AgWater Solutions Project
Case Study

Inland Valleys in Ghana: Untapped Potential

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The AWM Project

The AgWater Solutions project was implemented in five countries in Africa and two states in India between 2008 and 2012. The objective of the project was to identify investment options and opportunities in agricultural water management with the greatest potential to improve incomes and food security for poor farmers, and to develop tools and recommendations for stakeholders in the sector including policymakers, investors, NGOs and small-scale farmers.

The leading implementing institutions were the International Water Management Institute (IWMI), the Stockholm Environment Institute (SEI), the Food and Agriculture Organization of the United Nations (FAO), the International Food Policy Research Institute (IFPRI), International Development Enterprises (iDE) and CH2MHill.

For more information on the project or detailed reports please visit the project website http://awm-solutions.iwmi.org/home-page.aspx.

Table of Contents

Summary

This report is based on primary data collected from a random sample of 508 farmers in Ashanti and Northern Region coupled with secondary data from various sources.

Inland valleys are known as *dambos* in Eastern and Central Africa, *fadamas* in Nigeria and Chad; and *bas-fonds* or *marigots* in Francophone African countries. The term refers to the numerous flat-floored and shallow valleys that occur in the extensive plains and plateaus found across the African landscape. They cover approximately:

- 190 million ha in Sub-Saharan Africa (including lowlands),
- 50 million ha in West Africa alone, and
- 28,864 ha in Ghana (the figure becomes 1.9 million if lowlands are added).

The Government of Ghana expressed an interest in revitalizing its domestic rice sector to mitigate the burden of rice imports on foreign currency reserves and contribute to poverty reduction and youth employment. Rice development in inland valleys/lowlands provides a relatively low cost alternative.

There are discernable differences in the socioeconomic and demographic characteristics of inland valley rice cultivators with important implications for policy and other interventions:

- the majority of the sample farmers from Northern Region are illiterate,
- the majority of inland valley rice farmers from Ashanti are migrants from the North, and
- the participation of women household heads in inland valley rice cultivation in Northern Region is close to none.

Land tenure security is a significant impediment to the development of inland valleys; this is particularly so in Ashanti because most of the current practitioners are migrants.

The sample farm households, particularly those in Ashanti, are engaged in multiple livelihood strategies including on-farm, off-farm and non-farm activities.

In most inland valleys, agriculture is the dominant land use. In addition to rice they are commonly cultivated with oil palm, vegetables, cocoa, citrus, maize, cassava, yams, cowpeas, soy beans, sorghum, plantains, and mangoes. Rice has to compete with these crops.

Inland valley rice development requires significant labor, therefore competing for the scarce labor with other on-farm, off-farm, and non-farm activities. For this reason farmers have devised strategies for minimizing labor inputs such as zero tilling for land preparation and dibbling and broadcasting for planting instead of transplanting.

Due to its bimodal rainfall pattern, the Ashanti Region allows for the cultivation of two crops per year. However, in the Northern Region, only one crop can be produced. Cultivating two crops in a year requires full control irrigation facilities.

Farmers lack access to crucial technologies required to make the system work sustainably. Examples are:

- power tillers to mitigate the drudgery of plowing, paddling and leveling,
- mechanical harvesters to minimize quantitative and qualitative paddy rice output loss, and
- appropriate rice varieties that resist pests and diseases, respond to fertilizer and other inputs well and yet does not lodge.

Judging from the age of rice varieties currently in use, it seems that the rice seed sector is at its rudimentary level in the areas studied

Framers may lose crops due to biotic and abiotic factors including the absence of efficient water management (floods and droughts) and weed competition. The current realized yield levels are below potential due to poor agronomic practices and lack of good water management. Thus, the level of profit from rice cultivation in inland valleys is not enough to motivate farmers to sustainable pursue rice cultivation, particularly when the opportunity cost of family labor is considered. The profitability level can be raised through implementing multifaceted strategic interventions.

1. INTRODUCTION

Inland valleys are defined as the upper reaches of river systems in which river alluvial sedimentation processes are absent. They are composed of valley bottoms and minor floodplains, which may be submerged for part of the year. In these small valleys, alluvial sedimentation processes are of minor importance and watersheds are generally limited in extent (Figure 1). This definition excludes other agro-ecosystems, such as alluvial plains, mangrove swamps, deltas or lagoons. They do not yet have a distinct system of flood plains and levees. Inland valley is a term used to refer to numerous flat-floored and relatively shallow valleys that occur in the extensive undulating plains and plateaus found across the African landscape. They are known as *dambos* in Eastern and Central Africa, as *fadamas* in northern Nigeria and Chad, *bas-fonds* or *marigots* in Francophone African countries, and inland valleys in Sierra Leone. Inland valleys have far greater potential for rice production compared to uplands. Inland valleys constitute an important agricultural and hydrological asset at local and national levels and can make a major contribution to food security and poverty alleviation.

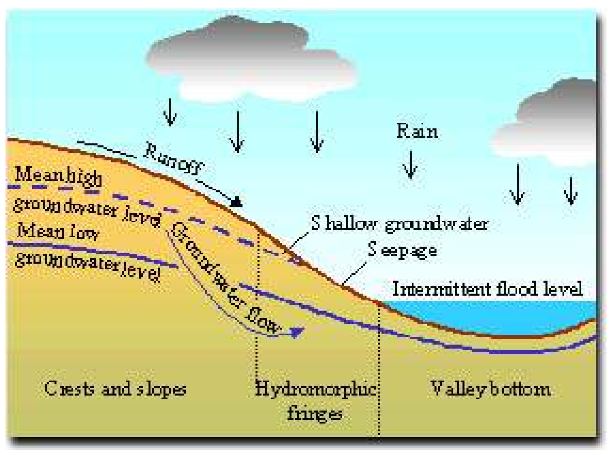

Figure 1. Inland valleys Source: Africa Rice Centre.

2. SIGNIFICANCE OF INLAND VALLEYS IN GHANA AND SUB-SAHARAN AFRICA

Estimates of the extent of inland valleys are not that accurate. They cover approximately 190 million ha in Sub-Saharan Africa (SSA), which is about 8% of the sub-continents land area. Another estimate puts the figure at 85 million ha in SSA. Inland valleys are estimated to occupy about 50 million ha of land in West Africa alone (Jamin *et al.*1996). Yet another estimate states that about 9% of the total geographic area of West Africa, which is 733 million ha, are lowlands consisting of inland valley bottoms and hydromorphic fringes.

Across West and Central Africa, 8-18% of the land is considered inland valleys of which only less than 10 to 25% is currently exploited depending on the country, mostly in the sub-humid and humid zones. Crop yields are often low and cultivation is limited by many constraints.

Many countries of Africa are currently pursuing a policy of boosting local production of rice to satisfy, partly or in whole, the ever increasing domestic demand. To augment the disparity between local production capacity and consumption, substantial quantities of rice is imported (Figure 2).

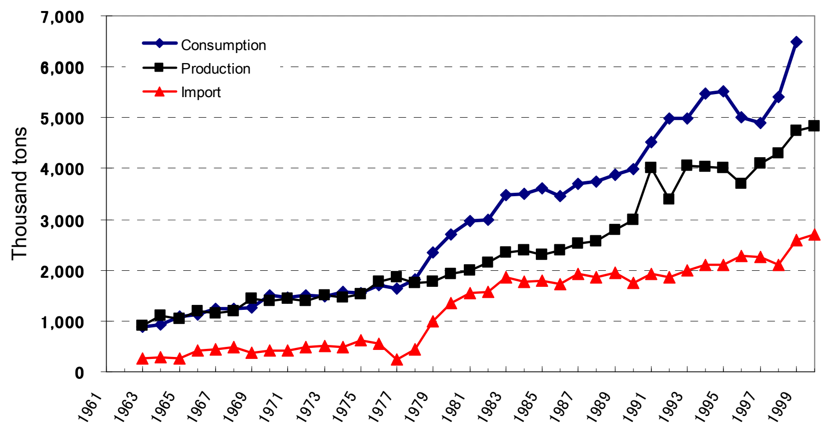

Figure 2. Rice consumption, production and import trends in West Africa.

Over reliance on imports, in addition to depressing local rice cultivation incentives, may pose significant stress on the foreign currency reserve of these countries. One possible way out of this problem is enhancing production in the inland valleys. In Ghana too, the gap between local production and consumption significantly widened, particularly since the late 1990s (Figure 3). This gap is filled by huge imports from Asian countries and USA.

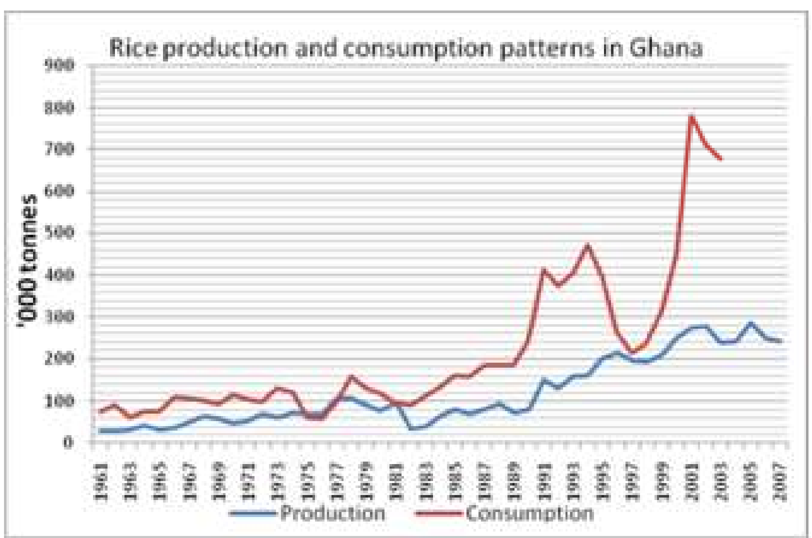

Figure 3 Rice production and consumption in Ghana.

The potential for irrigated rice production in the inland valleys and river flood plains is about 1.9 million ha in Ghana (FAO, 2005). Out of total land area of Ghana, 12.1% is occupied by inland valleys and flood plains. The distribution of inland valleys in the ten regions of Ghana is shown in Table 1. However, the accuracy of these estimates is questionable.

Table 1. Estimated size of inland valleys in the administrative regions of Ghana.

No	Regions	Size of inland valley (ha)
1	Upper West	2,598
2	Upper East	1,443
3	Northern	9,236
4	Brong Ahafo	4,041
5	Ashanti	3,464
6	Eastern	1,443
7	Western	3,752
8	Central	1,155
9	Greater Accra	577
10	Volta	1,155
	Total	28,864

Source: Otto and Asubonteng, 1995

Inland valleys have high potential for rice cultivation for several reasons such as easy access to water, high soil fertility relative to uplands, soil moisture availability during dry seasons, and higher water availability in wet seasons relative to uplands.

3. GHANA'S INLAND VALLEY AND LOWLAND DEVELOPMENT EXPERIENCE

Considering that Ghana is endowed with high potential for inland valley rice farming, several projects have been developed, including the Lowland Rice Development Project (LRDP). The first phase (1999-2003) of the LRDP focused on improving the production, processing and marketing of rice by smallholder farmers and processors. The project aimed at developing a profitable and sustainable intensive rice production system in the Northern Region, with the hope of adapting the process to other regions in the north savannah zone. The French government, through Agence Française de Development (AFD), provided a greater part of the funds for the project. Other financial partners included the Ghanaian government, the Agricultural Development Bank (ADB) and rural farmers of the Northern Region of Ghana. By the end of 2003, a total of about 1,000 hectares were put under intensive rice cultivation by about 2,500 smallholder farmers in three valleys: Sillum, Zuwari and Kulda-Yarong, all within a 50 km radius of Tamale. About 300 women processors located in the three valley areas were also trained in improved rice processing techniques.

The second phase of the AFD financed project is known as the Rice Sector Support Project (RSSP). RSSP is an expanded phase of the LRDP (1998-2003) and of the Food Security and Rice Producers Organization Project (FSRPOP 2003-2008) both in the Northern Region. Rice production has been identified for some years now as one of the priorities of the Government of Ghana because of the cost of imports needed to satisfy a national market which is growing fast. The second phase is expected to last from 2008 to 2013. The overall objectives of the RSSP project are:

- To develop rice production in four administrative regions, namely Northern, Upper East, Upper West, and Volta Regions. This involves the development of 6000 ha of lowland areas or inland valleys to permit more intensive and sustainable rice growing.

- Strengthening the rice sector at national level.
- Establishing a research program on systems for upgrading technically and economically inland valleys/lowland rice areas based in particular on techniques of zero tillage with cover crops and poly-aptitude rice varieties (which tolerate both flooding and rains). These systems are intended to reduce the impact of climate variability on yields, the amount of labor and investment per hectare, and therefore the credit requirements, and to increase the profitability of rice growing.

The RSSP is estimated to cost EUR 17.31 million over five years.

In addition, the Ministry of Agriculture is undertaking an inland valley rice development project with financial support from the African Development Bank (AFDB). The project was started in 2004 and was supposed to be implemented in 18 districts and five regions. The government identified 12,800 ha of potential inland valleys throughout the country which are suitable for rice cultivation if major constraints related to production, post-harvest, and marketing are removed and if farmers are fully involved in appropriate developments. The main project objective is to increase incomes of smallholder rice producers in the project area by increasing production of good quality rice. The project components are: crop production; credit provision; capacity building; adaptive research and studies; and project management. The project will increase rice production and farm incomes and therefore contribute to reduction in poverty. It will also reduce imports of rice and save Ghana foreign exchange.

In line with the goal of doubling the production of rice in SSA within 10 years (beginning 2008) as stipulated at the TICAD IV meeting in Tokyo, the Japanese government together with African governments, donors, and national and international research and development institutions, initiated several rice research and development projects. Some of these are being implemented in Ghana. One such project in Ghana is called Developing Improved Infrastructure and Technologies for Rice Production in Africa (DIITRPA). The main objective of DIITRPA is to establish small-scale rice production models in inland valleys by:

- introducing power tillers,
- applying technology of bounded, leveled, and puddled fields known as *sawah*,
- constructing small irrigation facilities such as storage and water regulating systems, farm ponds and irrigation canals,
- selecting suitable varieties,
- improving cultivation techniques (cultivation density, applying fertilizer, pest control, etc.,
- organizing farmers' groups, and
- formulating extension and support systems.

4. DATA AND METHODOLOGY

This document is based on data generated during 2007-2008 through sample surveys, and literature reviews. Two surveys were conducted: one in the Northern Region and the other in Ashanti Region (see Figure 4 and Figure 5). The survey in the Northern Region encompassed 28 communities, from which three hundred farmers were randomly selected. About 100 of the farmers belong to the Gollinga irrigation scheme. In Ashanti, data was gathered from 17 villages purposively drawn from six districts based on their proximity to inland valleys and prevalence of rice production activities. In total 508 inland valley rice cultivating farmers were randomly selected. Similar questionnaires were developed for the two locations.

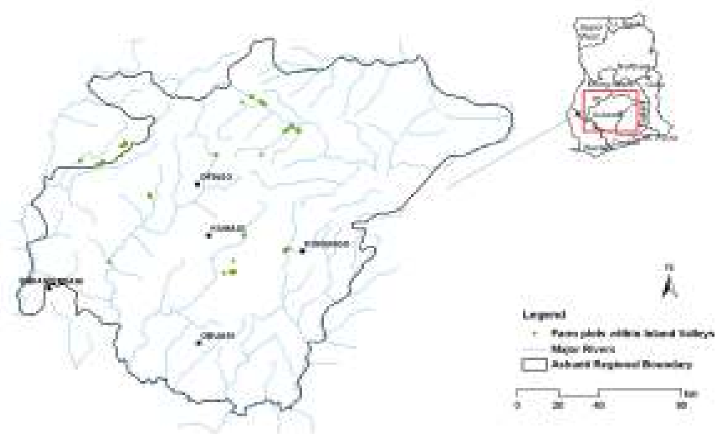

Figure 4: The location of the study sites in the Ashanti region.

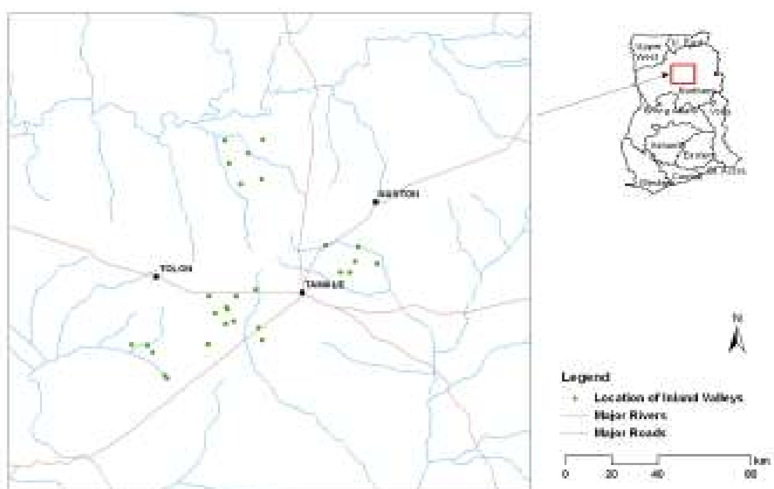

Figure 5. The location of the study sites in Northern Region

5. SOCIOECONOMIC AND DEMOGRAPHIC CHARACTERISTICS OF FARMERS ENGAGED IN INLAND VALLEY RICE CULTIVATION

The mean age of inland valley rice cultivators is 44 years. There is no significant difference in the age between farmers from the Tamale and the Ashanti samples (see Table 2).

Table 2. Age of the sample farmers in years.

	Ashanti		Tamale		Overall	
	Mean	N	Mean	N	Mean	N
Male	43.8	184	43.6	296	43.7	480
Female	43.8	23	47.0	3	44.2	26
Mean	43.8	207	43.6	299	43.7	506

However, 82.7% of the sample farmers from Ashanti practicing inland valley rice cultivation are immigrants from the North and other areas. The corresponding figure for the Tamale sample is a mere 1.7%. This indicates that inland valley rice cropping in Ashanti Region is done largely by migrants from the North who have more experience in rice agronomy (See Table 3).

Table 3. Origin of inland valleys rice farmers.

Origin	Ashanti		Tamale	
	N	%	%	N
Native	36	17.3	98.3	295
Migrants from North Region	142	68.3	-	-
Migrants from other areas	30	14.4	1.7	5
	208	100	100	300

5.1 Gender

More female farmers are engaged in rice cultivation in Ashanti than in Tamale (Table 4).

Table 4. Gender composition of sample farmers.

	Ashanti		Tamale		Total	
	%	N	%	N	%	N
Male	88.9	185	99.0	296	94.9	481
Female	11.1	23	1.0	3	5.1	26
Total	100	208	100	299	100	507

5.2 Education

In Ashanti, 45.7% of the sample farmers are illiterate. Mean years of schooling is 4.2. The proportion of illiteracy is significantly higher among women farmers. Surprisingly, 80.6% of the sample farmers from Tamale area are illiterate. All of the sample women farmers from Tamale are illiterate (see Table 5).

Table 5. Level of education of sample farmers.

Years of schooling	Ashanti (%)			Tamale (%)		
	Male	Female	Total	Male	Female	Total
0 (illiterate)	43.2	65.2	45.7	80.4	100	80.6
1 to 6	21.6	21.7	21.6	8.1	0.0	8.0
7-10	24.9	4.3	22.6	4.1	0.0	4.0
>11	10.2	8.7	10.1	7.4	0.0	7.4
N	185	23	208	296	3	299

5.3 Experience with rice cultivation

In Ashanti, mean years of experience in rice cultivation is 12.5 years and ranges from 1 to 56 years; 50.5% of the sample farmers had less than 10 years of rice cultivation experience (Table 6). The experience in rice cultivation for farmers from Tamale area dates back to the 1950s. Farmers from this region had more years of rice cultivation experience.

Table 6. Experience in rice cultivation.

	Ashanti		Tamale	
	Year	N	Year	N
Native	10.4	39	13.3	236
Migrant (North)	12.8	139	NA	NA
Migrant (Other)	14.1	30	8	4
	12.5	208	13.2	240

5.4 Land tenure and land size

Land tenure insecurity is often mentioned as the main impediment to the development of rice cultivation in inland valleys. There are visible land tenure differences between inland valley rice cultivators in Tamale and Ashanti (Tables 7 & 8).

Table 7. Owner of the land used for rice cultivation in Ashanti.

Owner	Natives	%	Migrants (North)	%	Migrants (Other)	%	Total	%
Traditional chief	9	23.1	61	43.9	12	40.0	82	39.4
Own	5	12.8	3	2.2	2	6.7	10	4.8
Family	3	7.7	0	0.0	0	0	3	1.4
Others	22	56.4	66	47.5	15	50.0	103	49.5
Government	0	0.0	9	6.5	1	3.3	10	4.8
	39		139		30		208	

Table 8. Ownership of land in Tamale.

	%	**N**
Traditional chief	11.3	34
Own	39.0	117
Family	49.0	147
Others	0.7	2
Total	100	300

Only one farmer from Ashanti Region reported having an upland rice field, whereas 14.3% of the sample farmers from Tamale area practiced upland rice cultivation (Table 9). In the Ashanti sample, irrigated rice farming was not considered in the original sample but 15.9% of the sample farmers reported having irrigated rice fields.

Table 9. Rice cultivation systems observed among sample farmers.

System	Tamale		Ashanti	
	Area (Acre)	%	Area (Acre)	%

Upland	1.25	14.3	3	0.5
Inland	2.49	93.3	2.2	98.6
Irrigated	0.74	32.3	2.26	15.9
N	300		208	

5.5 Occupation

In both regions, farming is the main livelihood strategy. However, a significant number of household members are engaged in non-farm and off-farm activities. This is particularly so for female members of the household (See Tables 10 &11).

Table 10. Major occupation of household members in Tamale.

Main occupation	Male		Female		Total	
	N	%	N	%	N	%
Arable crop farming	641	88.2	390	59.8	1,031	74.8
Livestock farming	2	0.3	0	0.0	2	0.1
Non-farm activities*	24	3.3	183	28.1	207	15.0
Off-farm activities & others**	60	8.3	79	12.1	139	10.1
Total	727	100	652	100.0	1379	100.0

*Non-farm activities include petty trading, salaried work, tailing, bricklaying, weaving, potting, etc.

** Off-farm activities include marketing crops and fish, firewood harvesting and sale.

Table 11. Major occupation of household members in Ashanti/Brong Ahafo.

Occupation	Male		Female		Total	
	N	%	N	%	N	%
Farming	272	81.4	215	72.2	487	77.1
Trading	13	3.9	46	15.4	59	9.3
Security	3	0.9	0	0	3	0.5
Crafts	43	12.9	37	12.4	80	12.7
Teaching	3	0.9	0	0	3	0.5
	334	100	298	100	632	100

*Crafts include hair dressing and semesters.

6. LAND USE PATTERNS IN INLAND VALLEYS

The natural vegetation of inland valleys depends on the agro-ecological zone type. In the semi-deciduous forest zone (e.g., Ashanti) the original vegetation is usually degraded and the present cover consist mainly of farmlands, thickets over fallow land and a few patches of secondary forest. Agriculture is the dominant land use. Inland valleys are commonly cultivated with rice, oil palm, vegetables, cocoa, and citrus. In the Guinea savanna zone (e.g. Tamale), inland valleys are virtually without trees. Agriculture is the dominant land use type in the area as well. A variety of crops are cultivated including rice, maize, cassava, yams, cow peas, soybeans, sorghum, plantains, and mangoes (Appendix 1). The major vegetables cultivated are okra, garden eggs, tomatoes, cow peas, and peppers. Some farmers also build fish ponds (Buri 2008).

7. LAND AND WATER MANAGEMENT

Inland valley rice development involves several operations. These may include land clearing, de-stumping, canal construction, dyke and pond construction, plowing, paddling and leveling. Other activities are nursery establishment, transplanting, fertilizer application, crop protection, harvesting and threshing. Activities can be broadly categorized into agronomic practices, including land and water management, which may be partial or full control. However, inland valley rice development usually refers to the partial control of water for supplementary irrigation.

7.1 Land management

Land management involves land clearing to know the nature and the slope of the field, flow of a stream and to locate stumps for de-stumping. Land clearing is done manually complemented by the application of Roundup© chemicals such as glyphosate to prevent re-growth of weeds. The recommended rate is 180 ml in 15 l of water. There are numerous types of Roundup© chemicals in use.

After clearing, the fields are de-stumped to remove the roots of trees) to enhance easy movement of machinery, avoid unnecessary break downs and create more space for planting rice (see Figure 6). Then the field is designed or laid out for plowing.

Figure 6. De-stumped oil palm tree in inland valley.

Plowing is done with tractors or bullocks, then the field is burned over and Roundup© chemicals applied (Table 12). The majority of farmers in Tamale use either their own or hired a tractor, whereas those in Ashanti practice slash and burning with or without application of Roundup©. Bullock plowing is not yet adopted in Ashanti. Despite NGO and government endeavors to expand the use of power tillers, not one farmer was found using one.

Table 12. Methods of land preparation.

Method	Tamale (%)	Ashanti
Own tractor	4.3	0.0
Hired tractor	81.0	29.3
Hired /own power tiller	0.0	0.0

Slush and burn/Roundup©	24.7	68.3
Own/hired bullock	15.3	0.0
N	300	2008

The average rental cost of a tractor in Tamale area was GHC 13.3 per acre. The average rental cost of a bullock is GHC 12.6 per acre.

7.2 Water management

Sufficient moisture and good water management is critical for the development of a rice crop. Water management decisions are influenced by the amount and distribution of rainfall. In Ashanti Region there are two distinct rainfall peaks, which allows for cultivating two crops per year with or without supplementary irrigation (Figure 7).

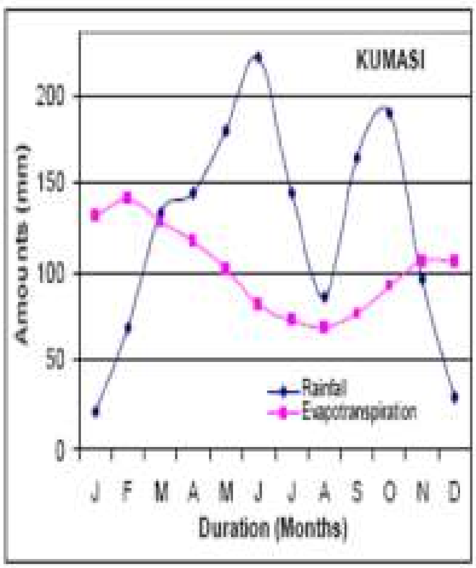

Figure 7. Rainfall peaks in Ashanti Region.

Tamale Region is characterized by a uni-modal rainfall pattern allowing for only one crop per year unless complemented by irrigation (Figure 8).

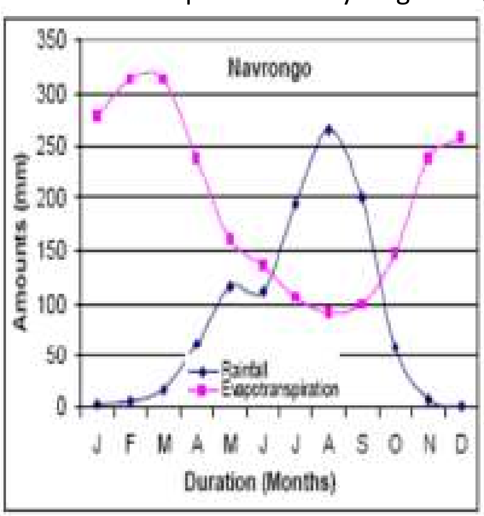

Figure 8. Rainfall pattern in the Upper East Region.

Water management issues can be visualized as two levels, i.e., community and plot or field level. At the community level, different water impounding or regulating structures are being promoted including weirs of different quality, ponds, and canals (see Figures 9 and 10). These structures are developed to provide supplementary irrigation to a crop where necessary.

Figure 9. Water regulating structure developed by the LRDP project in Northern Region.

Figure 10. Dyke constructed at one of DIITRPA project sites.

At the plot level, fields are bounded, puddled, and leveled to allow pooling and percolation of water in the field (see Figure 11).

Figure 11. Paddling of rice fields

8. AGRONOMIC PRACTICES

Three main planting methods are employed: transplanting, dibbling, and broadcasting (Table 13). Almost all sample farmers from Tamale area did dibbling or broadcasting. This is because farmers consider transplanting to be labor intensive. Transplanting starts with nursing rice seeds. The seeds are soaked to remove chaff or other foreign matter then transplanted at about 14 days post-emergence. Empty spaces need to be re-filled as necessary to maintain optimal planting density.

Table 13. Rice planting methods in inland valleys.

	Tamale (%)	Ashanti (%)	Total (%)
Transplanting	1.0	50.0	21.1
Dibbling	41.0	47.1	43.5
Broadcasting	58.0	2.9	35.4
N	300	208	508

A significant proportion of farmers in Ashanti did transplanting. Over all, dibbling and broadcasting are the most commonly practiced planting methods due to their relative labor economy. The per acre labor requirements for the three planting methods is summarized in Table 14. Labor availability greatly constrains the prospect of expansion of inland/lowland rice cultivation in both Ashanti and Northern Regions (see Box 1). Farm labor may be limited due to the availability of off-farm and non-farm employment opportunities. In Northern Region, lowland rice cultivation competes for labor with upland rainfed crop production, which is the dominant livelihood strategy. Consequently, some agronomic practices such as weeding are principally performed by women.

Table 14. Per acre labor requirement of planting methods.

	Ashanti	N	Tamale	N
Transplanting	26.50	99	37.67	4
Dibbling	14.97	101	22.40	117
Broadcasting	1.26	6	1.40	163

Box 1 Examples of labor requirements for developing inland valley for rice cultivation

Case 1: At Amoakokrom, six farmers were organized to develop rice on a 1.3 ha field. The labor requirement as closely monitored by the district extension personnel of MOFA were:

- land development and preparation required 163 person-days
- water management required 148 man-days
- agronomic practices required 73 person-days
- crop protection required 172 person-days
- harvesting and threshing required 187 person-days

The total labor required to operate the 1.3 ha rice field was 747 person-days, which translates into 575 person-days per hectare.

Case 2: In the Afari community a farmer has joined the DIITRPA project to develop a 1.7 ha rice farm in an inland valley. The labor associated with the establishment of this farm is:

- land development and preparation required 197 man-days
- water management required 212 person-days
- agronomic practices required 107 person-days
- crop protection required about 117 person-days
- harvesting and threshing required about 127 person-days

The total labor required to establish the farm was 760 person-days

Soil fertility management.

Farmers used three different fertilizers: urea, NPK and ammonia. The rates applied were too variable as indicated by the standard deviation statistics (Table 15). It is not clear if application rates are informed by any extension advice.

Table 15. Fertilize input use intensities (kg/acre).

Region	Urea		NPK		Ammonia	
	kg	SD	kg	SD	kg	SD
Ashanti	5.9	16.4	27.0	33.7	17.6	25.9
Tamale	4.5	-	30.3	-	13.8	-

Crop protection

Pests that significantly reduce the yield of paddy or even may totally destroy the crop are weeds, diseases, insects, and birds. Rice blast may also compromise the potential yield. Farmers are advised to use fungicides such as metalm at 10 g per 15 l of water. Stem borers may also attack young seedlings. Therefore, farmers are required to apply insecticides such as sunpyrifos at 50 ml per 15 liter of water. Perhaps the most significant pests are birds. Shortly after the heading stage of rice development, the fields have to be guarded against birds, further escalating the magnitude of the labor input**.**

Weed control is achieved through a combination of manual weeding and herbicides.

Harvesting and threshing

Harvesting is done manually using a sharp knife, sickle or cutlass. The sickle is the main tool. No one employs machinery such as harvesters. In Tamale, harvesting is mostly done from the end of October to January, with the majority of farmers harvesting the rice crop around November ending in December. Due to the *Harmattan* (West African trade wind) which normally affect the area from November each year, harvesting around this time has serious effects on the moisture content of the harvested paddy and hence on milling quality. A test done in 2002 showed that on the 7th of October the paddy ready for harvesting had a moisture content of 18.6% to 20.1%. A month later the moisture level dropped to 8.2% - 14.1 % (LRDP Annual Report, 2002). It was recommended that the rice crop be harvested in October. When the crop is harvested in late November, it has to be parboiled before milling. Failure to parboil properly results in considerable reduction of grain quality which fetches a low price. Threshing is done using rudimentary technology and leads both to quantitative and qualitative loss of the rice output (Table 16).

Table 16 Percentage distribution of threshing methods.

Method	Tamale (%)	Ashanti (%)
Tractor trampling	8.3	
Heap on the ground and beat with stick	74.0	
Put in a bag and beat with stick	1.7	23.1
Put on tarpaulin and beat with stick	16.0	
Hit against a barrel or wood slat		76.0
N	300	208

In both regions, threshing is mainly done by beating the harvest with stick (Figure 12).

Figure 12. Traditional rice threshing method in Upper East Region.

9. PROFITABILITY ANALYSIS

Yield comparisons

The realized yields reported by the farmers for 2007/2008 season on 374 plots in Ashanti are graphically displayed in Figure 13. No yield was obtained from about 2.7 percent of the fields for various reasons including flood damage, drought, and weed competition. About 80% of the plots recorded yield levels less than 1.8 t/acre and about 90.9% of the plots recorded yield levels of 2.4 t/acre or less.

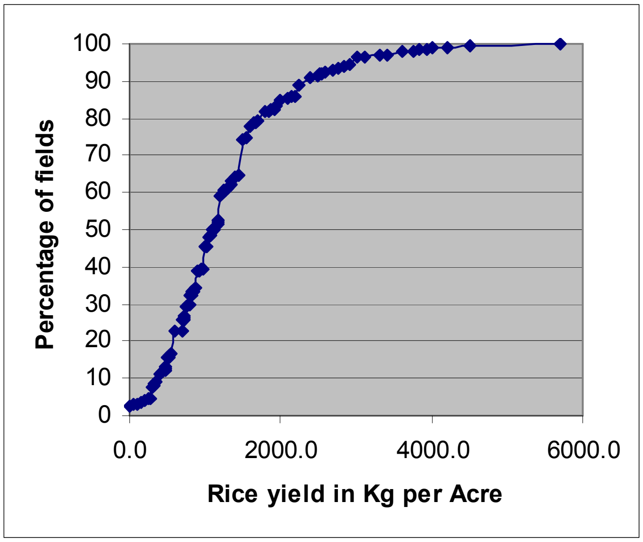

Figure 13. Cumulative distribution of yields.

In Tamale, the yields obtained vary by rice farming systems. The yield from inland valleys with limited water control gave about 2 t/acre, while the irrigated rice production gave about 3 t/acre (Figure 14).

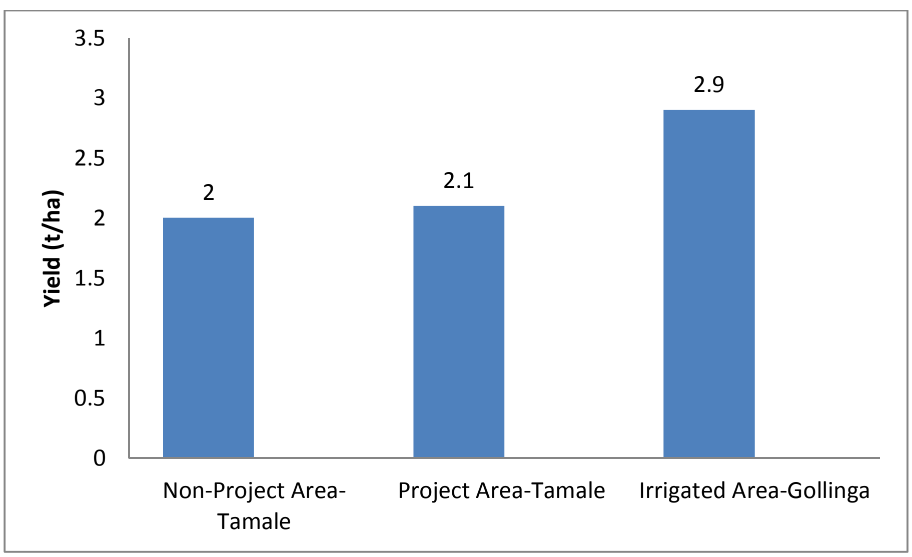

Figure 14. Paddy yield by rice cultivation system.

The yield values presented in Figure 14 are close to the values determined through careful measurement. DIITRPA project estimates for traditional lowland or inland valley is 2.0 t/ha. The farmers included in MOFA's recent initiative called "block farming" obtained 3.24 t/ha. The DIITRPA project site at Afari registered 4.2 t/ha.

Yield influencing factors

The effects of agronomic, weed control and water management practices on paddy yield have been analyzed using Analysis of Variance (ANOVA) and the results are summarized in Table 17. Most practices had significant yield effects in line with our expectations. However, the result for tillage technology was unexpected for those fields plowed by tractor which gave significantly lower yields than those fields with minimum or zero tillage.

Table 17. Effect of some technological factors on paddy yield.

No	Technology/practice	Mean yield (kg/acre)	N	F-statistic
1	Planting method			
	• Transplanting	1529.7	189	11.812***
	• Dibbling	1069.3	175	
	• Broadcasting	993.8	8	
2	Tillage			
	• Tractor	1074.8	102	8.432***
	• Other	1390.4	271	
3	Weed control			
	• Hand weeding (HW)	1516.1	44	6.749***
	• Herbicide	1488.2	126	
	• Herbicide + HW	1140.8	204	
4	Pest control			
	• Pesticide	1483.6	67	3.033*
	• No pesticide	1262.3	307	
5	Fertilizer			
	• Chemical fertilizer	1394.1	228	5.617**
	• No chemical fertilizer	1158.2	146	
6	Water Management			
	• Supplementary irrigation	1515.7	57	3.466*
	• No supplementary irrigation	1263.5	317	

The rice varieties grown by farmers in Ashanti are reported in Appendix 2, Table A2.1. During 2007/2008 season, about 14 rice varieties including NERICA were grown in the valleys. Five of these varieties occupied over 92% of the total rice cultivated area. Varieties Rita 7 and Mr. More alone occupied 51% of the total rice cultivated area. The area coverage of the varieties closely follows the yield level. Mororkor, China and Rita 7 varieties are the best.

Gross margin analysis

The gross margin analysis results are presented in Appendix 3 and summarized in Figure 18. The level of the gross margin is low by any standard, particularly when the value of family labor involved in the production process is incorporated in the cost calculation. It can be inferred from Figure 18 that as the level of water control increases, the level of gross margin significantly increases.

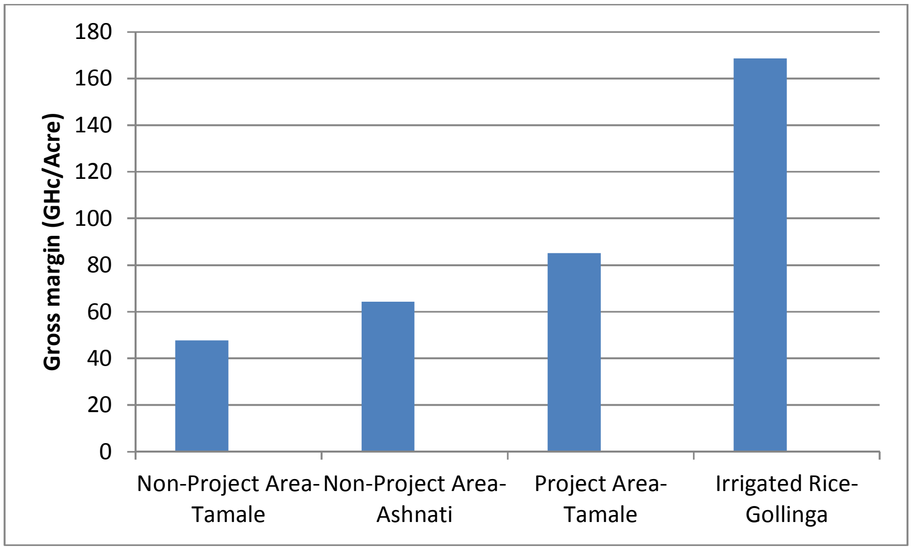

Figure 18. Gross margin analysis.

10. MAJOR CONSTRAINTS

The major constraints of rice development in inland valleys as articulated by practitioners and gleaned from the data presented in this report are summarized as follows.

Land tenure insecurity

Land tenure insecurity is a disincentive for the expansion of rice cultivation in inland valleys. The operators may not be interested to invest in any long-term land and water management infrastructure. If they have access they are most probably interested in gaining the most in the short term. This is why the sustainability of past projects was compromised.

Poor water management

Good water management contributes to rice yield improvement and enhances the yield response of other inputs such as fertilizers and seed variety.

Bird attacks

Farmers report that birds are a common pest causing significant damage to the crop unless the field is guarded. This is particularly a problem if the fields are cultivated during the dry or minor season, when rice is the only crop around. Bird watching alone can take op 102 person-days of scarce labor per season as observed in Ashanti.

High illiteracy rate among practitioners

Illiteracy is quite high among inland valley rice cultivators, particularly in Northern Region and especially among women farmers. They have little formal education. This situation can pose a challenge for any intervention strategy designed to introduce new technology, particularly machine operations requiring technical skills and numeracy.

Lack of finances
This is a general problem observed in rural Ghana where credit services are expensive to access. The lack of access to finance constrains farmers' ability to invest in yield boosting inputs such as fertilizers, improved seeds, agro-chemicals, and farm equipment.

Poor soil fertility
This is particularly a problem in Northern Region where considerable soil nutrient mining and land degradation is evident. Despite the poor soil fertility conditions, the quantity of inorganic fertilizers applied is below the official extension recommended rates.

Lack of affordable but efficient threshing technology
The main methods of threshing used by the farmers lead to substantial mixing of paddy with stones and other foreign materials. The end result is poor quality milled rice, which is unattractive to consumers, compounding the inferiority of the locally produced rice to compete with imported rice.

Low milling recovery rate
Farmers and millers claim that the milling recovery rate of paddy is low. For instance, an average of 37.0 kg of milled rice is obtained from 90 kg of paddy, which is indeed low. The low milling recovery rate of paddy is often cited by processors in the Tamale area as the reason for wanting to buy paddy at the lowest price possible to ensure that they do not run a loss after processing.

Lack of access to information or extension
In Tamale, one-third of the farmers have not had any form of training in rice farming practices. Farmer contact with agricultural extension officers is limited to one or two visits per season.

Exposure to water borne diseases
Increased presence of water borne diseases such as malaria is reported. Other diseases that may be of concern are Bilharzias, *Trypanosomiasis* (sleeping sickness), *Onchocerciasis* (river blindness) and *Dracontiasis* (guinea worm).

11. SUMMARY AND RECOMMENDATIONS

This report is based on primary data collected from a random sample of 508 farmers in Ashanti and Northern Region coupled with secondary data from various sources.

Inland valleys often known as *dambos* in Eastern and Central Africa; *fadamas* in Nigeria and Chad; and *bas-fonds* or *marigots* in Francophone African countries refer to the numerous flat-floored and shallow valleys that occur in the extensive plains and plateaus that are found across the African landscape. They cover approximately:

- 190 million ha in SSA (including lowlands)
- 50 million ha in West Africa alone
- 28,864 ha in Ghana (the figure becomes 1.9 million if lowlands are added)

The Government of Ghana showed an expressed interest in revitalizing its domestic rice sector to mitigate the burden of rice imports on foreign currency reserve and contribute to poverty reduction and youth employment. Rice development in inland valleys and lowland areas provides a relatively low cost alternative.

There are discernable differences in the socioeconomic and demographic characteristics of inland valley rice cultivators with important implications for policy and other interventions.

- The majority of the sample farmers from Northern Region are illiterate.
- The majority of inland valley rice farmers from Ashanti are migrants from the North.
- The participation of women household heads in inland valley rice cultivation in Northern Region is close to zero.

Land tenure security is a significant impediment to the development of inland valleys. This is particularly so in Ashanti because most of the current practitioners are migrants.

The sample farm households, particularly those in Ashanti, are engaged in multiple livelihood strategies including on-farm, off-farm and non-farm activities.

In most inland valleys agriculture is the dominant land use. In addition to rice, farmers commonly cultivate oil palm, vegetables, cocoa, citrus, maize, cassava, yams, cow peas, soybeans, sorghum, plantains, and mangoes. Rice has to compete with these crops.

Inland valley rice development requires significant labor, therefore competing for scarce labor with other on-farm, off-farm, and non-farm activities. For this reason farmers have devised strategies for minimizing labor inputs such zero tilling for land preparation and dibbling and broadcasting for planting instead of transplanting.

Due to its bimodal rainfall pattern, Ashanti Region allows the cultivation of two crops per year. In Northern Region only one crop can be produced. Cultivating two crops in a year requires full control irrigation facilities.

Farmers lack access to crucial technologies required to make the system work sustainably. Examples are:

- power tillers to mitigate the drudgery of plowing, paddling and leveling,
- mechanical harvesters to minimize quantitative and qualitative paddy rice output loss, and
- appropriate rice varieties that resist pests and diseases and respond to fertilizer and other inputs well and yet do not lodge.

Framers may lose crops due to biotic and abiotic factors including absence of efficient water management and weed competition. The current realized yield levels are below potential due to poor agronomic practices and lack of good water management. Thus, the level of profit from rice cultivation in inland valleys is not enough to motivate farmers to pursue rice cultivation in inland valleys, particularly when the opportunity cost of family labor is considered. The profitability level can be raised through implementing multifaceted strategic interventions along the lines suggested below.

Recommendations

- Improve water management. This allow for differentiated approaches for Northern Region and Ashanti. For Northern Region, the water management infrastructure should focus on full control irrigation to allow dry season cropping. In Ashanti, improvements in water management infrastructure should focus on providing supplementary irrigation.
- Ensure land tenure security through tenancy agreements.
- Improve agronomic recommendations (fertilizer rates, variety choice, etc.) based on site specific on-farm experiments. The recommendations should be based on input-output relations (economic analysis) not just on technical optima.
- Institute affordable long-term financing mechanisms for input procurements and investments that take into consideration the economic viability of rice cultivation in inland valleys.
- Improve post-harvest handling through mechanical threshers.
- Improve land management capability of farmers through introducing affordable equipment such as power tillers.
- Initiate capacity building initiatives for researchers, extension personnel, and farmers.

Appendix 1. Cropping and land use patterns in inland valleys.

Rice

Maize

Palm oil

Teak trees

Appendix 2. Rice varieties observed in study areas.

Table A2.1 The productivity of rice varieties grown in inland valleys

Name	Number of fields	Area (acres)	Mean yield (kg/acre)
Wita 7	114	114.8	1386.9
Mr. More	74	115.6	1171.3
Sikamo	70	73.6	1224.7
Jasmine	49	61.6	1292.5
China	42	53.5	1592.1
Nerica	6	7.5	1025.0
Mr. Hurry	6	3.8	1208.3
Mokorkor	4	7.0	1662.5
Long Grain	4	3.5	187.5
Agoma	1	3.0	900.0
Boak	1	0.8	1170.7
Gro 7	1	1.0	1050.0
Lapez	1	5.0	1110.0
Menfanse	1	1.0	1200.0

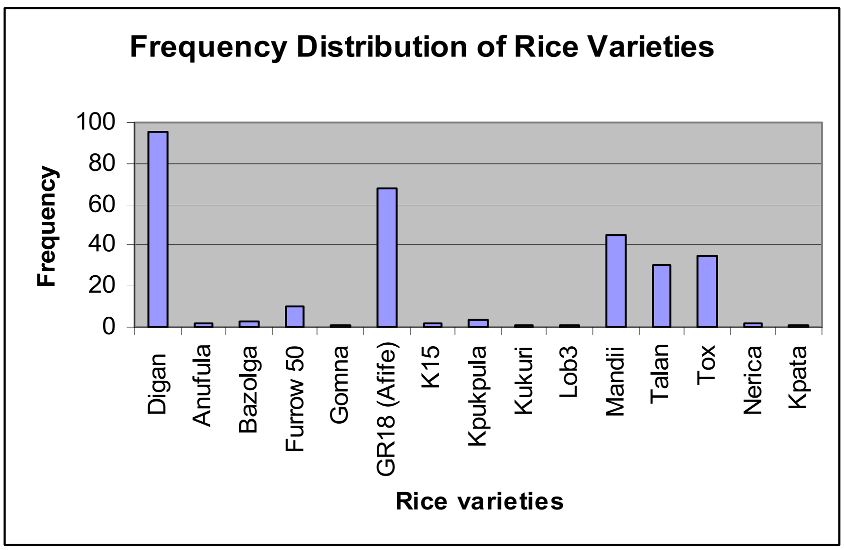

Figure A2.1 Rice varieties observed in Tamale Region

Appendix 3. Gross margin estimates.

Table A3. 1 Gross margin estimates for Tamale.

Items	AFD/MOFA-LRDP	Non-project area	Irrigated rice
Revenues	207.8	187.5	405.0
Costs			
Land preparation (tractor hire)	13.0	15.7	11.1
Seed	8.6	8.6	10.4
Hired labor cost	3.9	3.7	2.1
Herbicides	4.9	14.4	7.2
Fertilizer	12.7	25.8	47.5
Other costs	10.8	8.9	11.6
Total cost (excluding family labor)	53.8	76.9	89.9
Gross benefit	154.0	110.6	315.1
Value of family labor	68.9	62.9	146.5
Net benefits	85.1	47.7	168.6

Table A3.2 Gross margin estimates for Ashanti.

Gross value (GHC)	305.60
Direct cash costs	
Land preparation (tractor hire, Roundup cost)	21.30
Fertilizer	20.70
Herbicide	10.40
Seed	7.10
Others (pump rent, pesticide)	1.82
Labor (person-days)	90.01
Labor cost	180.00
Total variable cost	241.30
Net benefit	64.30