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How Do New Cash Crops Spread or Not Spread?: The Case of Rice in a Suburban Area, Ghana

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Abstract

This paper examines the determinants of rice-cultivation adoption in inland-valley bottom areas in Ghana. In West African countries, surging import of rice has shown farmers a new and potentially huge income source. Around the second largest urban area in Ghana, Kumsi, there are inland-valley bottoms which are suitable for rain-fed rice cultivation. The puzzle is that not much part of these inland-valley bottoms has been utilized for rice production. In 2001, in four villages around Kumasi, we conducted a detailed household survey both on lowland-rice and upland-maize farmers. We found that the profit from lowland-rice cultivation was significantly lower than that from upland-maize farming. This paper also examines our predictions made from the profit comparisons in 2001 with the results of rice-farmer census conducted in 2011 in the same four villages.

1 Introduction

This paper examines the determinants of rice-cultivation adoption in inland-valley bottom areas in Ghana. In a classic literature, Hirschman (1958, p. 121) argues that a critical role of international trade in the course of economic development is to reveal a new market for potential producers in a country. In West African countries such as Ghana, surging import of rice should have shown farmers a new and potentially huge income source. Ghana became an active rice importer in the 1990s. In 2008, the import of milled rice amounted to 116 thousand metric tons, which cost more than seventy-eight million US dollars (Food and Agriculture Organization (FAO) 2011). Combined with the trade of broken rice, import of rice accounted for 4.3% of Ghana's trade deficit in 2008 (International Monetary Fund (IMF) 2010).[1]

On the soil of Ghana, rice cultivation seems to be one of the most attractive for the farmers around Kumasi, the second largest urban area in the country. There are three major reasons. First, the surging rice consumption in West African countries is mainly due to the increase in urban population. Increasing opportunity cost of time and limited space for cooking have rendered rice a staple food in urban area of West Africa (Kennedy and Reardon 1994). Based on the survey on 300 urban residents, Tomlins et al. (2005, Table 1) shows that rice has already become the most preferred staple food for the urban residents in Ghana. According to the 2000 population census, Kumasi had more than one million population with a high growth rate (Ghana Statistical Service 2000). Thus, the farmers around Kumasi have had access to a huge market for rice.

Second, unlike Accra which is the largest urban area, Kumasi is an inland city. Transportation costs from the ports should provide locally produced rice competitive edge against imported rice. Third and most importantly, there are huge areas of inland valley bottom around Kumasi. In rainy seasons, many parts of inland valley bottom can be utilized as wet rice fields (Andriesse and Fresco 1991). The puzzle is that it was reported that not much parts of inland-

[1] In 2008, Ghana was the third largest importer of broken rice: imported 278 thousand metric tons with 137 million US dollars.

valley bottoms around Kumasi had been utilized for rice production (Dekuku et al. 1993). In our own survey in 2002 and 2008, we have confirmed under-utilization of inland-valley bottoms around Kumasi, in the sense that no or few rice farmers were found on many lowlands that had been cultivated for rice before. The specific purpose of this study is to tackle this puzzle. We identify the factors that prevent the realization potential absolute (biophysic) and comparative advantage of lowland rice production of the area.

This puzzle is not merely a local issue in Ghana. Even putting aside its obvious link to a large body of literature on the adoption of new agricultural technology, it is relevant for a general issue in African agriculture. There have been two major challenges to the agricultural sector in African countries: high population growth rate and relatively infertile soil. Over the past two decades, the average population growth rate in African countries, 2%, is higher than the average of developing countries.[2] Most of the African continent is, however, covered with relatively infertile soil. Bloom and Sachs (1998) therefore argued that the African continent would inevitably depend on the cereal production of the other continents.

An immediate threat of this dependence on imported cereal is a hike in world cereal prices. In fact, in 2008, several West African countries suffered from social unrest due to the price hike of imported rice. A possible long-term threat is lasting high labor cost compared to the Asian developing countries. To maintain the high economic growth rates since the beginning of the 21st century, West African countries need to improve their agricultural productivity for reducing and stabilizing food prices, and consequently reducing their labor cost. In sum, African countries need to raise its staple crop production on relatively infertile soil.

Two ordinary measures to enhance food production are intensification and *extensification*. In West African countries where traditional farm land is often located in upland, however, successful intensification of cereal production is likely to result in reducing the production of perennial crops for export such as cocoa and coffee. We should also note that in upland areas, perennial

[2]We should, however, note that the expected average population density of the African countries is still lower than that of the major Asian countries (Turner II, B. L., Hyden, and Kates 1993, 4).

crops are usually more environmentally friendly than annual food crops. Rapid agricultural *extensification* to marginal lands, on the other hand, may accelerate deforestation. Rice cultivation in inland valley bottoms provides a way to circumvent these environmental difficulties expected from intensification and extensification. Increasing the utilization rate of inland swamps will not cause deforestation. Plain geography of inland-valley bottom prevents soil loss from intensification (Andriesse and Fresco 1991; Hirose and Wakatsuki 2002). Exploring the obstacles for lowland rice cultivation in Ghana, therefore, may provide us a key to tackle the basic problem in the African agricultural sector.

In our study area, the Ashanti region in Ghana, the possible obstacles to rice farming in inland-valley bottoms can be summarized by the following four hypotheses.

1. Lack of well-specified land tenure system. The local ethnic of the study area, Asante, is known for its complicated land tenure and inheritance systems (Berry 2001).

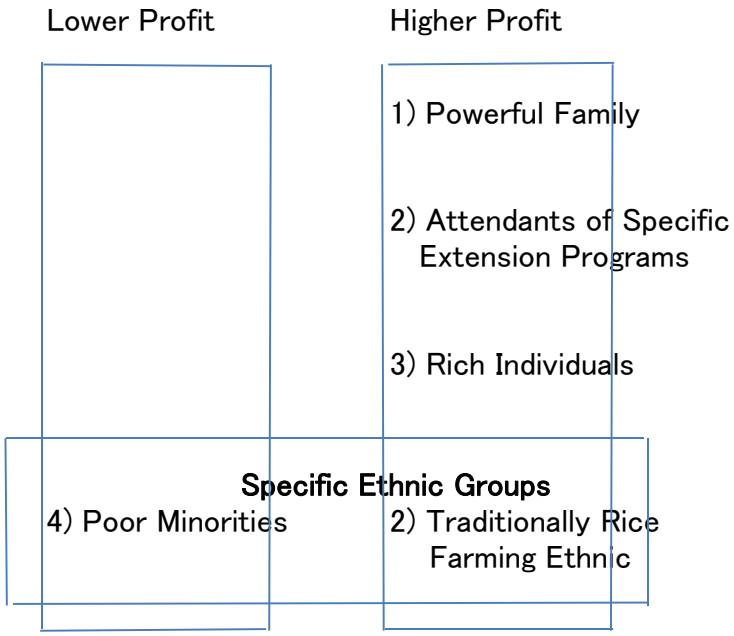
2. High learning cost of rice cultivation. In many countries, difficulties in learning has been a main suspect for slow diffusion of new agricultural technologies (Conley and Udry 2010).

3. Credit or labor constraints to farmers.

4. Lower profit of lowland rice compared to traditional upland farming. Due to small requirement of labor, slash-and-burn farming on upland is often profitable (Dvořàk 1992).

As a first step, we can evaluate these four hypotheses by examining the profit from rice farming and the characteristics of rice cultivators. Hypotheses 1, 2, and 3 indicate excess profit to the rice farming compared to the traditional upland farming. If hypothesis 1 holds, for example, rice farmers are likely to be limited in powerful families in the area who have traditionally stable right in lowlands. In contrast, hypothesis 4 suggests a lower profit from rice farming in inland-valley bottoms. Under hypothesis 4, those who cannot access profitable upland farming would reluctantly cultivate lowland rice. Figure 1 visualizes these four hypotheses. We conducted a series of field surveys around Kumasi to estimate the profit from lowland-rice and upland-maize

Figure 1: Four Hypotheses across Farmers' Characteristics and Profit



production. The latter, upland maize, is used as a yardstick to evaluate the excess or lower profit from lowland rice cultivation.

This paper proceeds as follows. Section 2 provides the background information of our study area. Section 3 explains the design of our field surveys. In section 4, we discuss general observations of the two surveys, extensive village survey and census in 6 villages. Section 5 examines the four hypotheses with the results of profit calculation of rice and maize farming. We found lower return from lowland rice than that from upland maize. Our estimates, although with some reservations, support hypothesis 4. Section 6 concludes the paper.

2 Study Area

Kumasi is located in the Equatorial-forest zone: approximately between latitude 6°30′ and 7°00′ North and longitude 1°30′ and 2°00′ West. Kumasi has been the political and cultural center

of the southern Ghana, and is the capital of the Ashanti Region. Between 1984 and 2000, its annual population growth rate was about 4.6%, which was much higher than the country average at that time: 2.5%. In the Ashanti Region, the majority ethnic group is Asante, which belongs to the Akan language group. In Ghana, traditional chieftaincy is still in practice with legal endorsement. The paramount chief of Asante states, *Asantehene*, lives in Kumasi.

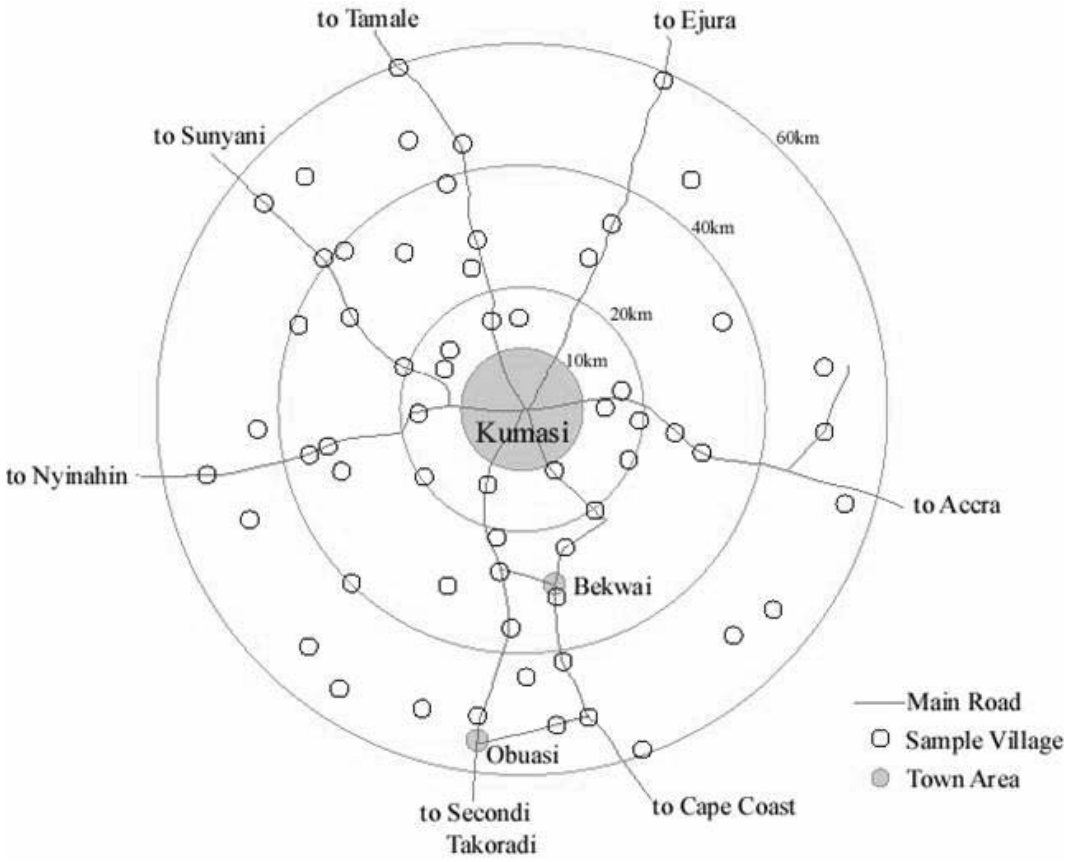
To consider the impacts of access to urban market, we set the study area within the 60 km radius from the center of Kumasi. In the study area, the average annual rainfall varies from 1,450 mm to 1,680 mm. The southern part of the study area has more precipitation than the northern part, but this difference is not so significant. There are two rainy seasons. The main rainy season starts in March and ends in July, whereas the minor rainy season starts in September and ends in November. The terrain is undulating: continua of upland and inland swamp.[3]

Since the early periods of the last century, cocoa has been the most important cash crop in the study area (Takane 2002). The major food crops have been cassava, maize, plantain, and cocoyam, all of which are usually cultivated on upland. Rice is a minor crop in the area. According to a rough official estimate in 1998, the cropped area of rice in the Ashanti region was 4,201 ha, while that of the maize was 109,890 ha (Policy, Planning, Monitoring and Evaluation Department (PPMED) 2000).

There are not many records about the rice cultivation in the Ashanti Region. Two exceptional studies by the West Africa Rice Development Association (WARDA), Dankyi, Anchirinah, and Apau (1996) and Dekuku et al. (1993), reported that the cultivation method of lowland rice in the area was mainly slash-and-burn, which we reconfirmed in the informal preparatory surveys in 2000. For the examination of our 4 hypotheses, we chose maize as a typical upland food crop in the area. McCann (2005, Ch. 3) provided a detailed history of maize cultivation in the Ashanti area since its arrival from the New World.

[3]According to the classification of rice-cultivation environments by Andriesse and Fresco (1991), the physio-hydrographic position of lowland in the study area is fluxial.

Figure 2: Villages surveyed in 2000 - 2001



3 Survey Design

The major parts of our field survey were conducted over the year of 2000 to 2002. The field survey consists of three parts: extensive village survey, census in 6 villages, and intensive farmers' survey in 4 villages. A follow-up census survey in these 4 villages was implemented a decade later, in 2011, to assess the diffusion of rice cultivation.

The extensive village survey was designed to obtain the general picture of the study area. Within the 60 km radius from the center of Kumasi, we randomly sampled 60 villages (rural towns) with lowland area (Figure 2). In each of the sampled village, we conducted a group interview with the leaders of village and farmers' group, then visited lowland areas to make a general observation and a distance measurement from the center of the village.

The census in 6 villages was implemented to obtain the population for the sampling of the intensive farmers' survey. The 6 villages were, therefore, selected from the villages with the record of relatively many number (at least 8) of rice farmers in the extensive survey. We visited all the residential buildings in the village, and enumerated all the households and their members in each building. The census inquired about the ethnicity of household head, the major income source of each household members (lowland rice farmer or not), and so on. Therefore the census itself provided valuable information on the characteristics of rice farmers compared with the other farmers in the villages. Based on the results of the census, out of 4 villages, we randomly sampled 58 rice farmers and 53 maize farmers for the intensive farmers' survey.[4] The intensive farmers' survey, conducted in the 2001-2002 crop season, is a detailed household survey on lowland rice production and upland maize production.

Our main output indicator is profit which is defined as crop sale plus imputed value of home consumption minus costs including in-kind payment. Note that the profit here depends not only on productivity but also on, for instance, sale price. Those farmers who can wait for higher crop prices may enjoy higher profit even with relatively low productivity. Similarly, those crops with a good marketing channel may have a leading edge to the other crops. These possibilities are what we would like to examine by comparing the profit from lowland rice and that from upland maize.

Although the sample size is relatively small, our intensive farmers' survey has three major advantages. First, the planted areas of rice and maize were measured by GPS. As was mentioned above, in the study are at the time of our investigation (2000-2002), the major cultivation practice was slash and burn. The information about the planted area under slash-and-burn practice is usually difficult to obtain. Farmers often burnt the large area, but might not plant crops all over the prepared area. In fact, among our sampled farmers, nine of rice and two of maize

[4]Upon sampling, we tried to exclude the farmers who cultivated both lowland rice and upland maize. This is to capture specific characteristics, if any, of lowland rice farmers for testing our four hypotheses. Due to some sampling error, we later found that 5 out of the sampled 58 rice farmers did cultivate upland maize. None of the sampled 53 maize farmers cultivated lowland rice in our study period.

farmers could not estimate the size of their planted area at all.

Second, based on the careful preliminary surveys, the questionnaire was designed to capture the details of output and input uses. For example, the questionnaire investigated not only the in-kind payment to hired workers, but also inquired about the amount of harvest used for home consumption and small gift to neighbors measured in minor units such as bowl. The count of these minor uses of outputs raised the gross output of lowland rice by 13 percent. In measuring profits of house enterprises, de Mel, McKenzie, and Woodruff (2009) find that the home consumption of business materials is the major cause of measurement error. In our survey, we tried to hold out the concerns raised by de Mel, McKenzie, and Woodruff (2009) by multiple visits to the respondents with well-designed questionnaire.

Lastly, field measurement was implemented on the density of intercrops in upland maize farms. In our study area, upland farming is characterized by mixed planting. The result of field measurement helps us separate the cost for intercrops from the maize cultivation.

4 Rice Cultivation in the Ashanti Region: Census survey

Table 1 summarizes the main characteristics of the 60 villages sampled in the extensive survey. There are 188 lowlands in the areas of these 60 villages: about 3 lowlands per village. Except for 9 lowlands, these areas were utilized for food crop cultivation such as vegetables, dry-season maize, and rain-season rice.[5] The group interviews counted in total 693 rice farmers in the crop season of 2000-2001.[6]

The spatial distribution of lowlands in the study sites is relatively equal: it does not depend on the distance from Kumasi or access to highway. But rice production in lowlands is not so equally distributed. In terms of the number of lowlands, villages in the remotest zone (from 40

[5] In local language *Twi*, lowland is referred to as *wora*. In the area of *wora*, there can be *woratini*. *Woratini* indicates lowland which usually dry up in the dry season. In contrast, *wora* in general can be waterlogged all over the year. So there are lowlands that cannot be used for food crop production.

[6] The number of rice farmers reported here is likely to be underestimated. In the later visits, if any, we sometimes noticed that village leaders mentioned a larger number of rice farmers. In the first visits, the leaders had suspected that investigations by strangers (that is, by us) might be related to land tax or rent payment.

Table 1: 60 Villages in Extensive Survey 2000

	(1)	(2)	(3)	(4)	(5)	(6)
		By Distance from Kumasi			By Access to Road	
	Total	- 20 Km	20-40 Km	40 - 60 Km	On Road	Off Road
Number of Villages Surveyed	60	12	24	24	30	30
Population in 1984 Census[a)]	664	1118	555	547	779	550
Travelling Time to Kumasi (minute)[b)]	66	34	55	92	50	81
Ohene[c)]	19	8	6	5	8	11
Ashanti Village	56	12	22	22	29	27
Zongo Area[d)]	26	4	8	14		9
Electricity	19	7	7	5	13	6
Dispensary	6	2	1	3	2	4
Rice Mill	15	3	4	8	7	8
Lowland in Village Area						
Number of Lowlands	188	37	70	81	98	90
Average Distance (meter)						
from Hamlet	1391	1549	1171	1392	1470	1199
from Bus Stop	2110	1624	2033	1963	1626	2245
Use of Lowland						
No Use except for Tree Crops	9	2	0	7	6	3
Vegetables in Dry Season	124	25	40	59	57	67
Use in Rainy Season						
No Use	40	13	5	22	16	24
Vegetables	30	5	17	8	19	11
Rice	98	11	38	49	48	50
Number of Rice Farmers[e)]	692	186	324	182	361	331

a) Official Government census in 1984.
b) All are by minibus or on foot and minibus.
c) Local traditional chief. See text.
d) Part of the village area where the migrants concentrate to live. See text.
e) For two lowlands, there are no information about the number of rice farmers.

km to 60 km away from Kumasi) have more rice producing lowlands than those in less remote zone. Vegetables, on the contrary, tend to be grown in lowlands near Kumasi, not only in the rainy season but also in the dry season. It means that market access is more important with vegetable production. However, if we compare the number of rice farmers per lowland, the tendency is reversed. Lowlands in 10-20 km zone have the most rice farmers on average, and lowlands 40 - 60 km zone have the least rice farmers on average.

Nineteen, that is, about one-third of the sampled villages have traditional chief, *ohene*. It indicates that these villages have relatively long histories. The other 41 villages were set up by the migrants either from these 19 villages or from the other villages. *Ohene* and his surrogates usually have strong rights over land. In principle, under the authority of *Asantehene*, *ohene* controls all the communal land in his village and the villages set up by the migrants from his village. In the study area, the land controlled by chiefs is referred to as stool land.

A characteristic of Ghanaian, or West African, society is migration. People often move either permanently or temporary to the other regions of the country (sometimes to the other countries). In our sample, 26 villages have *zongo* area where recent in-migrants, mainly from the northern regions, concentrate to live. Even without *zongo*, however, there usually are many migrants in villages.

Table 2 summarizes the main characteristics of the 6 villages where we implemented the census survey. These 6 villages were selected from the 60 villages in the extensive survey with at least 8 rice farmers. All the 6 villages except for one is located between 20 km and 50 km distance from Kumasi because villages in this zone tended to have more rice farmers than the others. Two of the 6 villages are villages with *Ohene* and the proportion of Ohene villages is the same as that in 60 villages. As for electricity, on the other hand, only one village (Village III) received public electricity supply at the time of interview. This rate of electrification is lower than that among the 60 villages, among which almost one third were electrified as of 2001. Since the electrification is one of the indicators of economic development, we could say that rice tended to be cultivated in the relatively less-developed villages around Kumasi. In fact,

Table 2: Villages in Census Survey 2001

Village	I	II	III	IV	V	VI
Population						
1984 Census[a)]	855	723	962	259	862	558
2001 Census	901	990	2171	505	1095	842
Ratio of Female	52.7%	50.0%	48.9%	46.9%	49.2%	50.8%
(NI on sex)	(0)	(0)	(17)	(34)	(0)	(2)
Average Age	24.5	23.9	23.1	22.9	22.6	22.4
(Std Dev)	(21.40)	(20.2)	(18.3)	(19.4)	(19.5)	(19.5)
(NI on age)	(0)	(0)	(29)	(42)	(11)	(9)
Number of Income[b)]	449	571	1282	250	600	563
Sources Reported						
Ratio of Farming	55.5%	46.8%	38.5%	53.2%	50.0%	53.3%
(NI on occupation)	(0)	(0)	(26)	(43)	(12)	(4)
Number of Rice Farmers[c)]						
in 2001 Census	30	40	80	25	24	30
Estimates in	42	24	64	19	22	17
the Extensive Survey						
Distance to	30.45	35.90	22.50	43.50	47.40	72.85
Kumasi (kilometer)[d)]						
Traveling Time to Kumasi	30	35	30	60	60	105
by Minibus (minute)						
Bus Fare to Kumasi	1300	1500	800	2200	1500	4600
in Old Ghanaian Cedi[e)]						
Electricity	N	N	Y	N	N	N
Ohene	Y	N	Y	N	N	N
Ashanti Village	Y	Y	Y	Y	Y	Y
Zongo Area	Y	Y	N	N	N	Y
Number of Lowlands	4	3	3	2	3	3
Distance from Village	333	314	1024	156	224	208
Center (meter)[f)]	417	476	2100	803	1005	647
	418	534	3100		1866	1850
	1276					

Source: Authors' survey conducted in 2001.

a) Official Government census in 1984.

b) For each household member, we asked up to 3 major income sources.

c) These two numbers are not directly comparable. The estimates in the extensive village survey is about the previous crop season: 2000-2001.

d) Straight distance measured on the topography maps.

e) At the time of our investigation: 7,000 Cedi = 1 USD.

f) Way of the major path to the lowland measured by GPS.

among the 6 census villages, Village III was much larger than the others in population, too. It is a kind of satellite town of Kumasi with the low ratio of farmers (38.5%).

One of the interesting observations in table 2 is that lowlands in the 6 census villages are located much nearer to village center than those identified in 60 villages of the extensive survey. Considering that most rice farmers need to carry the harvest from their rice fields to their home in the village on foot, the observation is understandable.

Our 58 lowland rice farmers and 53 upland maize farmers were sampled from the 4 villages: Villages I to IV. Tables 3 and 4 summarize the characteristics of rice- and maize-cultivating households in the census surveys in the two villages. As will be shown later, Village II recorded the lowest profit from lowland rice in the 4 sampled villages, while Village III recorded the highest. For reference, the results of the recent 2011 census survey are listed in these two tables.

Tables 3 and 4 clearly show that many rice farmers in the area were migrants, most of whom were Islams who had come from north, in particular, from Upper-east Region. This finding suggests the possibility of either hypothesis 2 (high learning cost so that the local ethnic, Asante, cannot do lowland rice) or hypothesis 4 (migrants cannot access profitable upland). In addition, we can observe that over the past decade, the number of rice farmers declined. There are, however, more Asante rice farmers recently.

Table 5 summarizes the size and mode of acquisition of lowland-rice and upland-maize fields. The bottom two rows show that between the lowland-rice and upland-maize fields, there is a sharp contrast in the mode of acquisition. While 69% of lowland rice fields was rented in, that ratio of upland-maize fields was 28%. About the planted area of lowland rice, there is no much difference between the farmers' estimates and the GPS measurements. Nine rice farmers, however, could not make any guess about the size of their planted area. In contrast, about the planted area of upland maize, farmers' estimate is nearly twice as large as the GPS measurement, while only 3 farmers could not provide the estimates. This difference may be partly because many lowland rice fields were rented in. Some farmers did field measurement

Table 3: Characteristics of Lowland Rice Farmers: Village II

	(1)	(2)	(3)	(4)	(5)	(6)
	2001 Census			**2011 Census**		
	Total (18 yrs ≥)	Rice Farmer	Upland Maize Farmers	Total (18 yrs ≥)	Rice Farmer[a)]	Upland Maize Farmers[b)]
Number	513	39[c)]	186	549	20	182
Ratio to Total (%)		(7.6%)	(36.3%)		(3.6%)	(33.2%)
Age	38.9	40.8	44.0	40.0	45.5	45.0
(Std)	(17.2)	(12.7)	(16.1)	(18.3)	(15.8)	(15.6)
Ratio of Female (%)	53.6%	15.8%	37.6%	53.2%	5.0%	31.9%
Family Head	182	28	106	233	18	131
(Ratio)	(35.5%)	(71.8%)	(57.0%)	(42.4%)	(90.0%)	(72.0%)
Below are only about family heads						
Religion: Only about Family Head						
Christian	60.4%	32.1%	62.3%	70.8%	51.4%	68.7%
Islam	29.1%	67.9%	26.4%	21.5%	48.6%	23.7%
Born in: Only about Family Head						
This Village	35.7%	14.3%	43.4%	37.8%	27.8%	48.1%
Other Village in Ashanti	35.2%	32.1%	34.9%	36.1%	22.2%	31.3%
Other Regions	26.4%	46.4%	19.8%	24.0%	50.0%	18.3%
Upper East	9.9%	28.6%	8.5%	2.1%	11.1%	2.3%
Upper West	0.0%	0.0%	0.0%	1.3%	5.6%	0.8%
North	4.4%	3.6%	2.8%	6.0%	16.7%	5.3%
Ethnicity: Only about Family Head						
Ashanti	58.6%	10.7%	61.3%	60.1%	33.3%	66.4%

a) Those farmers who planted rice in the past 3 years: either 2008, 2009, or 2010.
b) Those farmers who planted upland maize in the past 3 years: either 2008, 2009, or 2010.
c) Excluded one young rice farmer who is 17 yrs old.

Table 4: Characteristics of Lowland Rice Farmers: Village III

	(1)	(2)	(3)	(4)	(5)	(6)
	2001 Census			**2011 Census**		
	Total (18 yrs ≥)	Rice Farmer	Upland Maize Farmers	Total (18 yrs ≥)	Rice Farmer[a)]	Upland Maize Farmers[b)]
Number	1135	79[c)]	390	1282	49	335
Ratio to Total (%)		(7.0%)	(34.4%)		(3.8%)	(26.1%)
Age	36.2	35.2	43.0	36.8	39.8	46.1
(Std)	(15.7)	(11.7)	(14.4)	(16.0)	(12.4)	(14.6)
Ratio of Female (%)	47.8%	19.0%	33.1%	50.4%	24.5%	31.0%
Family Head	497	57	300	523	35	245
(Ratio)	(43.8%)	(72.2%)	(76.9%)	(40.8%)	(71.4%)	(73.1%)
Below are only about family heads						
Religion: Only about Family Head						
Christian	72.2%	36.8%	70.7%	70.6%	51.4%	65.3%
Islam	17.3%	49.1%	19.7%	19.3%	48.6%	25.3%
Born in: Only about Family Head						
This Village	36.0%	5.3%	38.7%	30.8%	25.7%	38.8%
Other Village in Ashanti	30.6%	15.8%	38.0%	35.0%	8.6%	30.0%
Other Regions	31.2%	79.0%	32.0%	33.3%	62.9%	30.6%
Upper East	14.5%	66.7%	19.3%	7.5%	20.0%	8.2%
Upper West	0.4%	0.0%	0.3%	1.9%	5.7%	2.0%
North	4.0%	5.3%	3.7%	8.2%	34.3%	10.2%
Ethnicity: Only about Family Head						
Ashanti	58.6%	3.5%	57.0%	51.1%	17.1%	55.5%

a) Those farmers who planted rice in the past 3 years: either 2008, 2009, or 2010.

b) Those farmers who planted upland maize in the past 3 years: either 2008, 2009, or 2010.

c) Excluded one old rice farmer who could not tell the age.

Table 5: Size and Mode of Acquisition of Rice and Maize Fields

	58 Lowland Rice Farms	53 Upland-maize Farms
Average Area (hectare)		
Farmers Estimates	0.77	0.76
(Standard Dev.)	(0.42)	(0.61)
[Number of No Answer]	[9]	[2]
Max	2.02	4.05
Min	0.13	0.11
Measrued by GPS	0.71	0.41
(Standard Dev.)	(0.42)	(0.37)
Max	2.40	1.95
Min	0.17	0.05
Rented in	40	15
	(69%)	(28%)
Allocated Family Land	4	6
	(7%)	(11%)

upon rent contract. In addition, those who rented in the farm land generally try to cultivate most of the area.

5 Profit

Table 6 summarizes the results of our profit calculations based on the 2001 farmers' survey. The first row (I) shows the total output value minus the costs that the farmers really paid by cash or in kind. This corresponds to the crop income from lowland rice or upland maize, which may be the main concern for those farmers without any alternative activities: that is, with low opportunity cost. In the study area, rice has been recognized as a cash crop. Our result is in line with such farmers' perception. The average crop income from lowland rice, 1,274,326 old Ghanaian Cedi (about 182 US dollars in 2002), is about double of that from upland maize (617,637 Cedi).

When we consider the labor inputs of respondents and their family members, however,

Table 6: Profit from Rice and Maize: (in old Ghanaian Cedi)

		(1) Lowland Rice	(2) Upland Maize	(3) Upland Maize (Subtract Costs for intercrop)[a)]	(4) Upland Maize > 0.2 ha (Subtract Costs for intercrop)[a)]
	Number of Observations	58	53	53	36
I)	Production Value[b)] - Cost of Purchased Inputs (Other than Land Rent)	1,274,326	617,637	727,288	866,084
		(1,653,360)	(647,568)	(656,052)	(717,533)
	per Hectare	1,748,488	2,199,435	2,566,253	2,134,655
II)	I) - Imputed Wages of Family Labor	-946,717	-254,379	112,756	162,801
		(1,932,032)	(645,016)	(572,718)	(626,547)
	per Hectare	-2,180,882	-960,493	400,410	595,830
III)	II) - Land Rent	-1,082,911	-288,465	78,670	124,702
		(1,923,079)	(636,992)	(566,514)	(624,598)
	per Hectare	-2,413,992	-1,085,771	275,132	497,639

Source: Survey data. In 2001, 7,000 Cedi = 1 USD.
Numbers in parentheses are standard errors.
a) Subtract the half of the cost for land preparation and weeding.
Refer to the text.
b) Include the value of captured grasscutter (sell as meat)

the numbers drastically change. In Row II) of table 6, from the crop income, we subtracted imputed labor cost of family members. For the shadow wage of respondents and their family members, we used the mode of daily wages to agricultural workers in each village.[7] With the imputed payments, both lowland rice and upland maize have negative earnings, but the red of the lowland rice is more than three-times larger than that of upland maize. This observation supports the results of informal interviews in which farmers often complained that lowland rice was a hard work in muddy fields.

Furthermore, column (2) of table 6 seriously underestimated the profit from upland maize. As was mentioned above, mixed cropping has been the common practice in upland farming. Only one out of our 53 maize farmers did not do intercropping. The other 52 farmers planted cassava, cocoyam, or plantain with maize. It is, however, virtually impossible to measure the return from these intercrops. This is because, farmers will harvest cassava, cocoyam and plantain over 2 to 3 years after the harvest of maize. To obtain some rough estimate of the return from intercrops, we randomly sampled the 4-square meters plots in the upland maize fields, and counted the number of crops. We found that the ratio of maize and intercrops is about fifty-fifty.

In column (3) of table 6, we calculated the profit from upland maize with the 50% of land preparation costs (clearing undergrowth, removing stumps, spraying herbicide, etc). Based on the counts of intercrops, we have boldly assumed that half of the land preparation cost was for intercrops, not for maize. In this calculation, although very small (78,670 Cedi, that is about 11 US dollars), the upland maize recorded positive profit after subtracting all the cost including the implicit payments to family labor. In other words, the shadow wage of upland-maize farmers was almost equal to the market wage rate.

Note that upland-maize has been the popular crop among the farmers in the area so that some of the sampled maize farms were cultivated as a side job: for instance, planted maize on a small open space in the oil palm plantation. To exclude such minor maize cultivations, in

[7] In these daily wages, we found little variation across the type of farm activities or hired workers' characteristics (except for sex). This observation may reflect the fact that in the study area, the labor market for casual wage workers is homogeneous due to the huge labor market in Kumasi.

column (4) of table 6, we summarize only the maize farms with the planted area of 0.2 hectare and above. The average profit becomes 124,702 Cedi, about 18 USD.

Among the 4 hypotheses we presented, our profit comparison supports hypothesis 4. Lowland rice, in spite of the good access to large market of Kumasi, still cannot compete with the upland maize in profit.[8] The main problem is the large labor inputs required for rice production. In particular, bird watching to protect young rice ear takes a lot of time of rice farmers. About for a month, from early morning to sunset, the rice farmers have to stay in the field to scare birds coming for their rice. In our 58 samples, bird watching accounted for 25% of the total farming cost of lowland rice.

The census results of 2001 and 2011 listed in tables 3 and 4 seem to suggest an increase in Asante rice farmers over the past decade. As of 2001, the Asante farmers might be at the stage of learning of rice farming from migrant farmers. When we calculate the profit of lowland rice of the 13 Asante samples, however, it was -498,292 Cedi: the red is less than half of the total average (-1,011,351 Cedi). At first glance, this is not supportive for hypothesis 2. But when we consider "Production Value minus Cost of Purchased Inputs" (row I of table 6), the average of the 13 Asante respondents is 1,105,682 Cedi. It is slightly lower than 1,345,887 Cedi. We need further examination about the determinants of the profit.

6 Conclusion

Based on the detailed survey on 111 farm households in central Ghana, we examine the four working hypotheses on the slow diffusion of a new cash crop in the area: lowland rice. We found that lowland-rice farmers suffered from very low shadow wage when we explicitly count the family labor inputs. The main difficulty in the lowland-rice cultivation in the are lied in its high labor demand. In the study area, lowland rice cannot compete with the higher profits from upland farming. Without further innovations in lowland rice farming, in particular in labor-

[8]The profit numbers, however, varied among 4 villages (Appendix). As a next step, we need to examine the differences across the four villages.

saving technologies, the extension services or projects for lowland rice promotion would be in vain. The smaller number of rice farmers found in the census implemented 10 years after the household survey shores up our prediction based on the profit calculation.[9] Our result suggests that the extension service should target at introducing labor-saving farming practices in lowland. In the field visit in 2011, we observed the use of fish net for bird chasing in the rice fields. It exemplifies farmers' search for labor-saving rice farming technologies.

Appendix I

Profit in each sampled village.

Appendix II: Data Construction

For robustness check, we have calculated profits from rice and maize under various assumptions on the opportunity costs of non-wage workers: e.g., respondents themselves, their family members, and exchange labors. In all the cases, we include the cost for lunch in the opportunity cost.

In the first case, we have adopt the ordinary daily wage rate collected in the village survey (need confirm) as the opportunity cost of non-wage workers (Table 6). In each villages, across various works from clearing to threshing, the same wage rate is applied. May be due to the access to a big labor market in Kumasi, wage rate is stable across months in our sample. Work with Less than 3 hours are excluded.

In the second case, as the opportunity costs in each work in rice and maize cropping, we use the average of the hourly wages for that work in each village. Suppose that Respondent A cleared the undergrowth of his plot for three day, six hours in each day, with a male member of his extended family. Suppose also that Respondent B in the same village also cleared the

[9] Admittedly, however, we have not explicitly considered the shift from agriculture to non-agricultural activities in the village economies in the area.

Table 7: Profit from Rice and Maize: Village I

		(1) Lowland Rice (Subtract Costs for	(2) Upland Maize	(3) Upland Maize intercrop)[a]
	Number of Observations	13	12	12
I)	Production Value[b] - Cost of Purchased Inputs (Other than Land Rent)	800,940 (1,173,667)	667,761 (927,989)	773,240 (891,228)
	per Hectare	1,372,201	2,523,041	2,991,042
II)	I) - Imputed Wages of Family Labor	-929,752 (1,045,834)	-221,656 (584,341)	121,365 (530,451)
	per Hectare	-2,122,152	-575,504	706,208
III)	II) - Land Rent	-1,026,957 (1,066,169)	-232,767 (601,990)	110,254 (542,328)
	per Hectare	-2,394,918	-596,642	685,069

Source: Survey data. In 2001, 7,000 Cedi = 1 USD.
Numbers in parentheses are standard errors.
a) Subtract the half of the cost for land preparation and weeding.
Refer to the text.
b) Include the value of captured grasscutter for lowland rice.

Table 8: Profit from Rice and Maize: Village II

		(1) Lowland Rice	(2) Upland Maize	(3) Upland Maize (Subtract Costs for intercrop)[a)]
	Number of Observations	17	16	16
I)	Production Value[b)] - Cost of Purchased Inputs (Other than Land Rent)	915,375 (546,966)	438,625 (389,220)	546,672 (425,337)
	per Hectare	2,149,566	1,809,265	2,156,103
II)	I) - Imputed Wages of Family Labor	-1,739,037 (1,655,433)	-180,552 (409,411)	88,661 (376,336)
	per Hectare	-3,797,585	-716,149	314,529
III)	II) - Land Rent	-1,857,469 (1,630,482)	-219,380 (372,412)	49,833 (343,037)
	per Hectare	-4,076,274	-903,696	126,982

Source: Survey data. In 2001, 7,000 Cedi = 1 USD.
Numbers in parentheses are standard errors.
a) Subtract the half of the cost for land preparation and weeding.
Refer to the text.
b) Include the value of captured grasscutter for lowland rice.

Table 9: Profit from Rice and Maize: Village III

		(1) Lowland Rice	(2) Upland Maize	(3) Upland Maize (Subtract Costs for intercrop)[a)]
	Number of Observations	18	17	17
I)	Production Value[b)] - Cost of Purchased Inputs (Other than Land Rent)	2,227,308 (1,913,612)	671,169 (529,854)	805,007 (540,373)
	per Hectare	2,118,775	2,481,925	2,936,392
II)	I) - Imputed Wages of Family Labor	269,669 (1,964,191)	-278,478 (603,913)	156,243 (481,513)
	per Hectare	-42,291	-1,415,449	382,515
III)	II) - Land Rent	94,613 (1,926,719)	-134,948 (611,941)	119,772 (496,015)
	per Hectare	-224,547	-1,575,995	221,970

Source: Survey data. In 2001, 7,000 Cedi = 1 USD.
Numbers in parentheses are standard errors.
a) Subtract the half of the cost for land preparation and weeding.
Refer to the text.
b) Include the value of captured grasscutter for lowland rice.

Table 10: Profit from Rice and Maize: Village IV

		(1) Lowland Rice	(2) Upland Maize	(3) Upland Maize (Subtract Costs for intercrop)[a)]
	Number of Observations	10	8	8
I)	Production Value[b)] - Cost of Purchased Inputs (Other than Land Rent)	1,199,628 (2,218,986)	590,469 (461,529)	658,188 (440,285)
	per Hectare	1,674,548	993,847	1,062,596
II)	I) - Imputed Wages of Family Labor	-1,396,272 (2,295,256)	-633,156 (788,059)	-177,625 (637,306)
	per Hectare	-2,573,065	-2,129,837	-918,452
III)	II) - Land Rent	-1,543,397 (2,372,997)	-687,156 (720,167)	-231,625 (569,548)
	per Hectare	-2,859,675	-2,211,843	-1,000,458

Source: Survey data. In 2001, 7,000 Cedi = 1 USD.
Numbers in parentheses are standard errors.
a) Subtract the half of the cost for land preparation and weeding.
Refer to the text.
b) Include the value of captured grasscutter for lowland rice.

undergrowth with a hired worker: 8,000 Cedi as a daily wage plus 1,000 Cedi for lunch. Respondent B spent two days, five hours in each day, for clearing undergrowth. From the case of Respondent B, we calculated the hourly wage for a male worker for clearing undergrowth as 1800 Cedi, and applied it to the six hours work of Respondent A and the extended family member of Respondent A, and Respondent B(1800 Cedi $\times$ 5 $\times$ 2 days). In the application, we have calculated and used the village-average hourly payment.

This seems to be a natural assumption, but has some problems. First, both in rice and maize cropping, there are works with no record of the use of daily-wage workers. In the case of rice farming, six out of fifteen works recorded no daily-wage payments to male workers. Complicating matters more in rice farming, there are only three works recording female daily-wage workers: planting, weeding, and harvesting. There are no records of daily wage payments to child workers.[10]

For female wage, in principle, we used 1000 Cedi less daily wage than the male workers (the lunch pay is assumed to be the same). This assumption is based on the observations in the work where we can observe both male and female hired workers. Second, Respondent A and B do not necessarily did their clearing work in the same period. Respondent A may do it in January, while Respondent B may do it very late, say, in April. In this case, Respondent A may have different opportunity cost than 1800 Cedi.

Table 11 shows a comparison between the profit calculation of the two methods discussed here. The imputed labor costs are significantly larger when we use the second method.

[10]This does not mean respondents hided the use of child labor. There are cases of hired child workers, but in piece rate.

Table 11: Profit Comparison under Two Assumptions

		(1) Lowland Rice		(2) Upland Maize	
			Imputed by hourly wage rate		Imputed by hourly wage rate
	Number of Observations	58	58	53	53
II)	Crop Income (I) - Imputed Wages of Family Labor	-946,717 (1,932,032)	-3,372,438 (3,215,515)	-254,379 (645,016)	-609,597 (920,323)
III)	II) - Land Rent	-1,082,911 (1,923,079)	-3,508,632 (3,213,796)	-288,465 (636,992)	-643,683 (921,036)

References

Andriesse, Wim and Louise O. Fresco. 1991. "A Characterization of Rice-growing Environments in West Africa." *Agriculture, Ecosystems and Environment* 33 (4):377–395.

Berry, Sara S. 2001. *Chiefs Know Their Boundaries: Essays on Property, Power, and the Past in Asante, 1896-1996*. Portsmouth, New Hampshire: Heinemann.

Bloom, David E. and Jeffrey D. Sachs. 1998. "Geography, Demography, and Economic Growth in Africa." *Brookings Papers on Economic Activity* 2:207–295.

Conley, Timothy G. and Christopher R. Udry. 2010. "Learning about a New Technology: Pineapple in Ghana." *American Economic Review* 100 (1):35–69.

Dankyi, A.A., V.M. Anchirinah, and A.O. Apau. 1996. "Adoption of Rice Technologies in the Wetlands of the Ashanti Region of Ghana." In 4th Plenary Session of the Rice Economics Task Force of West Africa, Bouake, Cote d'Ivoir.

de Mel, Suresh, David J. McKenzie, and Christopher Woodruff. 2009. "Measuring Microenterprise Profits: Must We Ask How the Sausage is Made?" *Journal of Development Economics* 88 (1):19–31.

Dekuku, R. C., Y.O. Amanwatia, K. O. Asubonteng, and L. Nartey. 1993. "Inland Valley Research and Development in Ghana." In *Proceedings of the 1st Annual Workshop of the*

Inland Valley Consortium, edited by J. Y. Jamin, W. Andriesses, L. Thiombiano, and P. N. Windmeijer. Bouake, Cote d'Ivoir, ??–??

Dvořàk, Karen Ann. 1992. "Resource Management by West African Farmers and the Economics of Shifting Cultivation." *American Journal of Agricultural Economics* 74 (3):809–815.

Food and Agriculture Organization (FAO). 2011. "FAOSTAT, http://www.fao.org/corp/statistics/en/ (accessed on January 20, 2011)." Rome.

Ghana Statistical Service. 2000. "2000 Population and Housing Census: Provisional Results." Ghana Statistical Service, Accra: Ghana.

Hirose, Shohei and Toshiyuki Wakatsuki, editors. 2002. *Restoration of Inland Valley Ecosystems in West Africa*. Tokyo: Association of Agriculture and Forestry Statistics.

Hirschman, Albert O. 1958. *The Strategy of Economic Development*. New Haven: Yale University Press.

International Monetary Fund (IMF). 2010. *International Financial Statistics July 2010*. Washington, D.C.: IMF.

Kennedy, Eileen and Thomas Reardon. 1994. "Shift to Non-traditional Grains in the Diets of East and West Africa: Role of Women's Opportunity Cost of Time." *Food Policy* 19 (1):45–56.

McCann, James. 2005. *Maize and Grace*. Cambridge, Massachusetts: Harvard University Press.

Policy, Planning, Monitoring and Evaluation Department (PPMED). 2000. "Regional and District Cropped Area, Yield and Production Estimates." mimeo, Agricultural Statistics and Census Division, Ministry of Food and Agriculture, Accra, Ghana.

Takane, Tsutomu. 2002. *The Cocoa Farmers of Southern Ghana*. Chiba: Institute of Developing Economies.

Tomlins, Keith, J.T. Manful, P. Larwer, and L. Hammond. 2005. "Urban Consumer Preferences and Sensory Evaluation of Locally Produced and Imported Rice in West Africa." *Food Quality and Preference* 16 (1):79–89.

Turner II, B. L., Goran Hyden, and Robert Kates. 1993. *Population Growth and Agricultural Change in Africa*. Gainesville: University Press of Florida.