. Also in Akatawia in the Eastern region some focus group members mentioned the mortgaging of crops that were yet to be harvested as a copping strategy against food insecurity.

The difference in food security situation between the villages in the two regions is again revealed in how households in these villages cope with actual food shortages. In the Eastern region most households are able to store enough food to last the period of the relatively short lean season. But in the Upper-East the consumption of less preferred food; reduction in the number of meals and limited portions; and the consumption of seed stock is common in all the 4 villages. In Gaane and Zanlerigu only relatively wealthy

households and households that possess livestock are able to purchase food. Livestock owning households sell off some of their animals to purchase food. Some households in Zanlerigu also sell household assets to purchase food. Outmigration is also important in these villages for coping with actual food shortage. Also, during the floods in 2007 Gaane and Doba received public food relief.

2.9: Chapter summary

There is no evidence from the village diagnostic survey to indicate any positive changes in the staple food crop economy. Indeed, the general picture is that of deterioration in factors that are expected to enhance productivity. Results of the focus group discussions suggest decreasing use of fertilizers due to increasing prices. Farmers' use of improved planting materials and technology has generally not changed since 2002. Food insecurity continues to be major problem in the Upper-East villages where the lean season lasts for about 6 out of the 12 months of the year. Probably the most important infrastructural change since 2002 in all the villages is mobile telecommunication network coverage which exists in all villages albeit very limited in Akatawia, Apaa and Shia.

These villages have relatively lower agro-ecological potential compared to those in the Eastern region. On the average we consider the Upper-East region villages to have an agro-ecological potential of about 37.5% compared to 62.5% for the villages in the Eastern region. The lowest potential village in the Upper-East is Shia with an estimated potential of 10% with the highest potential being 50% for Gaane and Doba. Apaa, Akatawia, and Asitey have almost equal estimated potential of about 60% with Gyedi having the highest potential of 70%. A rough estimation of poverty levels using the US$1 per day measure suggests that the poorest villages are in the Upper-East. We estimate that about 60%, 45%, 40% of households in Shia, Gaane, Zanlerigu and Doba live bellow US$1 a day respectively. Akatawia is probably poorest village in the Eastern region with about 35% of its population leaving under less than US$1 a day. Apaa and Asitey has about 30% and 20% respectively living in poverty per the definition while there may be no one living under a dollar a day in Gyedi. These are very rough estimates and the income and expenditure estimates at the household level would help us make a more accurate estimate of the welfare situation in the villages.

CHAPTER 3

HOUSEHOLD SAMPLE CHARACTERISTICS

3.1: Sample size and distribution

There was an attempt to re-visit all the randomly drawn households in 2002. In addition to the 2002 sample we set out to sample 20 new households in all study villages in order to investigate suspicions of sample bias during the 2002 survey. In all 279 households in 4 villages located in 3 districts in the Eastern region were interviewed. In Akatawia – Upper Manya Krobo district – 62 households were interviewed while 73 households were drawn from Asitey in the neighbouring Lower Manya Krobo district. These two villages belonged to the same district – the Manya Krobo district – in 2002. There are a total of 144 households in the Fanteakwa district – 76 from Gyedi and 68 from Apaa.

Table 3.1: Sample distribution*

Village	Re-interviewed 2002 households	Descendents of 2002 households	Replacement due to attrition	New sample (including immigrant) households	ALL
E/R	**140 (50.2)**	**24 (8.6)**	**35 (12.5)**	**80 (28.7)**	**279 (100)**
Akatawia	27 (43.6)	5 (8.1)	11 (17.7)	19 (30.6)	62 (100)
Asitey	33 (45.2)	11 (15.1)	8 (11.0)	21 (28.7)	73 (100)
Gyedi	48 (63.1)	5 (6.6)	3 (4.0)	20 (26.3)	76 (100)
Apaa	32 (47.1)	3 (4.4)	13 (19.1)	20 (26.4)	68 (100)
U-E/R	**188 (64.8)**	**6 (2.1)**	**15 (5.2)**	**81 (27.9)**	**290 (100)**
Gaane	47 (62.7)	1 (1.3)	7 (9.3)	20 (26.7)	75 (100)
Doba	46 (64.8)	0 (0.0)	5 (7.0)	20 (28.2)	71 (100)
Zanlerigu	46 (63.0)	3 (4.1)	3 (4.1)	21 (28.8)	73 (100)
Shia	49 (69.0)	2 (2.8)	0 (0.0)	20 (28.2)	71 (100)
All	**328 (57.6)**	**30 (5.3)**	**50 (8.8)**	**161 (28.3)**	**569 (100)**

Source: *AFRINT II Household Survey, 2008* ** The figures in parenthesis are percentages*

The 4 villages in the Upper-East region have a total sample of 290 households made up of 146 from the Kassena Nankana district (75 and 71 households from Gaane and Doba respectively) and 144 from the Talensi-Nabdam district – 73 households from Zanlerigu and 71 from Shia. The sample category distribution of all selected households is shown in Table 3.1.

3.2: Household demographic characteristics

Estimates from community leaders during the village 'diagnostics' survey indicates that 21.6% of households in the Eastern region villages were female headed with no child headed households (Table 3.2). In our sample however, only 15.4% of households are female headed (Table 3.3). About 25% of households were estimated to be headed by females in the Upper-East region study villages, according to community key informants. But our sample contains only about 12% female headed households. It therefore appears that female headed households are underrepresented if proportional representation was to be of the essence, and assuming the estimates by the community key informants were accurate.

The respondent in the household interviews were either the farm manager or head of household. Even though in most cases the household head was also the farm manager the total sample had more female farm managers than female heads of households. This suggests that there are a greater number of female farmers in our sample than household headship may suggest. In our sample, farm managers are the actual 'owners' of the farms and are the individuals who make most of the farming decisions. While the total Ghana sample had about 14% female headed households about 20% of farm managers are female. There are 15% female headed households in the Eastern region villages but as much as 23% of the households have females us the farm managers. In the Upper-East there are 12% female headed households but 16% of farm managers are female.

There are four types of households identified in our sample – nuclear, extended, polygamous, de jure female (includes households whose heads are either widowed, never married or divorced), de facto female headed, and unmarried male headed households. In the Eastern region villages, the first two are the most common in our sample – 68.7% and 20.9% respectively (Table 3.4). The most common household types in the Upper-East

region villages are nuclear and polygamous - 62.2% and 26.1% respectively. It is worth noting that Shia particularly has a very high number of polygamous households in the sample (42.3%). Also, there is a relatively high de jure female headed households in Zanlerigu (31.5%) compared to the proportion present in the entire sample (4.8%).

Table 3.2: Estimated population distribution of households by household head category

Village	Male headed		Female headed		Child headed		All	
	Est. No.	Per-cent	Est. No.	Per-cent	Est. No.	Per-cent	Est. No.	Per-cent
E/R	**469**	**78.4**	**129**	**21.6**	**0**	**0.0**	**598**	**100.0**
Akatawia	107	80.5	26	19.5	0	0.0	133	100.0
Asitey	210	70.0	90	30.0	0	0.0	300	100.0
Gyedi	57	87.7	8	12.3	0	0.0	65	100.0
Apaa	95	95.0	5	5.0	0	0.0	100	100.0
U-E/R	**881**	**68.3**	**323**	**25.1**	**85**	**6.6**	**1289**	**100.0**
Gaane	65	65.0	25	25.0	10	10.0	100	100.0
Doba	174	58.0	120	40.0	6	2.0	300	100.0
Zanlerigu	350	70.0	100	20.0	50	10.0	500	100.0
Shia	292	75.1	78	20.1	19	4.9	389	100.0
All	**1,350**	**71.5**	**452**	**24.0**	**85**	**4.5**	**1,887**	**100.0**

Source: *AFRINT II Village Diagnostics Survey, 2008*

Table 3.3: Household sample distribution by household head category

Village	Male headed households		Female headed households	
	Frequency	Percent	Frequency	Percent
E/R	**236**	**84.6**	**43**	**15.4**
Akatawia	50	80.6	12	19.4
Asitey	62	84.9	11	15.1
Gyedi	69	90.8	7	9.2
Apaa	55	80.9	13	19.1
U-E/R	**255**	**87.9**	**35**	**12.1**
Gaane	65	86.7	10	13.3
Doba	62	87.3	9	12.7
Zanlerigu	67	91.8	6	8.2
Shia	61	85.9	10	14.1
All	**491**	**86.3**	**78**	**13.7**

Source: *AFRINT II Household Survey, 2008*

Comparing household size figures from the two survey data sets (Afrint I and II) instead of the 2000 population census data, we observe reduction in household size in all survey

villages.[4] The mean household size of the study villages in 2008 was 5.2 as against 7.2 in 2002, an average decline of 2 persons per household (Table 3.5). The reduction was slightly higher (from 8.9 in 2002 down to 6.2 in 2008) in the Upper-East villages. The age structure in the households shows that, as expected, the majority of household members are in the 16-60 age group. In the Eastern region about 70% of household members are in the 16-60 age category while about 21% and 9% of members are below 15 years and above 60 years respectively. About 61% of household members are in the 16-60 age category in the Upper-East region. About 29% are aged 15 or younger while about 10% are above 60 years old. Household age structure and distribution could have important implications for household human capital endowments, which we would explore later in this report.

Table 3.4: Household type (%)

Village	Nuclear	Extended	Polygamous	De jure female headed	De facto female headed	Not yet married males	Total
E/R	**68.7**	**20.9**	**4.0**	**5.4**	**0.4**	**0.7**	**100**
Akatawia	61.3	22.6	3.2	9.7	1.6	1.6	100
Asitey	68.5	21.9	2.7	6.9	0.0	0.0	100
Gyedi	71.1	19.7	7.9	1.3	0.0	0.0	100
Apaa	73.5	19.1	1.5	4.4	0.0	1.5	100
U-E/R	**62.2**	**3.8**	**26.1**	**4.1**	**2.1**	**1.7**	**100**
Gaane	68.0	1.3	17.3	9.3	2.7	1.3	100
Doba	76.1	2.8	14.1	4.2	0.0	2.8	100
Zanlerigu	50.7	11.0	0.0	31.5	5.5	1.4	100
Shia	53.5	0.0	42.3	2.8	0.0	1.4	100
All	**65.4**	**12.1**	**15.3**	**4.8**	**1.2**	**1.2**	**100**

Source: *AFRINT II Household Survey, 2008*

The age of household heads range between 19 and 99 years in the entire sample with the average age at about 51 years (Table 3.6). Indeed, age of household heads is very similar in both regions. Sampled household heads in the Eastern region have an average age of about 51 years while those in the Upper-East are 52 years old, on the average. In Table 3.7 households are categorised based on age of household head in order to identify the life cycle stages in which they belong.

[4] In the Afrint I report only average household size figures from the 2000 population census of Ghana was reported for villages where such data was available.

Table 3.5: Household size and age composition

		2008 sample			
			Age category		
	Mean household size 2002	Mean household size 2008	16-60	15 and below	61 and above
E/R	**7.2**	**5.2**	**3.6**	**1.1**	**0.5**
Akatawia	7.4	6.0	4.2	1.2	0.6
Asitey	6.5	5.2	3.8	0.7	0.7
Gyedi	8.1	5.6	3.8	1.3	0.5
Apaa	6.9	4.0	2.7	1.1	0.2
U-E/R	**10.6**	**7.1**	**3.8**	**1.8**	**0.6**
Gaane	9.2	6.3	3.6	2.1	0.6
Doba	8.3	5.9	3.7	1.8	0.4
Zanlerigu	12.5	7.8	4.2	2.8	0.8
Shia	12.5	8.5	4.4	3.3	0.8
All	**8.9**	**6.2**	**3.8**	**1.8**	**0.6**

Source: *AFRINT II Household Survey, 2008*

This could be an important factor in explaining observed farm household characteristics and decisions. Economic well-being might also depend on the life-cycle stage of households with younger and older households having a relatively lower economic well-being (Ani L. Katchova, 2008). In this respect households are grouped into five based on age of household head: < 31 years, 31-40 years, 41-50 years, 51-60 years, and > 60 years. Our sampled households are quite evenly distributed among groups 2 to 5. Over all, slightly more households are in the >60 group (27%); followed by the 41-50 (26%), 31-40 (20%), and 51-60 (19%) age groups in that order. While households in the Upper-East villages have more households in the >60 years group those in the Eastern region have more households in the 41-50 years category (Table 3.7).

On the average farm managers in the whole sample have 5.2 years of schooling with the maximum number of years in school being 20 years (Table 3.8). The difference in educational attainment of farm managers between the two regions is however significant. Farm managers in the Eastern region sample have more than twice as many years of average schooling than those in the Upper-East region – 7.2 years for the former and 3.2 years for the later.

Table 3.6: Age of household head

Village	Mean	Min	Max
E/R	**50.5**	**19**	**99**
Akatawia	49.7	25	83
Asitey	53.8	22	90
Gyedi	48.0	19	99
Apaa	50.2	23	80
U-E/R	**51.8**	**20**	**95**
Gaane	48.9	26	95
Doba	47.6	25	79
Zanlerigu	57.1	27	95
Shia	53.7	20	85
All	**51.2**	**19**	**99**

Source: *AFRINT II Household Survey, 2008*

Table 3.7: Life cycle stage of sample households

Household	All		Eastern region		Upper-East region	
head age category	Freq.	Percent	Freq.	Percent	Freq.	Percent
Can't tell age	21	3.7	9	3.2	12	4.1
<31 years	30	5.3	14	5.0	16	5.5
31 to 40 years	113	19.9	59	21.2	54	18.6
41 to 50 years	146	25.7	74	26.6	72	24.7
51 to 60 years	109	19.2	55	19.8	54	18.6
>60 years	150	26.4	67	24.1	83	28.5
Total	569	100	278	100.0	291	100.0

Source: *AFRINT II Household Survey, 2008*

Grouping education of farm managers into levels of attainment – no educational, basic education (up to 9 years of schooling), secondary/post-secondary (up to 15 years of schooling), and tertiary (16 years or more years of schooling) we observe that 41.5% of farm managers in the total sample had no formal education at all (Table 3.9). The figure is even higher in the Upper-East as expected, with about 60% having no formal education while relatively much less number of farm manager (about 22%) had zero formal education in the Eastern region. Most 'educated' farm managers have either attained basic or secondary level education. About 29% and 27% in the total sample have up to basic and secondary level education respectively. Majority (about 43%) of educated farm managers in the Eastern region village household sample have attained up to secondary education but in the Upper-East majority (about 23%) of those educated have only basic level education.

Table 3.8: Number of years of school attended by farm managers

	Mean	Min	Max
E/R	**7.2**	**0**	**18**
Akatawia	6.0	0	17
Asitey	7.2	0	18
Gyedi	8.2	0	17
Apaa	7.3	0	15
U-E/R	**3.2**	**0**	**20**
Gaane	3.0	0	20
Doba	4.6	0	19
Zanlerigu	3.0	0	17
Shia	2.2	0	15
All	**5.2**	**0**	**20**

Source: *AFRINT II Household Survey, 2008*

Table 3.9: Level of education of farm managers

	All		Eastern region		Upper-East region	
Education level of farm manager	Freq.	Percent	Freq.	Percent	Freq.	Percent
No formal education	236	41.5	62	22.3	174	59.8
Basic education	165	29.0	97	34.9	68	23.4
Secondary/post-sec	156	27.4	112	40.3	44	15.1
Tertiary education	12	2.1	7	2.5	5	1.7
Total	569	100.0	278	100.0	291	100.0

Source: *AFRINT II Household Survey, 2008*

3.3: Chapter summary

There is little difference in demographic characteristics between the re-interviewed and newly sampled households. In the re-interviewed sample, 89% of farm managers in 2002 were also farm managers in 2008. It appears that a substantial number of female household heads in 2002 were de facto heads: their husbands were absent in 2002. Indeed, analysis from the panel suggests that 46% of female headed households in 2002 had become male headed households in 2008 but in the case of male headed households in 2002 only 6% had become female headed households by 2008. Even though this dynamics is not as pronounce in the case of farm managers there is still some significant shifts. About 36% of households in which females were the farm managers in 2002 have males as farm managers in 2008 but only about 8% experienced the shift from male to female farm managers in the same household. There are slightly more (about 16%) female headed

households in the new sample than in the old (about 12%); but even more female farm managers (25%) in the new sample than in the old (16%). The household panel shows an interesting development in terms of household type. Some households that were nuclear in 2002 had become extended in 2008 and vice versa. More common however is households that were extended family household that had become nuclear. Barring any errors of measurement, as much as 54% of households described as extended family households in 2002 were nuclear in 2008 but only 11% applies vice versa. This may be related to the general observation in Ghana and other African countries which suggests that households are becoming more nucleated (Ardayfio-Schandorf, 2006; Oheneba-Sakyi and Takyi, 2006). This may have substantial social capital implications and could impact on the ability of households to cope with livelihood stresses.

The average household size in the old sample is about 7 persons compared to 6 in the new. The average age of household heads and farm managers are 51 and 48 years respectively in the old sample but 55 and 46 years respectively in the new. Based on age of household head, the lifecycle stages of households are similar the two subsamples; even though a slight majority of households in the re-interviewed households are in the above 60s category while in the new sample a similar majority are in the 41-50 years category. On education, the new sample appears to be slightly less educated (5.1 years) than the re-interviewed households (5.3 years) but the difference is not significant.

CHAPTER 4

THE DYNAMICS OF STAPLE FOOD CROP PRODUCTION

This chapter of the report examines staple food crop production in the study villages over time. It investigates whether any changes have occurred in terms of crop production choice and farm expansion or intensification. It also answers the questions: are any observed changes in farm expansion or intensification based on available technology or the adoption of new ones? Are observed changes in staple from production and technology use temporal or long lasting?

4.1: Crop production choice

The general pattern of choice of crops cultivated has not under gone much change, at least with regards to the staples. Maize and cassava remain the main staples in the villages of the Eastern region while rice and sorghum are grown exclusively in the Upper-East villages. There are no significant differences in choice of crop cultivation between the new and re-interviewed household samples. However, a lot more farmers in the Upper-East (42% and 37%) were cultivating maize in 2006 and 2007 (the last two seasons prior to the survey) compared to 2001 (the seasons prior to the 2002 survey) where no household was recorded as having cultivated maize (Table 4.1). Indeed, from the panel about 38% of household in the Upper-East who did not cultivate any maize in 2001 did so in 2007. There also appears to be some significant variation in rice cultivation by households in the panel – about 22% of households that cultivated rice in 2002 did not cultivate the crop in 2008 while 42% of those who did not cultivate in 2002 did so in 2008.[5]

Regarding other food crops and vegetables, the trend remains the same and there is no significant difference in crop cultivation choice between the re-interviewed and new

[5] Reference to 2002 and 2008 in the report refers to the survey years and not necessarily the years in which crops were cultivated or harvested. Actual cultivation and harvesting mostly occurred in the year before the survey.

sample (Table A1, Appendix). In the entire panel only 6% of households who cultivated these crops in 2002 did not cultivate them in 2008. Disaggregation by region tells a similar story. In the case of cash crops, and non-food crops however the 2008 data shows that only 4% of households cultivated any such crops in the Upper-East region compared to 22% of households in the Eastern region villages. But this could be a result of the floods in the Upper-East in 2007. This is reflected in the fact that one season earlier (in 2006) 22% of households in those same villages cultivated cash and non-food crops (Table 4.1). A similar pattern is noticeable in comparing the re-interviewed and newly sampled households (Table A1, Appendix). Exploring the dynamics using the panel shows that in the entire sample, only 25% of households cultivating cash crops and non-food crops in 2002 continued to do so in 2008 – 27% of the Eastern region households and 23% in the Upper-East.

Table 4.1: Household crop choice by region

			Crops grown (% of households)	
	Crops	Obs.	Year 2006	Year 2007
E/R	Maize	278	95.7	94.6
	Cassava	278	95.7	96.0
	Other food & vegetables	278	92.4	92.1
	Non-food cash crops	278	13.3	21.9
U-E/R	Maize	291	41.9	36.8
	Sorghum	291	98.6	98.3
	Rice	291	79.4	71.5
	Other food & vegetables	291	96.2	75.9
	Non-food cash crops	291	21.6	4.1

Source: *AFRINT II Household Survey, 2008*

The newly sampled households are not very different from the entire 2002 sample with regards to crops cultivated in 2002 and when they were formed except in the case of maize cultivation in the Upper-East region (Table A2, Appendix). This is however not a peculiar because as reported earlier in the panel, a substantial number of households that did not cultivate the crop in 2002 indicated that the cultivated the crop in 2008. Thus the observed difference in maize cultivation in these villages between the new sample and the 2002 sample may be due to the fact that in 2002 household interviews it was taken for granted that maize was not considered a major crop in the Upper-East.

As has already been indicated there has been very little change in type of crop cultivated in all study villages. The few farmers who cultivated a crop in 2002 but not in 2008 stated economic and agronomic reasons. For same households this was considered temporary and not an abandonment of the crop. Only 12 households in the Eastern and 44 in the Upper-East region cultivated maize in 2002 but not in 2002 – mostly for agronomic reasons in the Upper-East villages but a matter of choice for the few households in the Eastern region. Only 14 and 5 households 'abandoned' cassava and sorghum respectively. The most widely abandoned crop was non-food cash crops (138 households – 64% of these in the Eastern region who cultivated crops such as cocoa) but more than 95% of these households did so not for economic, agronomic or labour reasons but other unstated reasons.

In the 2008 household sample there were households that cultivated some crops in the season prior to the survey but not in 2002. But again this was not seen entirely as an adoption of the crop because some of the households cultivated these crops between the periods. Some of the observations are therefore attributable to chance variation.

4.2: Crop production practices, technology use and farm productivity

4.2.1: Trends in crop production practices

Intercropping

Intercropping is a very common in Ghana particularly among small-holders. There are social, economic and agronomic advantages and disadvantages of this system of cropping (Ecological Agriculture Projects, 2002). Some of the advantages that apply in most of the study villages are the fact that it enables farmers avoid the risk of dependence on only one crop; reduction in the quantity of fertilizers than may be required given the issues with affordability. There also could be more flexibility in the distribution of labour; the availability of harvest over a much longer period of time; and importantly, farmer of little economic resources can produce a wide variety of crops.

In the total 2008 sample only 28%, 25% and 47% of households cultivated maize, cassava, and sorghum respectively in pure stands while rice is cultivated in pure stands only. The cultivation of crops in pure stands appears to be more common in the Upper-East villages.

For example, while only 11% of farmers cultivating maize did so in pure stands in the Eastern region, 68% of farmers who cultivated the crop in the Upper-East did so in pure stands (Table A3, Appendix). The dynamics in the panel analysis shows that planting maize in pure stands is not common in the Eastern region as 67% of the households that planted maize in pure stands in 2002 intercropped their maize with other crops in 2008 (Table A4, Appendix). For cassava, 59% of farmers who planted in pure stand in 2002 intercropped with other crops in 2008 while in the case of sorghum 56% transited from planting in pure stands to intercropping over the two periods (Tables A5 & A6).

Other production practices

Farm irrigation among staple crop farm farmers is nonexistent in all the study villages except in the case of rice production in the Upper-East region villages. Irrigation is also applied to vegetables in the Upper-East and to some extent in the Easter region. For all farmers who cultivated rice 26% of them applied irrigation. A closer look at the data shows most of the households who practice irrigation (80%) are located in Gaane where the irrigation company, ICOUR, operates. Decomposing the 2008 data into re-interviewed and newly sampled households, we observe a significant difference in rice irrigation between the two sub-samples with more rice irrigating households in the new sample (Table 4.2).

Table 4.2: Rice irrigation in the Upper-East region

	Re-interviewed	New sample	Total
No irrigation	108 78.26	46 65.71	154 74.04
Irrigation	30 21.74	24 34.29	54 25.96
Total	138 100.00	70 100.00	208 100.00

Pearson chi2 (1) = 3.8034 Pr = 0.051

Source: *AFRINT II Household Survey, 2008*

Farmers in the villages across the two regions practice a wide range of agricultural techniques. Specifically for maize production the 3 most important, in terms of the

proportion of farmers who apply such techniques in the entire Ghana sample, are zero or minimum tillage, improved planting practices, and fallowing (Table A7, Appendix). But in the Eastern region villages where maize is most commonly cultivated, intercropping with nitrogen fixing crops ('improved intercropping') is most important (Table 4.3). Fallowing, improved planting practices and zero or minimum tillage are the most commonly practiced on cassava farms. Soil improvements appear to be relatively more important to farmers in the Upper-East region villages. All the most important cultivation practice either for sorghum or rice are targeted at soil improvements or conservation (Table 4.3). In 2002 the 3 most important practices in the Eastern region for both maize and cassava farms were fallowing, crop rotation, and improved intercropping in that order. For sorghum, animal manuring, improved intercropping and soil conservation were most commonly practiced while for rice farms soil conservation, zero or minimum tillage and animal manuring were relatively more common.

Table 4. 3: Most common farm practices by crop type

Order of importance	Eastern Region		Upper-East Region	
	Maize	Cassava	Sorghum	Rice
1	Improved intercropping	Fallowing	Improved intercropping	Improved planting practices
2	Zero or minimum tillage	Improved planting practices	Animal manuring	Zero or minimum tillage
3	Improved planting practices	Zero or minimum tillage	Green manuring	Soil and water conservation

A simple transition matrix (Table A12, Appendix) shows apparent changes towards or away from crop rotation, zero or minimum tillage, and green manuring, in particular. For crop rotation which has become less popular among farmers in the Eastern region villages 69% of maize famers and 70% of cassava farmers who rotated these crops with other crops in 2002 were no longer doing so during the 2008 survey. Minimum or zero tillage had also become relatively more widespread on all the 4 staple crop farms in 2008. Indeed, 78% and 71% of farmers who were not practicing the technique on their maize and cassava

farms respectively had adopted the practice in 2008. In the Upper-East region also, 76% and 70% of sorghum and rice farmers were now applying minimum tillage even though they were not applying it in 2002. Green manuring has also become more popular among sorghum farmers: 86% of farmers not applying green manures in 2002 were doing so in 2008.

4.2.2: Land preparation and the availability and use of farm input

Land preparation

During the key informant and focused group interviews it was clear that mechanised agriculture was more common in the study villages in the Upper-East region and almost nonexistent in the Eastern region where most of the villages had no access to tractors, for example. This is evident in the household survey results which suggest that in the preparation of land for the cultivation of all staple crops slashing with the cutlass is the most common method of land preparation in the Eastern region and this involves very little or no soil disturbance. 84% of maize farmers and 90% of cassava farmers use this method of land preparation in those villages. Only 3 farmers use the tractor to prepare land for maize cultivation and 1 farmer for cassava in the Eastern region. In Upper-East region study villages however, oxen and tractor ploughing is common. Oxen ploughing is used by more than two-thirds (68%) of all farmers to prepare land for maize planting while for sorghum planting 74% of farmers use oxen ploughing. Tractors are used in maize land preparation by some farmers (19% of Upper-East sample maize farmers). In preparing land for rice planting 45% of our sampled farmers mainly use oxen ploughing while 37% use the tractor.

There appears to be some significant shifts in land preparation methods in both regions: from hoe cultivation to cutlass cultivation in the Eastern region and from hoe to oxen ploughing on sorghum farms in the Upper-East villages (Tables A14, Appendix). In the case of the Eastern region villages the hoe and cutlass has always been the traditional implements of farming but it appears the use of the cutlass for land preparation has become more common and this is what may be reflecting in the zero or minimum tillage technique of cultivation which has also become widespread. About 85% of maize farmers and 87% of cassava farmers have shifted from hoe cultivation methods of land

preparation in 2002 to cutlass cultivation methods in 2008. In the Upper-East villages the main changes in land preparation are on sorghum farms where we observe shifts from hoe cultivation and tractor ploughing to oxen ploughing. Specifically, 66% of farmers who prepared their sorghum lands by hoeing in 2002 were now doing so using the oxen plough while out of the few farmers (8 farmers) who prepared their sorghum fields using the tractor in 2002, 50% of them have shifted to oxen ploughing in 2008 (Table A14, Appendix). Some rice farmers also using more oxen ploughing than hoe cultivation – 60% of those who prepared their rice fields by hoe cultivation in 2002 were utilising oxen ploughs in 2008.

Table 4.4: Methods of land preparation by form type

Main method of land preparation	Entire sample		Eastern region		Upper-East region	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Maize farms						
Cutlass slashing	217	59.8	216	84.4	1	0.9
Oxen ploughing	73	20.1	0	0.0	73	68.2
Tractor ploughing	23	6.3	3	1.2	20	18.7
Hoe cultivation	50	13.8	37	14.4	13	12.2
	All		Re-interviewed		New sample	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Cassava farms (E/R)						
Cutlass slashing	240	90.2	124	91.2	116	89.2
Oxen ploughing	0	0.0	0	0.0	0	0.0
Tractor ploughing	1	0.4	0	0.0	1	0.8
Hoe cultivation	25	9.4	12	8.8	13	10.0
Sorghum farms (U-E/R)						
Cutlass slashing	1	0.3	1	0.5	0	0.0
Oxen ploughing	211	73.8	138	74.6	73	72.3
Tractor ploughing	8	2.8	5	2.7	3	3.0
Hoe cultivation	66	23.1	41	22.2	25	24.7
Rice farms (U-E/R)						
Cutlass slashing	1	0.5	1	0.7	0	0.0
Oxen ploughing	95	45.7	62	44.9	33	47.1
Tractor ploughing	77	37.0	53	38.4	24	34.3
Hoe cultivation	35	16.8	22	15.9	13	18.6

Planting materials

The village diagnostic surveys suggest that farm inputs such as improved seeds and fertilizers are available in the survey villages but prices were prohibitive particularly in the case of fertilizer use. Newly two-thirds of all maize farmers in our sample use

improved variety maize planting material. A relatively larger proportion of maize farmers in the Eastern region (about 66%) use the OPV than farmers in the Upper-East villages (62%) and there is a significant relationship between region and choice of maize planting material. Traditional varieties of cassava are most common among farmers. Only about 36% of farmers are planting a different variety of cassava as compared to when their households were formed.

Table 4.5: Staple crop planting material use

Main planting material	Entire sample		Eastern region		Upper-East region	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Maize varieties						
Traditional	127	34.8	89	34.5	38	35.5
OPV, composite	235	64.4	169	65.5	66	61.7
Hybrid	3	0.8	0.0	0.0	3	2.8
				Pearson chi2(2) =	7.4277	Pr = 0.024

	Upper-East region		Re-interviewed		New sample	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Sorghum Varieties						
Traditional	249	87.1	163	88.1	86	85.1
Improved	37	12.9	22	11.9	15	14.9
				Pearson $chi^2(1)$ =	0.5081	Pr = 0.476
Rice varieties						
Traditional	74	35.6	53	38.4	21	30.0
Improved	134	64.4	85	61.5	49	30.0
				Pearson $chi^2(1)$ =	1.4317	Pr = 0.231

Also, 37% of cassava farmers were planting cassava varieties different from that which their parents were cultivating. Some 12% of farmers had experimented with some new cassava varieties which they received from NGOs but the traditional variety remains the most preferred because it cooks better and is preferred for the preparation of traditional dishes. The main planting material for sorghum is the traditional variety – 87% of farmers use this variety. There is no significant difference in the choice of sorghum variety planting material between the re-interviewed sample and the new sample. Unlike sorghum, improved variety rice is more widely cultivated than the traditional variety. But in some of the rice cultivating villages (Zanlerigu and Shia) more farmers (66% and 60% respectively) cultivate the traditional rice variety. In Gaane where the irrigation company

operates, the main rice planting material for 93% of our sampled farmers was the improved variety.

Table 4.6: Trends in maize variety cultivation

2002	2008 Traditional	Improved	Total
Traditional	25	43	68
	36.76	63.24	100.00
Improved	11	26	37
	29.73	70.27	100.00
Hybrid	3	12	15
	20.00	80.00	100.00
Total	39	81	120
	32.50	67.50	100.00

Table 4.7: Trends in sorghum variety cultivation

2002	2008 Traditional	Improved	Total
Traditional	154	21	175
	88.00	12.00	100.00
Improved	5	0	5
	100.00	0.00	100.00
Hybrid	1	0	1
	100.00	0.00	100.00
Total	160	21	181
	88.40	11.60	100.00

Table 4.8: Trends in rice variety cultivation

	2008		
2002	Traditional	Improved	Total
Traditional	37	40	77
	48.05	51.95	100.00
Improved	10	34	44
	22.73	77.27	100.00
Total	47	74	121
	38.84	61.16	100.00

Even though our key informant interviews suggested very minimal or no cultivation of NERICAs 38% of rice farmers indicated they have cultivated NERICA or NERICA descendants.

The trends in crop variety choices show some changes in the case of maize and rice but not sorghum (Table 4.5, Table 4.6, and Table 4.7). For maize, 63% of farmers in the Easter region who cultivated mainly traditional maize varieties in 2002 had OPV as their main variety. Also, for rice, 52% of farmers were cultivating the improved variety in 2008 even though it was their main planting material in 2002.

Table 4.9: Main sources of planting materials

	Maize		Sorghum		Rice	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Own stock	203	58.5	269	94.39	167	80.29
Other farmers or neighbours	10	2.88	2	0.7	6	2.88
Purchased in the market	60	17.29	13	4.56	27	12.98
Purchased from MoFA	74	21.33	1	0.35	8	3.85
Total	347	100	285	100	208	100

The most common source of planting material for all the staple crops is farmers' own stock (Table 4.8). But importantly, 39% and 17% of farmers respectively purchase their maize and rice planning materials. Only 5% of sorghum farmers purchase seed for

planting. With regards to maize there are significant regional differences. For example, 77% of maize farmers in the Upper-East region villages obtain their seeds from own stock compared to 50% from the Eastern region villages. Consequently, a relatively larger proportion of maize farmers in the Eastern region (47%) purchase their maize seeds compared 21% in the Upper-East. There is a very strong significant relationship between type of planting material and the source from which they are obtained. For example, whiles the majority (81%) of farmer who cultivate traditional varieties of maize obtained the seed from their own stock those who cultivate improved seeds (51%) purchase their seeds either from the open market or from the MoFA (A12, Appendix).

Chemical fertilizer consumption in survey villages

Fertilizers are available in the right quantity to farmers in all survey villages provided they can afford it. About 67% and 52% of farmers in the Eastern and Upper-East region villages respectively use some quantity of chemical fertilizers. There is a significant relationship between region and fertilizer use with relatively more farmers in the Eastern region tending to use chemical fertilizers (Table 4.10). Specifically relating to the most recent season before the survey in 2008, even fewer farmers applied fertilizers on their staple crop farms – less than 1%, 2% and 17% for cassava, sorghum and rice respectively. For maize which is cultivated in both regions 33% and 17% of farmers in the Eastern and Upper-East regions respectively applied some fertilizers to the crop during the 2007 season (Table 4.10). Again the regional differences are statistically significant. But we found no significant difference in fertilizer use between the re-interviewed households and the newly sampled households.

Given the average fertilizer prices obtained during the key informant interviews in the study villages and household fertilizer expenditures by crop we use a simple relationship, $Q_{fij} = A_i^{-1}(P_{fij}^{-1} * E_{fij})$, to estimate the per hector quantities of fertilizer use by households in the study villages. A, Q, P and E are farm size, quantity, price and expenditure on fertilizers respectively; the subscripts *i* and *j* denotes a particular staple in a specific survey village. For the entire maize farmer sample our estimates from the data shows an average application of 83kg/ha of fertilizer on maize farms (Table 4.11). There are however significant regional differences – 71kg/ha in the Eastern region villages and 103kg/ha in the Upper-East (A15, Appendix). The differences show that even though

more farmers in the Eastern region apply fertilizer to their maize farms quantity applied is significantly greater in the Upper-East.

Table 4.10: The use of chemical fertilizers among farmers by region

Fertilizer use in recent times	Region		
Fertilizer use	E/R	U-E/R	Total
no	92	141	233
	33.09	48.45	40.95
yes	186	150	336
	66.91	51.55	59.05
Total	278	291	569
	100.00	100.00	100.00
Pearson chi2(1) = 13.8721 Pr = 0.000			
Fertilizer use in 2007, maize			
no	186	239	425
	66.91	82.13	74.69
yes	92	52	144
	33.09	17.87	25.31
Total	278	291	569
	100.00	100.00	100.00
Pearson chi2(1) = 17.4326 Pr = 0.000			

For rice farms an average of 63kg/ha of fertilizer is estimated to be applied. It is probably a reasonable to assumption that fertilizer application may differ by farm type: intercropping or pure stands. We probe this by estimating the difference in estimated quantity of fertilizer use per hector and found intercropped farms receive significantly less fertilizer per hector compared to pure stands (Table A15).

Farmers in our sample and indeed in most parts of Ghana rarely apply fertilizers on cassava. The same applies to sorghum in the Upper-East villages. About 94% of sorghum farmers indicated that they did not apply fertilizers to their farms in 2002. Farmers' own assessment of changes in fertilizer use appears mixed. For example, in the Upper-East region an equal proportion of farmers (25% each) indicated that they were applying more or less fertilizers on their maize farms in 2008 compared to 2002 (Table 4.12). Indeed, in

the Eastern region villages more farmers (22%) indicated an increase in fertiliser application on their maize farm since 2002 compared to farmers who had experienced declines in the use of fertilizer on maize (13%). Some rice farmers (52%) increased fertilizer application on their rice fields in 2008 compared to 2002 but others (35%) were applying less fertilizer in 2008.

4. 11: Fertilizer application by crop

	Obs.	Mean	Std. Dev.	Min	Max
Avg. qty of fertilizer. (kg)					
Maize	144	69	87	1	412
Cassava	5	21	43	1	98
Sorghum	11	47	25	18	94
Rice	100	44	61	0	281
Avg. qty of fertilizer (kg/ha)					
Maize	144	83	69	3	258
Cassava	5	25	27	3	60
Sorghum	11	50	21	22	89
Rice	100	63	72	2	227
Expenditure on fertilizer ($)					
Maize	144	29	40	0	206
Cassava	5	9	18	0	41
Sorghum	11	16	8	6	31
Rice	100	15	21	0	93

4. 12: Changes in fertilizer use on maize since 2002, farmers' assessment

	Region		
	Eastern	Upper-East	Total
No fertiliser applied in 2002	145 57.77	49 46.67	194 54.49
Fertilizer use decreased since	36 14.34	26 24.76	62 17.42
Amount unchanged	14 5.58	4 3.81	18 5.06
Fertilizer use increased since	56 22.31	26 24.76	82 23.03
Total	251 100.00	105 100.00	356 100.00
Pearson chi2(3) = 6.9401 Pr = 0.074			

Pesticide application is relatively more common on maize and rice farms than cassava and sorghum farms. More farmers in the Eastern region also appear to use pesticides than those in the other villages (Table 4.13). With regards to maize which is cultivated in both regions there is a significant relationship between pesticide use and regional location, with significantly more maize farmer in the Eastern region applying pesticides (Table A16). The panel transition matrix reveals a substantial number of farmers (49%) applying pesticides on their maize farms in the Eastern region who were not applying in 2002 (Table A17). On rice farms only 21% of farmers who were not applying pesticides in 2002 were applying them in 2008 (Table A17).

4. 13: Pesticide application

	% of farmers applying
Maize	
Eastern region	52.3
Upper-East region	16.8
Cassava	29.8
Sorghum	3.2
Rice	25.0

4.2.2: Farm size, farm output and productivity of staple crops

Farm size

Staple crop farm sizes have not changed much in our study villages over the past decade. Table 4.14 shows farm sizes estimated from the 2008 survey where we asked farmers about the size of their farms up to two seasons before the survey. Farm sizes range from 0.01 of a hector to 5 hectors. The average maize farm is 0.6ha and had not changed since 2005. Sorghum farms are the largest average farms in our sample. Further investigations show that the first percentile farm size remained 0.2ha with the median farm size being 0.4ha for maize and cassava (thus farms in the Eastern region) since 2005. 25% of sorghum farmers have been cultivating 0.6ha since 2005 with the median sorghum farm size also remaining at 0.8ha since 2005. Rice farms have shown a slight decline in size over the period 2005 to 2007. The first percentile rice farm size was 0.4ha in 2005 and 2006 but by 2007 it had dropped to 0.2ha with median rice farm also declining from 0.5ha in 2005 to

0.4ha in 2007. For maze which is cultivated in both regions we found no significant difference in farm size (Table A18).

We observe significant differences in farm size between the re-interviewed sample and the new sample for maize, cassava and rice but not for sorghum for all three seasons (Table A18). The dynamics from the panel data, which covers the period 1999 to 2007, shows slightly more variation in farm size with a general trend towards declining farm sizes (Table A19). The variation appears to come relatively more from between household farm size variation than variations within the households over the period. It is worth noting that 55% and 58% of newly sampled households in the Eastern region indicated that they were cultivating a larger maize and cassava farms respectively compared to when their households were formed. On the contrary, their counterpart households in the Upper-East region who cultivate sorghum and rice indicated that their farm sizes have remained the same since they formed the households. But in both regions, when farmers were asked to compare farm sizes in 2008 to that in 2002 there were indications of farms remaining unchanged or declining in size.

4.14: Staple crop farm size, 2005-2007

Variable	Obs.	Mean	Std. Dev.	Min	Max
maize					
2007	368	0.60	0.62	0.01	5.00
2006	351	0.60	0.62	0.01	5.00
2005	336	0.60	0.66	0.01	5.00
Cassava					
2007	268	0.52	0.53	0.01	4.00
2006	252	0.53	0.57	0.01	4.00
2005	241	0.50	0.54	0.01	3.20
Sorghum					
2007	286	0.95	0.63	0.10	4.40
2006	286	0.97	0.63	0.10	4.40
2005	284	0.97	0.64	0.10	4.40
Rice					
2007	208	0.60	0.45	0.02	3.00
2006	202	0.64	0.46	0.02	2.40
2005	199	0.64	0.46	0.02	2.40

With the observed general decline or unchanging trends in farm sizes it would be reasonable to assume that any increases in yields may be attributable to increasing intensification rather than extensification. We examine this in the next sub-section.

Output and productivity

As indicated in the last sub-section farm sizes have remained largely unchanged, at least since 2002 which suggests that any expected increases in household staple crop output would be as a result of intensified cropping. The observed average yield figures (Table 4.15) shows declining sorghum and rice yields while maize appears to experience a general increase over all. With the case of rice, further disaggregation of yield outcomes reveal increasing yields only in the Eastern region villages (Figure 4.2). For farmers who cultivate maize in the Upper-East region villages the trend in yield is similar to the case of sorghum and rice. Thus, there appears to be a general decline in yields of all grains in the Upper-East. The district level investigations from the data are no different (Figure 4.4 and Figure 4.5).

For maize which has shown a relative rise in yields in the Eastern region, a district level disaggregation of the data (Figure 4.3) shows a relatively higher rise in yields in the Krobo districts (Akatawia and Asitey) even though average yields remain higher in the Fanteakwa districts where Gyedi and Appa are located.

Table 4.15: Staple crop output and yield, 2005-2007

	Output (kg)	Mean farm size (ha)	Yield (kg/ha)
Maize			
2005	576.44	0.60	866.82
2006	563.00	0.60	846.70
2007	660.69	0.60	907.21
Sorghum			
2005	174.96	0.97	207.77
2006	155.81	0.97	187.30
2007	76.02	0.95	91.01
Rice			
2005	332.73	0.64	540.98
2006	323.05	0.64	502.43
2007	240.68	0.60	381.47

Figure 4. 1: Grain yields in survey villages, 2005-2007

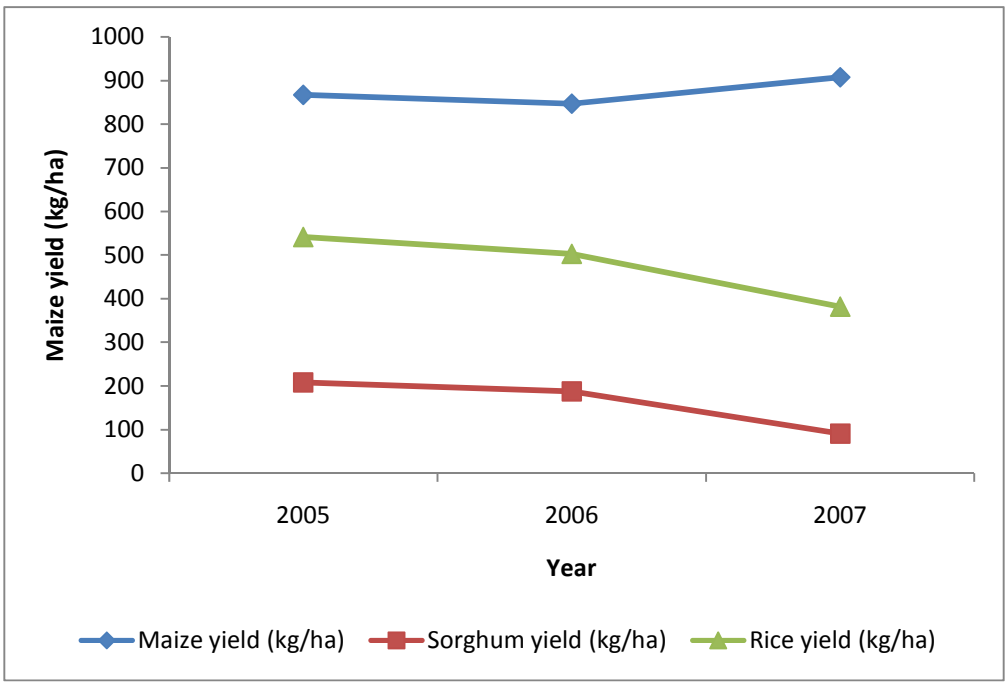
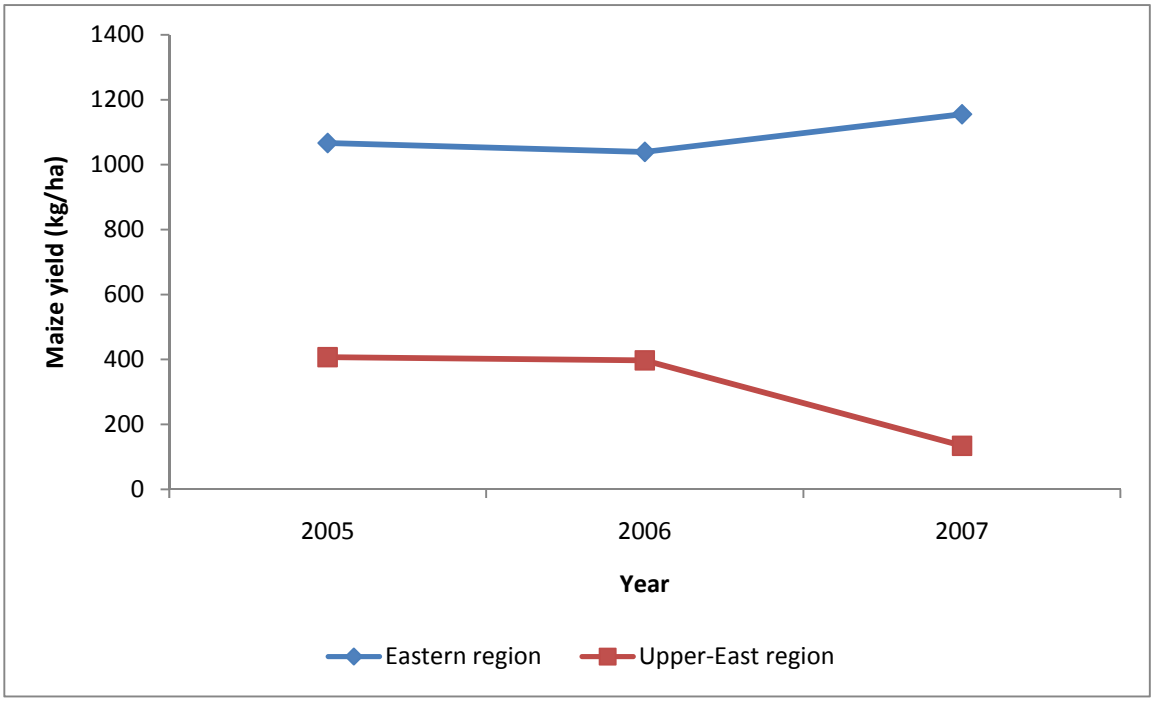


Figure 4. 2: Differences in maize yields by region in survey villages, 2005-2007



Given the availability of district level yield data on all the staples from MoFA, we test whether there is any significant difference between average yields in our survey villages and the entire district averages. Unfortunately we could only do this for the year 2007 for which the official district yield figures are available. The MoFA 2007 yield figures suggest that among the two districts of the Eastern region the Fanteakwa district recorded a higher average maize yield of 1,920kg/ha as against 1,640kg/ha in Manya Krobo district. In the Upper-East region MoFA district average yields for 2007 were 370kg/ha and 460kg/ha for Kasena Nankana and Talensi Nabdam respectively. First, our data also shows relatively higher maize yields in the Fanteakwa villages than in the Krobo villages as is the case for the Talensi Nabdam villages compared to the Kassena Nankana villages. The average 2007 maize yield for our Fanteakwa villages was 1,278kg/ha while that for the Krobo villages is 1,050kg/ha (Table A26, Appendix). The sample averages were 118kg/ha and 115kg/ha for Talensi Nabdam and Kasena Nankana in that order. It is important to note however that our survey villages in the Upper-East experienced flooding in 2007 but this was quite wide spread in the district.

Figure 4. 3: Differences in maize yields by survey districts, 2005, 2007

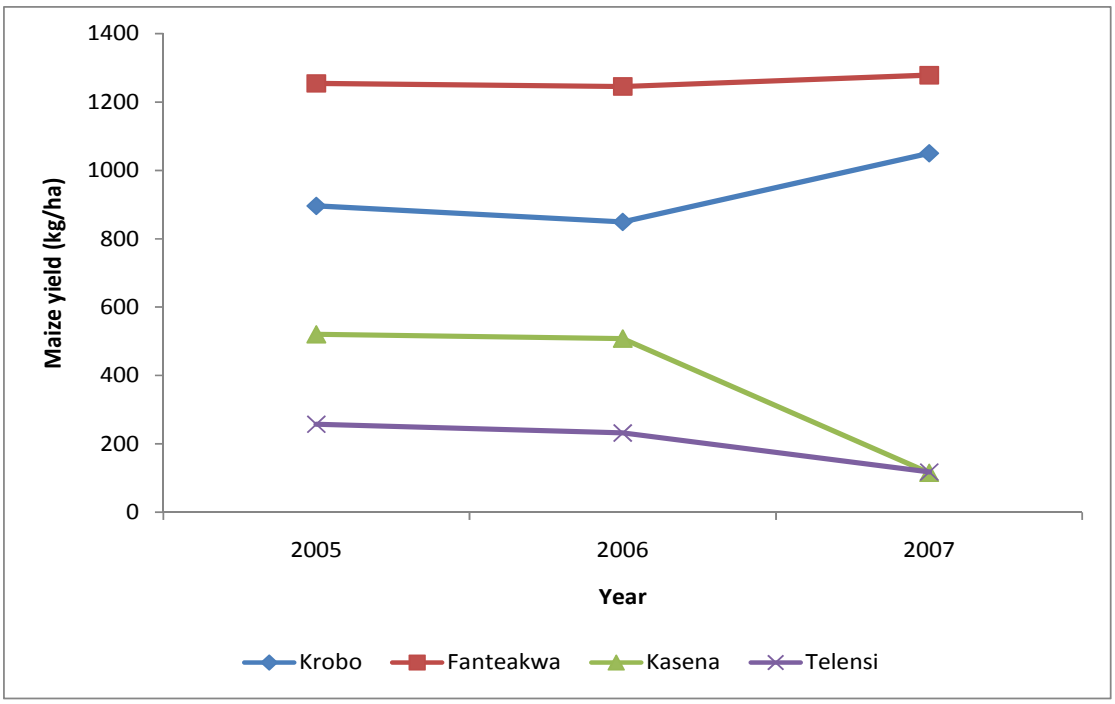


Figure 4. 4: Sorghum yields by survey district, 2005-2007

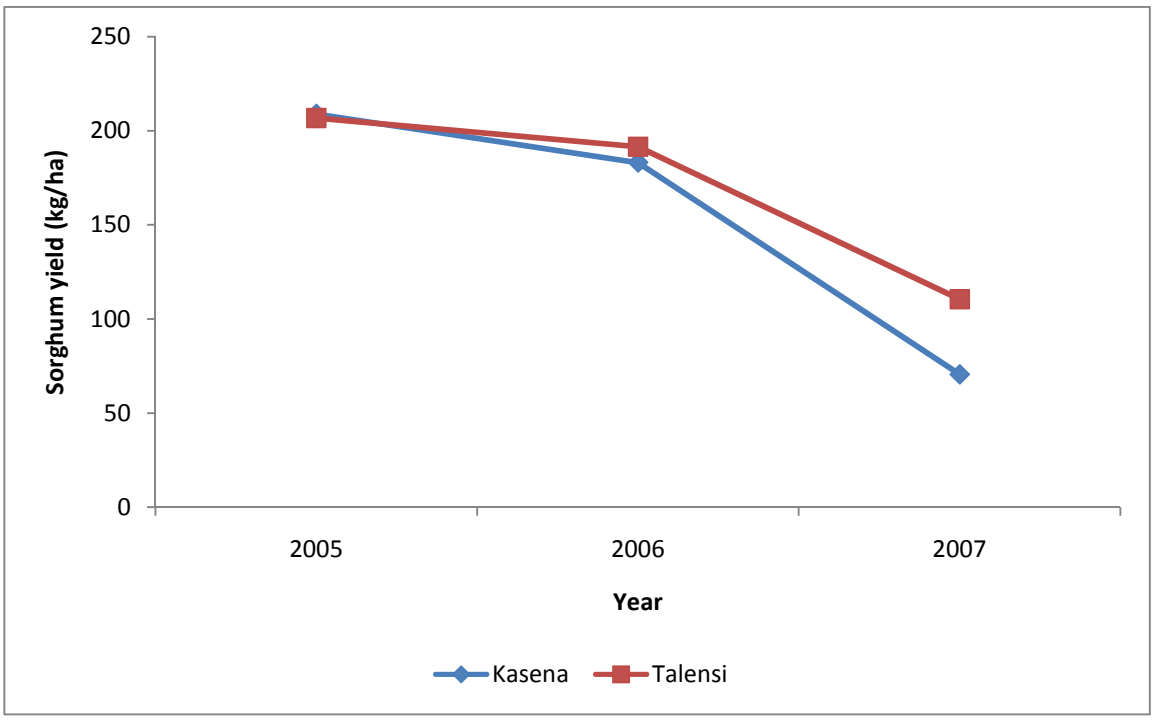
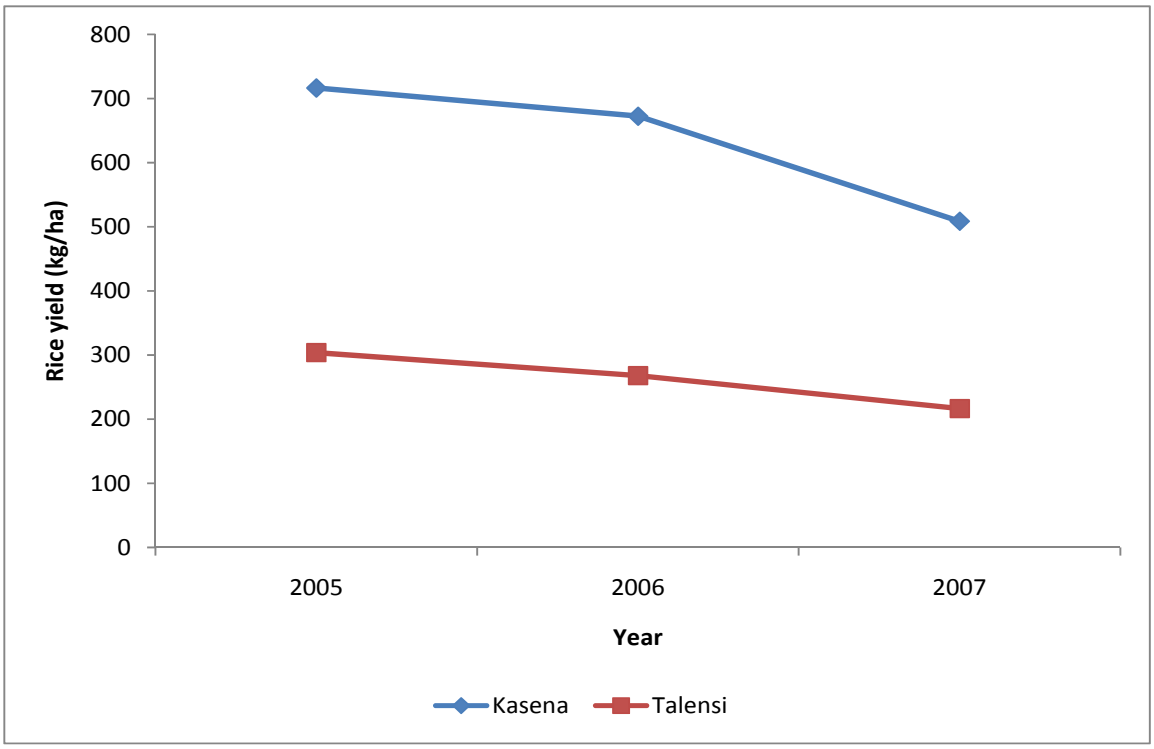


Figure 4. 5: Rice yields in survey districts, 2005-2007



The statistical tests (Table A28, Appendix) shows that in all cases the average yields in our survey villages are significantly less than the MoFA district averages. Similar tests for sorghum and rice shows similar results (Table A29, Appendix). There also exists statistically significant difference in maize yields across regions and also across districts throughout the period 2005-2007 in our sample. In 2007 however, there was no difference in maize yields across districts in the Upper-East region. Maize yields also differ significantly by sample category but only in 2007 with our newly sampled households attaining higher yields. With regards to sorghum and rice, yields differ significantly by district only in 2007 for sorghum but throughout the period 2005-2007 in the case of rice. Re-interviewed sorghum farmers obtain significantly higher yields throughout the period 2005-2007 as compared to our newly sampled households but the is no difference between them in rice yields over the period.

Next we attempt to investigate simple relationships between the observed farm productivity and possible precipitants. First we consider fertilizer use. The assumption is that by and large farmers who apply fertilizers would obtain higher per hector yields. We find no simple significant relationship between fertilizer use and maize yields. Indeed farmers who did not apply fertilizers in 2007 obtained significantly higher yields (Table 4.16). Even though fertilizer application in the Upper-East correlated with relatively higher maize yields, the relationship is not statistically significant (Table A30, Appendix). What this suggests is that many other factors influence productivity and that the effect of the relatively low application of fertilizers are not manifesting in this simple relationship analysis. Disaggregating into per hector fertilizer application quartiles in order to explore whether farmers in the higher quartiles of per hector fertilizer application may be benefiting from yield improvement also did not show any definite pattern albeit in the Eastern region the highest average maize yields are found in households who are in the third and fourth per hector fertilizer application quartiles (Table 4.18).

For rice yields however, there exist a statistically significant difference in yields between farmers who apply fertilizer and those who do not application (Table 4.17).

Table 4.16: Fertilizer application and maize yields, 2007

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
No fertilizer	198	980.9327	47.10452	662.8193	888.0389	1073.827
Some fertilizer	123	788.5442	56.17751	623.0388	677.3352	899.7532
Combined	321	907.2138	36.48199	653.6286	835.4389	978.9886
diff		192.3885	74.38259		46.04612	338.7309

```
diff = mean(no) - mean(yes)                                   t =   2.5865
Ho: diff = 0                                     degrees of freedom =      319

 Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9949         Pr(|T| > |t|) = 0.0101          Pr(T > t) = 0.0051
```

Table 4. 17: Fertilizer application and rice yields, 2007

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
No fertilizer	96	261.5618	29.92776	293.231	202.1476	320.9759
Some fertilizer	97	500.1519	50.84412	500.7565	399.2271	601.0767
combined	193	381.4749	30.72762	426.8817	320.8679	442.082
diff		-238.5901	59.14882		-355.2589	-121.9213

```
 diff = mean(no) - mean(yes)                                  t =  -4.0337
Ho: diff = 0                                     degrees of freedom =      191
    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0001          Pr(T > t) = 1.0000
```

Table 4.18: Maize yields and per hector fertilizer application quartiles

Average per hector fertilizer application quartile	Mean maize yield (kg/ha)
1st Quartile	1038.967
2nd Quartile	941.7962
3rd Quartile	1047.452
4th Quartile	1241.226

Aside from fertilizer application we also explored relationships between agricultural technology application and farm productivity but found no evidence using simple statistical analysis. However we find the well known negative relationship between farm size deciles and farm productivity for maize and sorghum during the period 2005-2007. In the case of rice we observe week positive relationship in 2007 and 2006 but a negative relationship in 2005 (Figure A1, A2 and A3). In order to explore further the determinants of staple crop productivity there would be the need for a more sophisticated modelling approach within which we can jointly take into account all other plausible factors. This is however beyond the current report and would be explored elsewhere.

4.2.3: Staple utilisation and marketing

The most important use of staple crop output is for home consumption. But this is not necessarily in terms of quantities consumed at home. For example, from the average quantity utilisation of staple crop output figures in Table 4.19 the biggest shares of maize, and rice outputs are sold. Even in the case of sorghum a substantial proportion of households utilise the grains for local wine brewing which is essential for sale. Indeed, even for cassava sales, was ranked as the most important during the last season before the survey. Utilisation out output for home consumption is however more widespread as indicated by the percentages in the third column of Table 4.19 below. While 97%, 98% and 99% of households utilise maize, sorghum, and rice respectively for home consumption, a fewer proportion of households sold their output.

Table 4.19: Household utilisation of staple crop output

	Obs.	% of households	Quantity (Kg) Mean	Std. Dev.	Min	Max
Maize						
Home consumption	331	97.4	100.5	80.5	0.6	600.0
Payment for labour	36	10.6	174.7	177.1	12.5	750.0
Sale	254	74.7	599.9	802.2	30.0	7000.0
Other	231	67.9	146.0	406.6	0.4	4550.0
Total	340		663.6	907.9	0.6	7000.0
Sorghum						
Home consumption	268	98.2	65.4	80.3	0.6	763.0
Payment for labour	14	5.1	28.1	19.7	2.0	82.0
Sale	9	3.3	66.7	36.8	15.0	109.0
Other	73	26.7	30.7	33.2	0.2	191.0
Total	273		76.0	95.4	0.6	872.0
Rice						
Home consumption	192	99.0	116.4	166.9	3.0	1733.0
Payment for labour	27	13.9	139.7	183.5	16.7	800.0
Sale	63	32.5	243.4	298.1	16.7	1700.0
Other	85	43.8	107.7	357.3	0.4	3000.0
Total	194		260.8	527.7	3.0	4425.0

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Appendices

Table A.1: Type of crop cultivation by sample group

	Re-interviewed households			New sample		
		% of households			% of households	
	Obs.	Year 2006	Year 2007	Obs.	Year 2006	Year 2007
Eastern region						
Maize	140	95.7	95.0	138	95.7	94.2
Cassava	140	95.0	97.1	138	96.4	94.9
Other food & vegetables	140	91.4	90.7	138	93.5	93.5
Non-food cash crops	140	15.0	26.4	138	11.6	17.4
Upper-East region						
Maize	188	45.2	38.3	103	35.9	34.0
Sorghum	188	98.4	98.4	103	99.0	98.1
Rice	188	79.8	73.4	103	78.6	68.0
Other food & vegetables	188	96.8	73.9	103	95.1	79.6
Non-food cash crops	188	21.8	4.8	103	21.4	2.9

Table A. 2: Type of crop cultivation history among new and re-interviewed sample

	when household was formed		2002	
	New sample	Re-interviewed sample	New household	Re-interviewed sample
	%	%	%	%
E/R				
Maize	95	94	90	98
Cassava	96	94	90	98
Other food crops and vegetables	88	76	84	80
Cash crops & non-food crops	8	12	14	17
U-E/R				
Maize	41	8	43	0
Sorghum	89	92	99	99
Rice	77	80	80	85
Other food crops and vegetables	96	86	96	88
Cash crops & non-food crops	22	11	24	12

Table A. 3: Proportion of households who cultivated in pure stand (%)

	All	E/R	U-E/R	Re-interviewed	New sample
Maize	28	11	68	31	23
Cassava	n.a	25	n.a	24	26
Sorghum	n.a	n.a	47	46	49
Rice	n.a	n.a	100	100	100

Table A. 4: Dynamics of maize pure stand/intercropping (E/R)

	2008		Total
2002	Pure stand	Intercropped	
Pure stand	8	16	24
	33.33%	66.67%	100.00%
Intercropped	9	97	106
	8.49%	91.51%	100.00%
Total	17	113	130
	13.08%	86.92%	100.00%

Table A. 5: Dynamics of cassava pure stand/intercropping (E/R)

	2008		Total
2002	Pure stand	Intercropped	
Pure stand	15	22	37
	40.54%	59.46%	100.00%
Intercropped	16	67	83
	19.28%	80.72%	100.00%
Total	31	89	120
	25.83%	74.17%	100.00%

Table A. 6: Dynamics of sorghum pure stand/intercropping (U-E/R)

	2008		
2002	Pure stand	Intercropped	Total
Pure stand	24	31	55
	43.64%	56.36%	100.00%
Intercropped	60	65	125
	48.00%	52.00%	100.00%
Total	84	96	180
	46.67%	53.33%	100.00%

Table A. 7: Agricultural practices in maize cultivation by region

	Entire sample		Eastern region		Upper-East region	
Agricultural practices	Obs.	% practicing	Obs.	% practicing	Obs.	% practicing
Crop rotation	369	23.0	262	13.0	107	29.9
Improved intercropping	369	16.8	262	85.5	107	26.2
Fallowing	369	63.7	262	1.1	107	10.3
Improved fallowing	369	1.4	262	4.2	107	1.9
Animal manure	369	25.2	262	0.0	107	76.6
Zero or minimum tillage	369	76.4	262	74.4	107	81.3
Breaking the hard pan	369	5.7	262	0.0	107	19.6
Green manuring	369	22.5	262	6.9	107	60.7
Soil & water conservation	369	10.0	262	1.1	107	31.8
Improved planting practices	369	76.2	262	73.7	107	82.2
INM	369	2.4	262	0.0	107	8.4
IPM	369	1.9	262	0.0	107	6.5
Agro forestry	369	3.3	262	1.1	107	8.4
Pesticides/herbicides	369	42.0	262	52.3	107	16.8

Table A. 8: Agricultural practices in maize cultivation by sample type

	Old sample		New sample	
Agricultural practices	Obs.	% practicing	Obs.	% practicing
Crop rotation	205	22.4	164	23.8
Improved intercropping	205	16.6	164	17.1
Fallowing	205	56.6	164	72.6
Improved fallowing	205	1.5	164	1.2
Animal manure	205	28.3	164	21.3
Zero or minimum tillage	205	79.0	164	73.2
Breaking the hard pan	205	7.3	164	3.7
Green manuring	205	25.9	164	18.3
Soil & water conservation	205	13.7	164	5.5
Improved planting practices	205	77.6	164	74.4
INM	205	3.4	164	1.2
IPM	205	2.4	164	1.2
Agro forestry	205	3.4	164	3.0
Pesticides/herbicides	205	40.0	164	44.5

Table A. 9: Agricultural practices in cassava cultivation, Eastern region

	Entire E/R sample		Re-interviewed		New	
Agricultural practices	Obs.	% practicing	Obs.	% practicing	Obs.	% practicing
Crop rotation	267	19.1	136	22.1	131	16.0
Improved intercropping	267	9.4	136	5.9	131	13.0
Fallowing	267	74.9	136	77.2	131	72.5
Improved fallowing	267	0.4	136	0.0	131	0.8
Animal manure	267	2.2	136	2.2	131	2.3
Zero or minimum tillage	267	66.7	136	66.2	131	67.2
Breaking the hard pan	267	0.4	136	0.0	131	0.8
Green manuring	267	10.9	136	11.8	131	9.9
Soil & water conservation	267	2.2	136	1.5	131	3.1
Improved planting practices	267	69.3	136	70.6	131	67.9
INM	267	0.0	136	0.0	131	0.0
IPM	267	0.0	136	0.0	131	0.0
Agro forestry	267	1.1	136	0.7	131	1.5
Pesticides/herbicides	267	30.0	136	27.2	131	32.8

Table A. 10: Agricultural practices in sorghum cultivation, Upper-East region

	Entire U-E/R sample		Re-interviewed		New	
Agricultural practices	Obs.	% practicing	Obs.	% practicing	Obs.	% practicing
Crop rotation	286	15.4	185	15.7	101	14.9
Improved intercropping	286	92.0	185	90.8	101	94.1
Fallowing	286	5.2	185	3.8	101	7.9
Improved fallowing	286	1.0	185	0.5	101	2.0
Animal manure	286	91.6	185	91.9	101	91.1
Zero or minimum tillage	286	76.2	185	75.1	101	78.2
Breaking the hard pan	286	11.2	185	10.8	101	11.9
Green manuring	286	80.8	185	84.9	101	73.3
Soil & water conservation	286	46.5	185	44.3	101	50.5
Improved planting practices	286	69.2	185	68.6	101	70.3
INM	286	2.4	185	3.2	101	1.0
IPM	286	0.7	185	1.1	101	0.0
Agro forestry	286	5.9	185	6.5	101	5.0
Pesticides/herbicides	286	3.1	185	4.3	101	1.0

Table A. 11: Agricultural practices in rice cultivation, Upper-East region

	Entire U-E/R sample		Re-interviewed		New	
Agricultural practices	Obs.	% practicing	Obs.	% practicing	Obs.	% practicing
Crop rotation	208	7.7	138	10.9	70	1.4
Improved intercropping	208	2.9	138	3.6	70	1.4
Fallowing	208	2.9	138	2.9	70	2.9
Improved fallowing	208	1.0	138	1.4	70	0.0
Animal manure	208	37.5	138	41.3	70	30.0
Zero or minimum tillage	208	72.6	138	70.3	70	77.1
Breaking the hard pan	208	25.5	138	28.3	70	20.0
Green manuring	208	27.9	138	32.6	70	18.6
Soil & water conservation	208	71.2	138	68.8	70	75.7
Improved planting practices	208	76.9	138	72.5	70	85.7
INM	208	7.7	138	5.8	70	11.4
IPM	208	6.3	138	5.8	70	7.1
Agro forestry	208	1.0	138	1.4	70	0.0
Pesticides/herbicides	208	25.0	138	26.1	70	22.9

Table A. 12: The dynamics of agricultural techniques on stable crop farms

Rotating maize with other crops

2002	2008 No	2008 Yes	Total
No	78	15	93
	83.87	16.13	100.00
Yes	25	11	36
	69.44	30.56	100.00
Total	103	26	129
	79.84	20.16	100.00

Rotating cassava with other crops

2002	2008 No	2008 Yes	Total
No	81	18	99
	81.82	18.18	100.00
Yes	23	10	33
	69.70	30.30	100.00
Total	104	28	132
	78.79	21.21	100.00

Rotating sorghum with other crops

2002	2008 No	2008 yes	Total
No	112	20	132
	84.85	15.15	100.00
Yes	41	9	50
	82.00	18.00	100.00
Total	153	29	182
	84.07	15.93	100.00

Rotating rice with other crops

2002	2008 No	2008 Yes	Total
No	101	12	113
	89.38	10.62	100.00
Yes	12	2	14
	85.71	14.29	100.00
Total	113	14	127
	88.98	11.02	100.00

Fallowing maize farms

2002	2008 No	2008 Yes	Total
No	1	21	22
	4.55	95.45	100.00
Yes	17	90	107
	15.89	84.11	100.00
Total	18	111	129
	13.95	86.05	100.00

Fallowing cassava farms

2002	2008 No	2008 Yes	Total
No	5	19	24
	20.83	79.17	100.00
Yes	22	85	107
	20.56	79.44	100.00
Total	27	104	131
	20.61	79.39	100.00

Fallowing on sorghum farms

2002	2008 No	2008 Yes	Total
No	156	7	163
	95.71	4.29	100.00
Yes	20	0	20
	100.00	0.00	100.00
Total	176	7	183
	96.17	3.83	100.00

Fallowing on rice farms

2002	2008 No	2008 Yes	Total
No	121	3	124
	97.58	2.42	100.00
Yes	3	0	3
	100.00	0.00	100.00
Total	124	3	127
	97.64	2.36	100.00

Intercropping maize with nitrogen fixing crops

	2008		
2002	No	Yes	Total
No	93	12	105
	88.57	11.43	100.00
Yes	22	2	24
	91.67	8.33	100.00
Total	115	14	129
	89.15	10.85	100.00

Intercropping cassava with nitrogen fixing crops

	2008		
2002	No	Yes	Total
No	102	6	108
	94.44	5.56	100.00
Yes	22	2	24
	91.67	8.33	100.00
Total	124	8	132
	93.94	6.06	100.00

Intercropping sorghum with nitrogen fixing crops

	2008		
2002	No	Yes	Total
No	4	39	43
	9.30	90.70	100.00
Yes	12	128	140
	8.57	91.43	100.00
Total	16	167	183
	8.74	91.26	100.00

Intercropping rice with nitrogen fixing crops

	2008		
2002	No	Yes	Total
No	113	4	117
	96.58	3.42	100.00
Yes	10	0	10
	100.00	0.00	100.00
Total	123	4	127
	96.85	3.15	100.00

Zero or minimum tillage on maize farms

	2008		
2002	No	Yes	Total
No	26	93	119
	21.85	78.15	100.00
Yes	3	6	9
	33.33	66.67	100.00
Total	29	99	128
	22.66	77.34	100.00

Zero or minimum tillage on cassava farms

	2008		
2002	No	Yes	Total
No	35	86	121
	28.93	71.07	100.00
Yes	8	3	11
	72.73	27.27	100.00
Total	43	89	132
	32.58	67.42	100.00

Zero or minimum tillage on sorghum farms

	2008		
2002	No	Yes	Total
No	28	88	116
	24.14	75.86	100.00
Yes	18	49	67
	26.87	73.13	100.00
Total	46	137	183
	25.14	74.86	100.00

Zero or minimum tillage on rice farms

	2008		
2002	No	Yes	Total
No	26	61	87
	29.89	70.11	100.00
Yes	11	29	40
	27.50	72.50	100.00
Total	37	90	127
	29.13	70.87	100.00

Animal manure application on maize farms

	2008		
2002	No	Yes	Total
No	123	2	125
	98.40	1.60	100.00
Yes	2	1	3
	66.67	33.33	100.00
Total	125	3	128
	97.66	2.34	100.00

Animal manure application on cassava farms

	2008		
2002	No	Yes	Total
No	123	2	125
	98.40	1.60	100.00
Yes	6	1	7
	85.71	14.29	100.00
Total	129	3	132
	97.73	2.27	100.00

Animal manure application on sorghum farms

	2008		
2002	No	Yes	Total
No	6	31	37
	16.22	83.78	100.00
Yes	9	137	146
	6.16	93.84	100.00
Total	15	168	183
	8.20	91.80	100.00

Animal manure application on rice farms

	2008		
2002	No	Yes	Total
No	66	32	98
	67.35	32.65	100.00
Yes	12	17	29
	41.38	58.62	100.00
Total	78	49	127
	61.42	38.58	100.00

Green manuring on maize farms

	2008		
2002	No	Yes	Total
No	107	9	116
	92.24	7.76	100.00
Yes	12	0	12
	100.00	0.00	100.00
Total	119	9	128
	92.97	7.03	100.00

Green manuring on cassava farms

	2008		
2002	No	Yes	Total
No	103	14	117
	88.03	11.97	100.00
Yes	12	3	15
	80.00	20.00	100.00
Total	115	17	132
	87.12	12.88	100.00

Green manuring on sorghum farms

	2008		
2002	No	Yes	Total
No	17	102	119
	14.29	85.71	100.00
Yes	10	54	64
	15.63	84.38	100.00
Total	27	156	183
	14.75	85.25	100.00

Green manuring on rice farms

	2008		
2002	No	Yes	Total
No	72	37	109
	66.06	33.94	100.00
Yes	15	3	18
	83.33	16.67	100.00
Total	87	40	127
	68.50	31.50	100.00

Soil conservation on maize farms

	2008		
2002	No	Yes	Total
No	118	2	120
	98.33	1.67	100.00
Yes	8	0	8
	100.00	0.00	100.00
Total	126	2	128
	98.44	1.56	100.00

Soil conservation on cassava farms

	2008		
2002	No	Yes	Total
No	123	3	126
	97.62	2.38	100.00
Yes	6	0	6
	100.00	0.00	100.00
Total	129	3	132
	97.73	2.27	100.00

Soil conservation on sorghum farms

	2008		
2002	No	Yes	Total
No	66	35	101
	65.35	34.65	100.00
Yes	37	45	82
	45.12	54.88	100.00
Total	103	80	183
	56.28	43.72	100.00

Soil conservation on rice farms

	2008		
2002	No	Yes	Total
No	23	44	67
	34.33	65.67	100.00
Yes	16	44	60
	26.67	73.33	100.00
Total	39	88	127
	30.71	69.29	100.00

Table A. 13: Relationship between type of maize planting material and where it is obtained

	Sources of maize seeds				
	own stock	other farmer	market	MoFA	Total
Traditional	92	5	15	2	114
	80.70	4.39	13.16	1.75	100.00
Improved	106	5	44	72	227
	46.70	2.20	19.38	31.72	100.00
hybrid	2	0	1	0	3
	66.67	0.00	33.33	0.00	100.00
Total	200	10	60	74	344
	58.14	2.91	17.44	21.51	100.00

Pearson chi2(6) = 50.9131 Pr = 0.000

Table A. 14: Changes in land preparation methods

I: shifts for hoe to cutlass cultivation in the Eastern region

Maize	2008		
2002	Hoe	Cutlass	Total
Hoe	18	106	124
	14.52	85.48	100.00
Tractor	1	0	1
	100.00	0.00	100.00
Total	19	106	125
	15.20	84.80	100.00
Cassava			Total
Hoe	9	59	68
	13.24	86.76	100.00

Tractor	1	0	1
	100.00	0.00	100.00
Total	10	59	69
	14.49	85.51	100.00

II: From hoe to oxen ploughing in the Upper-East

Sorghum	2008				
2002	Hoe	Oxen plough	Tractor	Cutlass	Total
Hoe	21	45	2	0	68
	30.88	66.18	2.94	0.00	100.00
Oxen plough	15	85	2	1	103
	14.56	82.52	1.94	0.97	100.00
Tractor	3	4	1	0	8
	37.50	50.00	12.50	0.00	100.00
Cutlass	1	1	0	0	2
	50.00	50.00	0.00	0.00	100.00
Total	40	135	5	1	181
	22.10	74.59	2.76	0.55	100.00

Rice	2008				
2002	Hoe	Oxen plough	Tractor	Cutlass	Total
Hoe	10	27	8	0	45
	22.22	60.00	17.78	0.00	100.00
Oxen plough	6	20	6	1	33
	18.18	60.61	18.18	3.03	100.00
Tractor	3	7	37	0	47
	6.38	14.89	78.72	0.00	100.00
Total	19	54	51	1	125
	15.20	43.20	40.80	0.80	100.00

Table A. 15: Regional difference in quantity of fertilizer application on maize farms

A

```
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group   |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------  +--------------------------------------------------------------------
Eastern    |      92    70.83021    5.807802    55.70648    59.29373     82.3667
Upper-East |      52    103.3406    11.54663     83.2639    80.15983    126.5215
---------  +--------------------------------------------------------------------
Combined   |     144    82.57009    5.708719    68.50463    71.28571    93.85447
---------  +--------------------------------------------------------------------
    diff   |           -32.51043    11.61073               -55.46265   -9.558219
------------------------------------------------------------------------------
    diff = mean(eastern) - mean(upper ea)                         t =  -2.8000
Ho: diff = 0                                     degrees of freedom =      142

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0029         Pr(|T| > |t|) = 0.0058          Pr(T > t) = 0.9971
```

A15 B: Relationship between intercropping and fertilizer application

```
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group   |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
-----------+------------------------------------------------------------------
pure stand |      53     92.4192    10.25607    74.66531    71.83889    112.9995
intercrop  |      91     76.8338    6.749048    64.38182    63.42564    90.24196
-----------+------------------------------------------------------------------
combined   |     144    82.57009    5.708719    68.50463    71.28571    93.85447
-----------+------------------------------------------------------------------
    diff   |             15.5854    11.80641               -7.753643    38.92443
------------------------------------------------------------------------------
    diff = mean(pure sta) - mean(intercro)                        t =   1.3201
Ho: diff = 0                                     degrees of freedom =      142

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9055         Pr(|T| > |t|) = 0.1889          Pr(T > t) = 0.0945
```

Table A. 16: Differences in pesticide application on maize by region

	Region		
	Eastern	Upper east	Total
no	125	89	214
	47.71	83.18	57.99
yes	137	18	155
	52.29	16.82	42.01
Total	262	107	369
	100.00	100.00	100.00

Pearson chi2(1) = 39.2311 Pr = 0.000

Table A. 17: Changes in pesticide application on maize and rice farms, 2002-2008

Maize	2008		
2002	No	Yes	Total
No	55	53	108
	50.93	49.07	100.00
Yes	5	11	16
	31.25	68.75	100.00
Total	60	64	124
	48.39	51.61	100.00
Rice			
No	89	24	113
	78.76	21.24	100.00
Yes	2	11	13
	15.38	84.62	100.00
Total	91	35	126
	72.22	27.78	100.00

Table A. 18: Differences in maize farm size by region, 2005-2007

Most recent season, 2007

```
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
 eastern |     261    .6167663    .0431453    .6970341    .5318075     .701725
upper ea |     107    .5514019    .0378249    .3912642    .4764103    .6263935
---------+--------------------------------------------------------------------
combined |     368    .5977609    .0325252    .6239415    .5338017      .66172
---------+--------------------------------------------------------------------
    diff |            .0653644    .0716399                -.075513    .2062418
------------------------------------------------------------------------------
    diff = mean(eastern) - mean(upper ea)                         t =   0.9124
Ho: diff = 0                                     degrees of freedom =      366

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.8189         Pr(|T| > |t|) = 0.3622          Pr(T > t) = 0.1811
```

Season before the most recent , 2006

```
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
 eastern |     248    .5916653    .0423282    .6665852    .5082951    .6750356
upper ea |     103    .6067961    .0485319    .4925448    .5105334    .7030589
---------+--------------------------------------------------------------------
combined |     351    .5961054    .0330898    .6199374    .5310255    .6611853
---------+--------------------------------------------------------------------
    diff |           -.0151308    .0727698               -.1582534    .1279918
------------------------------------------------------------------------------
    diff = mean(eastern) - mean(upper ea)                         t =  -0.2079
Ho: diff = 0                                     degrees of freedom =      349

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.4177         Pr(|T| > |t|) = 0.8354          Pr(T > t) = 0.5823
```

Two seasons before the most recent, 2005

```
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
 eastern |     239    .6021883    .0478677    .7400163    .5078899    .6964867
upper ea |      97    .5948454    .0434095    .4275344    .5086781    .6810126
---------+--------------------------------------------------------------------
combined |     336    .6000685    .0362469    .6644169    .5287682    .6713687
---------+--------------------------------------------------------------------
    diff |            .0073429    .0801068               -.1502344    .1649203
------------------------------------------------------------------------------
    diff = mean(eastern) - mean(upper ea)                         t =   0.0917
Ho: diff = 0                                     degrees of freedom =      334

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.5365         Pr(|T| > |t|) = 0.9270          Pr(T > t) = 0.4635
```

Table A. 19: Differences in maize farm size by sample category, 2005-2007

2007

```
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
     old |     204    .6567941    .0444916    .6354679    .5690691    .7445192
     new |     164    .5243293    .0471004    .6031798    .4313236    .6173349
---------+--------------------------------------------------------------------
combined |     368    .5977609    .0325252    .6239415    .5338017      .66172
---------+--------------------------------------------------------------------
    diff |            .1324649    .0651606                .0043287     .260601
------------------------------------------------------------------------------
    diff = mean(old) - mean(new)                                  t =   2.0329
Ho: diff = 0                                     degrees of freedom =      366

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9786         Pr(|T| > |t|) = 0.0428          Pr(T > t) = 0.0214
```

2006

```
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
     old |     196    .6697092    .0441644    .6183022    .5826079    .7568105
     new |     155    .5030323    .0491061    .6113657    .4060238    .6000407
---------+--------------------------------------------------------------------
combined |     351    .5961054    .0330898    .6199374    .5310255    .6611853
---------+--------------------------------------------------------------------
    diff |            .1666769    .0661321                .0366094    .2967444
------------------------------------------------------------------------------
    diff = mean(old) - mean(new)                                      t =   2.5204
Ho: diff = 0                                     degrees of freedom =      349

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9939         Pr(|T| > |t|) = 0.0122          Pr(T > t) = 0.0061
```

2005

```
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
     old |     191    .6705916    .0503518    .6958754    .5712713    .7699119
     new |     145    .5071724    .0507031    .6105459     .406954    .6073909
---------+--------------------------------------------------------------------
combined |     336    .6000685    .0362469    .6644169    .5287682    .6713687
---------+--------------------------------------------------------------------
    diff |            .1634192    .0727449                .0203234     .306515
------------------------------------------------------------------------------
    diff = mean(old) - mean(new)                                      t =   2.2465
Ho: diff = 0                                     degrees of freedom =      334

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9873         Pr(|T| > |t|) = 0.0253          Pr(T > t) = 0.0127
```

Table A. 20: Differences in cassava farm size by sample category, 2005-2007

2007

```
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
     old |     136    .5776912    .0463398    .5404105    .4860453    .6693371
     new |     132    .4601515    .0442063    .5078919    .3727009    .5476022
---------+--------------------------------------------------------------------
combined |     268    .5197985    .0321894    .5269633    .4564212    .5831759
---------+--------------------------------------------------------------------
    diff |            .1175397    .0641031               -.0086743    .2437536
------------------------------------------------------------------------------
    diff = mean(old) - mean(new)                                      t =   1.8336
Ho: diff = 0                                     degrees of freedom =      266

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9661         Pr(|T| > |t|) = 0.0678          Pr(T > t) = 0.0339
```

2006

```
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
     old |     127    .6141732     .054245    .6113106    .5068239    .7215226
     new |     125       .4434    .0449648    .5027223     .354402     .532398
---------+--------------------------------------------------------------------
combined |     252    .5294643     .035622     .565481    .4593083    .5996203
---------+--------------------------------------------------------------------
    diff |            .1707732    .0705667                .0317922    .3097543
------------------------------------------------------------------------------
    diff = mean(old) - mean(new)                                  t =   2.4200
Ho: diff = 0                                     degrees of freedom =      250

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9919         Pr(|T| > |t|) = 0.0162          Pr(T > t) = 0.0081
```

2005

```
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
     old |     125       .5648    .0547966    .6126445    .4563422    .6732578
     new |     116    .4344828    .0407772    .4391837     .353711    .5152545
---------+--------------------------------------------------------------------
combined |     241    .5020747    .0347249    .5390755    .4336702    .5704792
---------+--------------------------------------------------------------------
    diff |            .1303172    .0691315               -.0058676    .2665021
------------------------------------------------------------------------------
    diff = mean(old) - mean(new)                                      t =   1.8851
Ho: diff = 0                                     degrees of freedom =      239

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9697         Pr(|T| > |t|) = 0.0606          Pr(T > t) = 0.0303
```

Table A. 21: Differences in sorghum farm size by sample category

2007

```
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
     old |     185    .9724325    .0483297    .6573556    .8770807    1.067784
     new |     101    .9168317    .0569187    .5720261    .8039066    1.029757
---------+--------------------------------------------------------------------
combined |     286    .9527972    .0371399    .6280931    .8796939    1.025901
---------+--------------------------------------------------------------------
    diff |            .0556007    .0777738               -.0974855     .208687
------------------------------------------------------------------------------
    diff = mean(old) - mean(new)                                      t =   0.7149
Ho: diff = 0                                     degrees of freedom =      284

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.7624         Pr(|T| > |t|) = 0.4753          Pr(T > t) = 0.2376
```

2006

```
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
     old |     185    .9951352    .0490107    .6666171      .89844     1.09183
     new |     101    .9168317    .0565698     .568519    .8045989    1.029064
---------+--------------------------------------------------------------------
combined |     286    .9674825    .0374778    .6338066    .8937142    1.041251
---------+--------------------------------------------------------------------
    diff |            .0783035    .0784143               -.0760435    .2326505
------------------------------------------------------------------------------
    diff = mean(old) - mean(new)                                      t =   0.9986
Ho: diff = 0                                     degrees of freedom =      284

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.8406         Pr(|T| > |t|) = 0.3188          Pr(T > t) = 0.1594
```

2005

```
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
     old |     184    .9983696    .0493632    .6695954    .9009753    1.095764
     new |     100        .918    .0577592    .5775917    .8033933    1.032607
---------+--------------------------------------------------------------------
combined |     284    .9700704     .037908    .6388362    .8954531    1.044688
---------+--------------------------------------------------------------------
    diff |            .0803696    .0793634               -.0758503    .2365894
------------------------------------------------------------------------------
    diff = mean(old) - mean(new)                                      t =   1.0127
Ho: diff = 0                                     degrees of freedom =      282

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.8440         Pr(|T| > |t|) = 0.3121          Pr(T > t) = 0.1560
```

Table A. 22: Differences in rice farm size by sample category

2007

```
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
     old |     138    .6528986    .0412077    .4840812    .5714131     .734384
     new |      70        .496    .0404152    .3381381    .4153738    .5766262
---------+--------------------------------------------------------------------
combined |     208    .6000962    .0309098    .4457876    .5391578    .6610346
---------+--------------------------------------------------------------------
    diff |            .1568986     .064655                .0294282    .2843689
------------------------------------------------------------------------------
    diff = mean(old) - mean(new)                                      t =   2.4267
Ho: diff = 0                                     degrees of freedom =      206

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9920         Pr(|T| > |t|) = 0.0161          Pr(T > t) = 0.0080
```

2006

```
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
     old |     135    .6859259    .0426092    .4950747    .6016523    .7701996
     new |      67     .540597    .0443557    .3630672     .452038    .6291561
---------+--------------------------------------------------------------------
combined |     202    .6377228    .0323493    .4597693    .5739353    .7015102
---------+--------------------------------------------------------------------
    diff |            .1453289    .0681093                .0110244    .2796334
------------------------------------------------------------------------------
    diff = mean(old) - mean(new)                                  t =   2.1338
Ho: diff = 0                                     degrees of freedom =      200

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9830         Pr(|T| > |t|) = 0.0341          Pr(T > t) = 0.0170
```

2005

```
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
     old |     133    .6917293    .0434086    .5006125    .6058628    .7775959
     new |      66    .5442424    .0445679    .3620712    .4552342    .6332507
---------+--------------------------------------------------------------------
combined |     199    .6428141    .0328662    .4636353    .5780013    .7076269
---------+--------------------------------------------------------------------
    diff |            .1474869    .0691916                .0110356    .2839382
------------------------------------------------------------------------------
    diff = mean(old) - mean(new)                                      t =   2.1316
Ho: diff = 0                                     degrees of freedom =      197

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9829         Pr(|T| > |t|) = 0.0343          Pr(T > t) = 0.0171
```

Table A. 23: Changes in maize farm size over time, 1999-2007

		Mean	Std. Dev.	Min	Max	Observations
Maize						
2001/2007	overall	1.45	9.77	0.02	160.00	N = 268
	between		6.81	0.07	80.80	n = 140
	within		6.88	-77.75	80.65	T-bar = 1.91429
2000/2006	overall	0.94	1.11	0.01	10.00	N = 258
	between		0.86	0.04	5.94	n = 138
	within		0.70	-3.12	5.00	T-bar = 1.86957
1999/2005	overall	0.99	1.53	0.01	19.00	N = 254
	between		1.15	0.04	11.10	n = 139
	within		0.98	-6.91	8.89	T-bar = 1.82734
Cassava						
2001/2007	overall	0.77	0.82	0.01	8.80	N = 271
	between		0.62	0.07	5.40	n = 140
	within		0.53	-2.63	4.17	T-bar = 1.93571
2000/2006	overall	0.80	0.85	0.02	8.00	N = 259
	between		0.72	0.04	5.40	n = 139
	within		0.49	-1.80	3.40	T-bar = 1.86331
1999/2005	overall	0.80	0.87	0.02	8.40	N = 253
	between		0.73	0.04	5.80	n = 139
	within		0.50	-1.80	3.40	T-bar = 1.82014
Sorghum						
2001/2007	overall	0.88	0.60	0.10	4.40	N = 368
	between		0.46	0.15	3.00	n = 188
	within		0.39	-0.92	2.68	T-bar = 1.95745
2000/2006	overall	1.36	1.38	0.20	10.00	N = 293
	between		0.94	0.20	5.50	n = 187
	within		0.96	-3.14	5.86	T-bar = 1.56684
1999/2005	overall	0.92	0.73	0.10	8.00	N = 364
	between		0.56	0.15	4.40	n = 188
	within		0.46	-2.68	4.52	T-bar = 1.93617
Rice						
2001/2007	overall	0.64	0.75	0.10	11.00	N = 300
	between		0.54	0.10	5.90	n = 173
	within		0.50	-4.46	5.74	T-bar = 1.7341
2000/2006	overall	0.61	0.49	0.10	4.00	N = 294
	between		0.39	0.10	2.80	n = 171
	within		0.29	-0.69	1.91	T-bar = 1.7193
1999/2005	overall	0.64	0.69	0.10	9.00	N = 288
	between		0.54	0.10	5.50	n = 170
	within		0.39	-2.86	4.14	T-bar = 1.69412

Table A. 24: Staple crop yield in survey villages, 2005-2007

	Variable	Obs	Mean	Std. Dev.	Min	Max
Maize						
2007	Output (kg)	321	660.69	931.46	0.60	7000.00
	Area (ha)	368	0.60	0.62	0.01	5.00
	Yield (kg/ha)	321	907.21	653.63	1.50	3100.00
2006	Output (kg)	336	563.00	752.18	16.70	5000.00
	Area (ha)	351	0.60	0.62	0.01	5.00
	Yield (kg/ha)	336	846.70	584.39	42.50	2500.00
2005	Output (kg)	311	576.44	812.42	5.50	7650.00
	Area (ha)	336	0.60	0.66	0.01	5.00
	Yield (kg/ha)	310	866.82	672.85	27.50	6250.00
Sorghum						
2007	Output (kg)	273	76.02	95.43	0.60	872.00
	Area (ha)	286	0.95	0.63	0.10	4.40
	Yield (kg/ha)	273	91.01	99.42	0.75	726.67
2006	Output (kg)	280	155.81	132.46	6.00	818.00
	Area (ha)	286	0.97	0.63	0.10	4.40
	Yield (kg/ha)	280	187.30	143.35	11.25	820.00
2005	Output (kg)	267	174.96	143.85	9.00	818.00
	Area (ha)	284	0.97	0.64	0.10	4.40
	Yield (kg/ha)	267	207.77	154.82	11.25	1090.00
Rice						
2007	Output (kg)	193	240.68	448.05	3.00	4425.00
	Area (ha)	208	0.60	0.45	0.02	3.00
	Yield (kg/ha)	193	381.47	426.88	25.00	2602.94
2006	Output (kg)	202	323.05	442.50	8.00	3600.00
	Area (ha)	202	0.64	0.46	0.02	2.40
	Yield (kg/ha)	200	502.43	443.78	41.67	2250.00
2005	Output (kg)	193	332.73	424.87	3.00	3750.00
	Area (ha)	199	0.64	0.46	0.02	2.40
	Yield (kg/ha)	193	540.98	491.19	15.00	3500.00

Table A. 25: Maize yield by region, 2005-2007

Variable	Obs	Mean	Std. Dev.	Min	Max
2007			**Eastern region**		
Output (kg)	243	847.82	996.17	50.00	7000.00
Area (ha)	261	0.62	0.70	0.01	5.00
Yield (kg/ha)	243	1155.29	543.24	81.04	3100.00
2006					
Output (kg)	235	707.96	843.63	20.00	5000.00
Area (ha)	248	0.59	0.67	0.01	5.00
Yield (kg/ha)	235	1039.60	556.12	96.09	2500.00
2005					
Output (kg)	217	722.70	919.08	25.00	7650.00
Area (ha)	239	0.60	0.74	0.01	5.00
Yield (kg/ha)	216	1066.77	684.30	138.67	6250.00
			Upper-East region		
2007					
Output (kg)	78	77.71	179.03	0.60	1500.00
Area (ha)	107	0.55	0.39	0.10	2.40
Yield (kg/ha)	78	134.38	220.87	1.50	1500.00
2006					
Output (kg)	101	225.72	256.28	16.70	1300.00
Area (ha)	103	0.61	0.49	0.10	3.00
Yield (kg/ha)	101	397.86	359.81	42.50	2125.00
2005					
Output (kg)	94	238.81	270.34	5.50	1750.00
Area (ha)	97	0.59	0.43	0.10	2.40
Yield (kg/ha)	94	407.36	339.78	27.50	2000.00

Table A. 26: Maize output and yield by district

			Upper Manya/Lower Manya		
Variable	Obs	Mean	Std. Dev.	Min	Max
2007					
Output (kg)	130	928.19	978.26	100.00	6000.00
Area (ha)	130	0.67	0.82	0.01	5.00
Yield (kg/ha)	130	1049.99	523.87	81.04	2080.00
2006					
Output (kg)	124	743.15	884.01	50.00	5000.00
Area (ha)	127	0.65	0.81	0.01	5.00
Yield (kg/ha)	124	848.86	491.03	96.09	2080.00
2005					
Output (kg)	116	827.59	1004.15	25.00	7650.00
Area (ha)	122	0.68	0.87	0.01	5.00
Yield (kg/ha)	116	895.72	475.06	138.67	2080.00

Maize Output and yield by district (continued)

Variable	Obs	Mean	Std. Dev.	Min	Max
			Fanteakwa		
2007					
Output (kg)	114	761.89	1010.76	50.00	7000.00
Area (ha)	132	0.56	0.54	0.02	3.50
Yield (kg/ha)	114	1278.39	540.10	250.00	3100.00
2006					
Output (kg)	112	674.29	796.89	20.00	5000.00
Area (ha)	122	0.55	0.52	0.04	3.00
Yield (kg/ha)	112	1245.36	552.03	200.00	2500.00
2005					
Output (kg)	102	613.48	802.61	50.00	5000.00
Area (ha)	118	0.52	0.56	0.04	3.20
Yield (kg/ha)	101	1254.26	828.24	187.50	6250.00
			Kassena/ Nankana		
2007					
Output (kg)	39	60.36	70.32	0.60	300.00
Area (ha)	65	0.52	0.41	0.10	2.40
Yield (kg/ha)	39	115.18	133.31	1.50	750.00
2006					
Output (kg)	60	255.57	270.38	17.00	1250.00
Area (ha)	61	0.56	0.47	0.10	2.40
Yield (kg/ha)	60	507.91	420.82	42.50	2125.00
2005					
Output (kg)	54	268.61	237.52	17.00	1000.00
Area (ha)	56	0.56	0.45	0.10	2.40
Yield (kg/ha)	54	520.37	365.23	83.33	2000.00
			Talensi Nabdam		
2007					
Output (kg)	38	58.09	78.99	6.00	375.00
Area (ha)	41	0.59	0.37	0.20	1.60
Yield (kg/ha)	38	118.14	179.47	6.88	1000.00
2006					
Output (kg)	40	154.10	146.96	16.70	750.00
Area (ha)	41	0.62	0.37	0.20	1.60
Yield (kg/ha)	40	231.89	130.88	42.50	500.00
2005					
Output (kg)	39	158.81	179.58	5.50	1000.00
Area (ha)	40	0.64	0.41	0.20	1.60
Yield (kg/ha)	39	257.19	231.54	27.50	1250.00

Table A. 27: Sorghum and rice yields in the Upper-East region survey districts

	Obs	Mean	Std. Dev.	Min	Max
Sorghum			Kesanna Nankana		
2007					
Output (kg)	133	56.28	77.33	3.00	545.00
Area (ha)	143	0.90	0.63	0.10	4.00
Yield (kg/ha)	133	70.57	68.73	3.75	410.00
2006					
Output (kg)	139	142.34	123.18	9.00	818.00
Area (ha)	143	0.91	0.62	0.10	4.00
Yield (kg/ha)	139	183.14	141.83	11.25	820.00
2005					
Output (kg)	129	165.81	143.20	18.00	818.00
Area (ha)	141	0.92	0.63	0.10	4.00
Yield (kg/ha)	129	208.90	156.77	11.25	1022.50
Rice					
2007					
Output (kg)	109	352.07	565.70	8.00	4425.00
Area (ha)	120	0.65	0.48	0.02	3.00
Yield (kg/ha)	109	508.52	487.44	25.00	2602.94
2006					
Output (kg)	117	461.59	534.87	18.00	3600.00
Area (ha)	117	0.67	0.45	0.02	2.00
Yield (kg/ha)	116	672.21	491.31	83.33	2250.00
2005					
Output (kg)	111	457.05	509.47	33.00	3750.00
Area (ha)	113	0.66	0.44	0.02	2.00
Yield (kg/ha)	111	716.23	553.49	75.00	3500.00

Table A27 continued

Sorghum			Talensi Nabdam		
2007					
Output (kg)	140	94.78	106.84	0.60	872.00
Area (ha)	143	1.01	0.63	0.20	4.40
Yield (kg/ha)	140	110.43	118.65	0.75	726.67
2006					
Output (kg)	141	169.08	140.18	6.00	818.00
Area (ha)	143	1.03	0.65	0.20	4.40
Yield (kg/ha)	141	191.40	145.23	15.00	820.00
2005					
Output (kg)	138	183.52	144.45	9.00	818.00
Area (ha)	143	1.02	0.65	0.20	4.40
Yield (kg/ha)	138	206.71	153.53	22.50	1090.00
Rice					
2007					
Output (kg)	84	96.13	102.58	3.00	550.00
Area (ha)	88	0.53	0.39	0.10	2.00
Yield (kg/ha)	84	216.62	252.34	25.00	1333.33
2006					
Output (kg)	85	132.35	99.66	8.00	500.00
Area (ha)	85	0.60	0.48	0.10	2.40
Yield (kg/ha)	84	267.99	204.52	41.67	1250.00
2005					
Output (kg)	82	164.45	159.85	3.00	1000.00
Area (ha)	86	0.61	0.49	0.10	2.40
Yield (kg/ha)	82	303.75	238.33	15.00	1250.00

A. 28: Comparison of average maize yields in survey villages to district average yields in 2007

I. Manya Krobo district (Akatawia and Asitey)

```
One-sample t test
------------------------------------------------------------------------------
Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
  my2007 |     130    1049.987    45.94641    523.8697    959.0811    1140.893
------------------------------------------------------------------------------
    mean = mean(my2007)                                           t = -12.8413
Ho: mean = 1640                                  degrees of freedom =      129

   Ha: mean < 1640             Ha: mean != 1640               Ha: mean > 1640
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000
```

II. Fanteakwa District (Gyedi and Appa)

```
One-sample t test
------------------------------------------------------------------------------
Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
  my2007 |     114    1278.385     50.5849    540.0989    1178.167    1378.603
------------------------------------------------------------------------------
    mean = mean(my2007)                                           t = -12.6839
Ho: mean = 1920                                  degrees of freedom =      113

   Ha: mean < 1920             Ha: mean != 1920               Ha: mean > 1920
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000
```

III. Kasena Nankana (Gaane and Doba)

```
One-sample t test
------------------------------------------------------------------------------
Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
  my2007 |      39    115.1795    21.34594    133.3054    71.96688    158.3921
------------------------------------------------------------------------------
    mean = mean(my2007)                                           t = -11.9377
Ho: mean = 370                                   degrees of freedom =       38

   Ha: mean < 370               Ha: mean != 370               Ha: mean > 370
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000
```

IV. Telensi Nabdam (Zanlerigu and Shia)

```
One-sample t test
------------------------------------------------------------------------------
Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
  my2007 |      38    118.1414    29.11436     179.473    59.15014    177.1328
------------------------------------------------------------------------------
    mean = mean(my2007)                                           t = -11.7419
Ho: mean = 460                                   degrees of freedom =       37

   Ha: mean < 460               Ha: mean != 460               Ha: mean > 460
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000
```

A. 29: Comparison of average sorghum and rice yields in survey villages to district average yields in 2007

I. Kasena Nankana (Gaane and Doba), Sorghum

```
One-sample t test
------------------------------------------------------------------------------
Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
  sy2007 |     133     70.5695    5.959569     68.7291    58.78089    82.35812
------------------------------------------------------------------------------
    mean = mean(sy2007)                                           t = -43.5318
Ho: mean = 330                                   degrees of freedom =      132

   Ha: mean < 330               Ha: mean != 330               Ha: mean > 330
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000
```

Telensi Nabdam (Zanlerigu and Shia), Sorghum

```
One-sample t test
------------------------------------------------------------------------------
Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
  sy2007 |     140    110.4293    10.02753    118.6474    90.60307    130.2555
------------------------------------------------------------------------------
    mean = mean(sy2007)                                           t = -47.8254
Ho: mean = 590                                   degrees of freedom =      139

   Ha: mean < 590               Ha: mean != 590               Ha: mean > 590
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000
```

III. Kasena Nankana (Gaane and Doba), Rice

```
One-sample t test
------------------------------------------------------------------------------
Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
  ry2007 |     109    508.5228    46.68787    487.4357    415.9793    601.0662
------------------------------------------------------------------------------
    mean = mean(ry2007)                                           t = -20.5937
Ho: mean = 1470                                  degrees of freedom =      108

   Ha: mean < 1470             Ha: mean != 1470               Ha: mean > 1470
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000
```

Telensi Nabdam (Zanlerigu and Shia), Rice

```
One-sample t test
------------------------------------------------------------------------------
Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
  ry2007 |      84    216.6152    27.53308    252.3448     161.853    271.3774
------------------------------------------------------------------------------
    mean = mean(ry2007)                                           t = -38.6221
Ho: mean = 1280                                  degrees of freedom =       83

   Ha: mean < 1280             Ha: mean != 1280               Ha: mean > 1280
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000
```

A. 30: Relationship between fertilizer application on maize farms: Upper-East villages, 2007

```
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
      no |      42    109.7153    26.00218    168.5134    57.20281    162.2277
     yes |      36    163.1481    44.86989    269.2194    72.05742    254.2389
---------+--------------------------------------------------------------------
combined |      78    134.3766    25.00875    220.8713    84.57781    184.1754
---------+--------------------------------------------------------------------
    diff |           -53.43287    50.12174               -153.259    46.39323
------------------------------------------------------------------------------
    diff = mean(no) - mean(yes)                                   t =  -1.0661
Ho: diff = 0                                     degrees of freedom =       76

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.1449         Pr(|T| > |t|) = 0.2898          Pr(T > t) = 0.8551
```

Figure A. 1: Relationship between maize farm size and productivity, 2005-2007

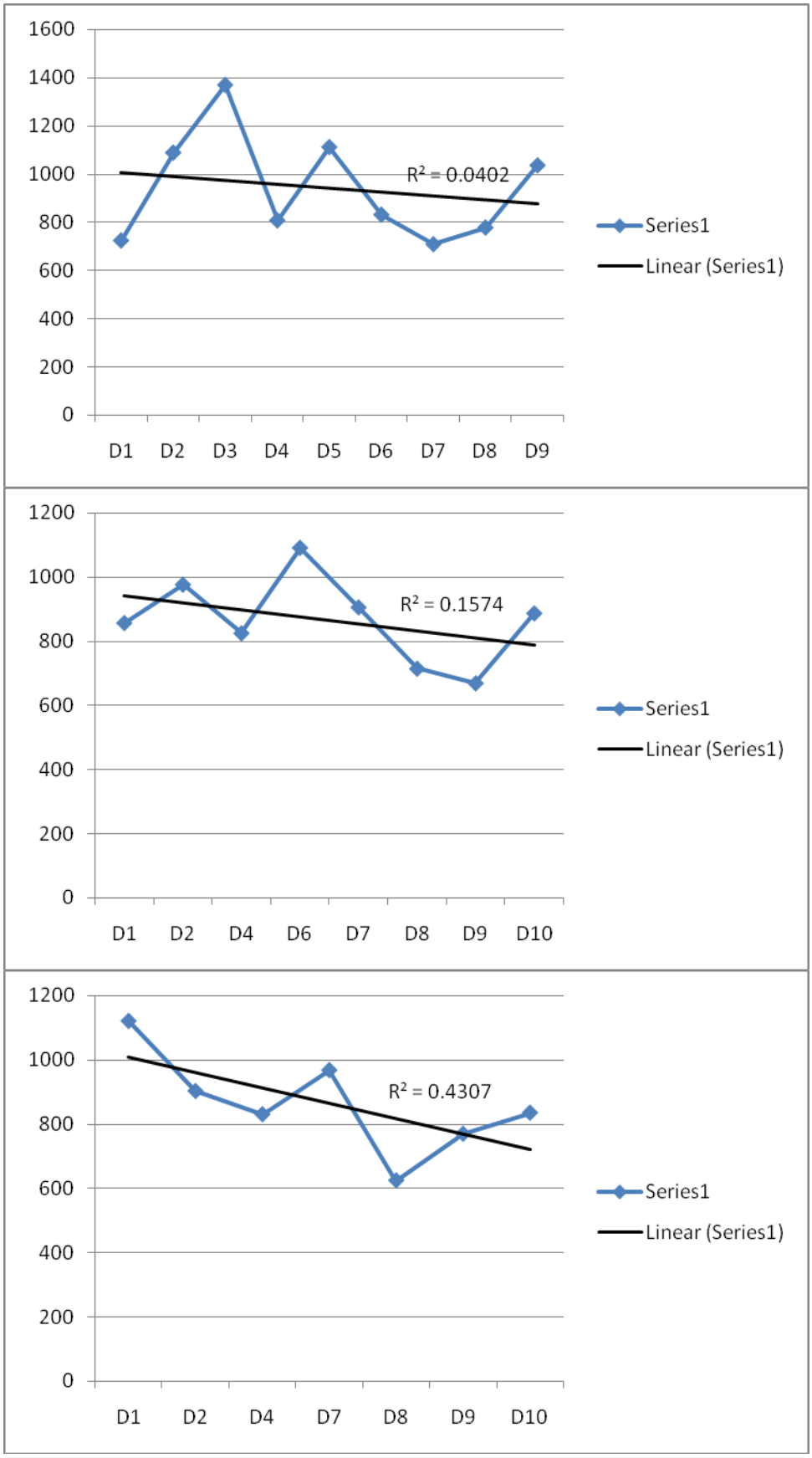

Figure A. 2: Relationship between sorghum farm size and productivity, 2005-2007

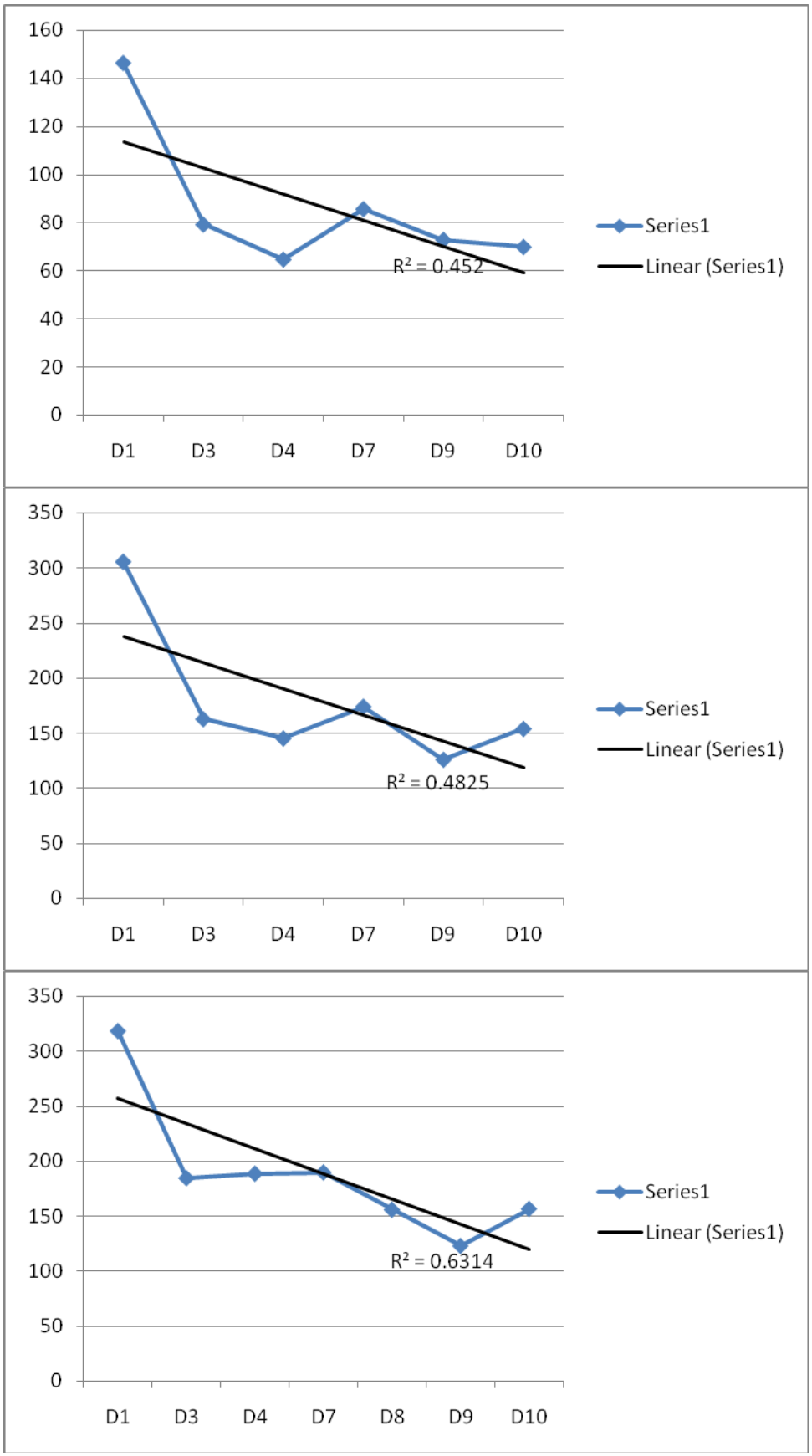

Figure A. 3: Figure A. 3: Relationship between rice farm size and productivity, 2005-2007