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Intensification of Lowland Cropping Systems and Informal Land Ownership in West Africa: Comparison of Two Large Inland Markets in Côte d'Ivoire and Ghana

Takeshi Sakurai

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Institute of Economic Research
Hitotsubashi University
Kunitachi, Tokyo, 186-8603 Japan

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Takeshi Sakurai*

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* Professor, Institute of Economic Research, Hitotsubashi University

Email: sakurai@ier.hit-u.ac.jp

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Abstract

The enhancement of agricultural productivity is the key to economic development of Sub-Saharan Africa. Particularly, the intensification of lowland agriculture is critically important in West Africa since demand for rice and vegetables is increasing rapidly due to urbanization. As has been debated much, informal land tenure system in Sub-Saharan Africa can be a constraint to the intensification. This paper, applying an endogenous switching probit model where lowland ownership is endogenously selected, analyzes data collected in the area around two large inland cities, Bouaké in Côte d'Ivoire and Kumasi in Ghana. Regression results reveal that village ownership has a positive impact on the intensification of lowland cropping in the Bouaké area, while it discourages the intensification of lowland cropping as well as investment in tree plantation in lowlands in the Kumasi area. The findings support the hypotheses since land is relatively scarcer in the Kumasi area than in the Bouaké area.

Key words: informal land ownership, lowland agriculture, intensification, land use, crop choice, Côte d'Ivoire, Ghana

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1. Introduction

Most countries in Sub-Saharan Africa depend on agriculture for their economic growth as well as poverty reduction, and therefore the enhancement of agricultural productivity is key to their development (World Bank [25]). Lowland ecology is one of the highly potential agro-ecologies of productivity growth since most of the lowlands are currently unexploited or extensively used in Sub-Saharan Africa, particularly in West Africa (Andriesse et al. [1]). Rice and vegetables among others are promising crops in lowland ecology not only because both require more water than other crops but also because their demand has been increasing due to urbanization and recent economic boom in Sub-Saharan Africa.

In West Africa, while rice is one of the important staples and its demand has been growing since the 1970s, regional rice production cannot meet the increasing demand. The growth of rice import has been accelerated since the mid 1990s and the rice self-sufficiency rate has declined sharply since the year of 2000 (Sakurai [23]). It means that there exist emerging market opportunities for domestic rice producers and that improvement of rice productivity is crucial for them to compete with the imports and to benefit from the opportunities. Moreover, since the enhancement of domestic rice production will mitigate the

burden of augmenting payment for the imported rice, it will also contribute regional economic growth.

On the other hand, demand for vegetables is also increasing as urban population is growing and their diet has been diversified. Unlike the case of rice, vegetables are not competing with imports, but rather are being exported to European countries although the quantity exported is still relatively small compared with the vegetables produced and marketed for local consumption (Erenstein et al. [8]). From producers' point of view, vegetable production is another potential income-generating activity that utilizes lowlands.

Rice and vegetables have different biological characteristics as plants and different physical characteristics as commodities such as transportability and storability. In addition, their market opportunities also differ significantly. Hence, it is of interest to examine what determines crop choice in lowlands and what induces the intensification of lowland cropping system. Such information is indispensable for formulating policies to develop lowland agriculture in Sub-Saharan Africa that shares similar urbanization process.

With respect to agricultural intensification in general, factors such as population pressure (Boserup [3]), policy and market opportunity (Lele and Stone [15]), and relative factor prices (Hayami and Ruttan [12]) are known to be driving forces in the literature. But little empirical evidence has been provided in the case of Sub-Saharan Africa's lowlands, except for the recent works done by Sakurai [22], Erenstein [6], and Erenstein, Oswald, and Mahaman

[7]). Those studies commonly indicate that the proximity to urban centers is one of the significant determinants of rice production and its intensification in West African countries, but their analyses ignore other important variables such as land tenure system and factor prices. The effect of land tenure security has been debated for a long time in the context of agriculture development in Sub-Saharan Africa (for example Atwood [2], Besley [4], Brassell, Gaspart, and Platteau [5], Gavian and Fafchamps [10], Hayes, Roth, and Zepeda [13], Otsuka et al. [17], Place and Hazell [18], and Staastad and Bromley [21]). But the determinants of informal lowland ownership and its consequence on lowland agriculture had not been investigated until Sakurai [22] who studied the case of rice production in the peri-urban area of the city of Bouaké, Côte d'Ivoire, showing that lowland ownership has little influence on the adoption of water control technologies. However, it does not necessarily mean that land ownership has no impact on lowland cropping because it may affect the use of lowland for agriculture and the choice of crops cultivated in lowlands.

Hence, the present paper investigates the determinants of lowland use and crop choice particularly focusing on lowland ownership, using the data collected in the lowlands around the city of Bouaké, Côte d'Ivoire and around the city of Kumasi, Ghana. The Bouaké data is the same as Sakurai [22] used, while the Kumasi data is the same as Tachibana, Shinagawa, and Sakurai [24] used. Although both Bouaké and Kumasi are large inland cities sharing the same ethnic culture including customary land tenure arrangements, observed lowland utilization is

quite different. Therefore, the comparison of the two cases in West Africa will bring us better understanding of the effects of land ownership on the intensification of lowland agriculture.

2. Methods

1) Study Sites in Côte d'Ivoire and Ghana

Two large inland cities in West Africa are selected: Bouaké in the Bandama Valley region of Côte d'Ivoire and Kumasi in the Ashanti region of Ghana. They are the second largest cities in each country with a population of 461,000 in 1998 and 1,117,000 in 2000 respectively (Institut National de la Statistique in Bouaké [14] and Ghana Statistical Service [11]). Both cities serve as the central market in each inland region where locally produced agricultural products as well as those produced in other regions and imported are being traded. Although both cities are not prohibitively far from coastal port cities, local rice should have advantage in terms of transportation costs over imported rice. In 2001 local rice sold at 250 to 300 FCFA/kg and imported rice sold at 250 to 600 FCFA/kg in Bouaké's retail market. Corresponding figures were 2,600 to 3,200 cedis/kg and 2,600 to 6,000 cedis/kg in Kumasi's retail market (according to our own survey). Because the exchange rate between FCFA and cedi was about 1 FCFA = 10 cedis in the same period, nominal rice prices were almost equivalent in the two inland markets.

With respect to agro-ecology, Bouaké is situated in the transitional zone between the

humid forest and the savanna zones and its annual rainfall is about 1,000mm on average. Kumasi, on the other hand, is in the humid forest zone with an average of 1,400mm annual rainfall. Annual rainfall pattern is bimodal in both areas, but the period of the rainy season is longer in the Kumasi area. In both areas rice is mainly produced in lowlands during the rainy season without modern irrigation technologies, that is, in rainfed lowland ecology. Upland rice is rarely cultivated. Instead, uplands are used for yam, maize, and cassava, which are traditional staple foods. Rice cultivation in lowlands was introduced in these areas relatively recently.

2) Sampling in Côte d'Ivoire

In Côte d'Ivoire 11 contiguous sub-prefectures around the city of Bouaké were selected. Based on the village list of each sub-prefecture obtained from the National Institute of Statistics in Bouaké, 179 villages were randomly selected from 857 villages in the list. The number of villages sampled in each sub-prefecture was determined so that it would be proportional to the total number of villages in each sub-prefecture (sampling rate was about 21 percent). From December 1999 to May 2001, all the 179 sample villages were visited several times to collect village level information on lowland use as well as village characteristics by means of group interview of village leaders. Out of the 179 sample villages, 157 villages have at least one lowland and hence those 157 villages are used for the analyses in this paper.

3) Sampling in Ghana

In Ghana there are 1,586 villages within the 60km radius from the center of the city of Kumasi identified on topographic sheets issued by the Survey Department of Ghana. Then, 40 villages were randomly drawn from the villages along the highways, and another 40 villages from the villages off the highways. After the initial visit to all the selected villages, 40 villages out of the 80 villages were deleted because there were no lowlands in the village area. The remaining 40 villages were stratified into three groups based on the distance from the center of Kumasi: 10-20km, 20-40km, and 40-60km. Then, another 20 villages were re-sampled so that there were 12 samples from 10-20km stratum, and 24 samples from 20-40km stratum and 40-60km stratum respectively while keeping the numbers of villages on the highways and off the highways equal. This brought the total number of sample villages to 60 (i.e. 30 located along the highways and 30 located off the highways).[1] Group interviews with the village leaders to obtain information on the village and its lowland areas were conducted from September to December 2000.

3. Descriptions of Lowland Characteristics

1) Use of Lowlands

Of the 179 sample villages, 157 villages have lowlands within the village territory in the Bouaké area, while 40 villages of the 80 villages investigated have lowlands within the village territory in the Kumasi area. The share of villages with lowlands in all sample villages

is much higher in the Bouaké area than in the Kumasi area. The total number of lowlands available for the 157 villages is 317 in the Bouaké area and it is 188 in the sampled 60 villages in the Kumasi area, suggesting that the average number of lowlands per village with lowlands is greater in the latter than the former. However, if villages without accessible lowlands are included, the average number of lowlands per village becomes 1.8 in the Bouaké area and 1.6 in the Kumasi area.[2] This means that the average number of lowlands per village does not differ much between the two study sites, but the distribution of lowlands is more skewed in the Kumasi area.

Table 1 shows the use of lowlands in the Bouaké and the Kumasi areas. In the Bouaké area about 60 percent of the all sample lowlands are not currently (i.e. during the year when the survey was conducted) utilized even in the rainy season. In the Kumasi area, on the other hand, almost all the lowlands are currently utilized and tree plantation is prevalent. If lowland utilization is compared between the two study sites, the utilization rate is much higher in the Kumasi area than in the Bouaké area: that is, unused lowlands are relatively scarce in the Kumasi area. The difference could be explained in several ways, but the prevalence of tree plantations and the existence of the second rainy season will be significant factors characterizing lowland use in the Kumasi area.

2) Crop Choice in Lowlands

As for crop choice, rice mono-cropping (only rice is cultivated) is the single dominant

land use in the Bouaké area (Table 1). Vegetable production, either mono-cropping (only vegetables are cultivated) or multiple-cropping (both rice and vegetables, but no other crops are cultivated), comes second, but other crops such as maize are seldom grown in the Bouaké area (Table 1).

Based on the observed cropping pattern, lowland use in the Bouaké area is classified into 5 in this paper as shown in Figure 1: (a) tree or no-use, (b) rice mono-cropping, (c) vegetable mono-cropping, (d) rice-vegetable multiple cropping, and (e) other food crop production. Land use of "tree or no-use" could include fallow land, tree plantations, and virgin land although the latter two are few. In terms of intensification, "tree or no-use" is the least intensified, while rice-vegetable multiple cropping is considered to be the most intensified. Rice mono-cropping and vegetable mono-cropping will fall between "tree or no use" and multiple cropping, but it is not possible to determine *a priori* which mono-cropping is more intensified. The fifth category, other food crops, does not have many cases as shown in Figure 1, and hence it will not be analyzed separately.

On the other hand, in the Kumasi area, palm trees were planted in almost all the cases of tree plantation, and teak and cocoa trees were observed only in a few cases. In the majority of the lowlands with tree plantation, annual food crops such as rice, vegetables, and maize are also grown (Table 1). Those crops are often intercropped with trees while they are still small, but sometimes they are planted separately. In either case annual food crops are not major crops

in tree-planted lowlands. There are also a significant number of lowlands without tree plantations in the Kumasi area, where rice, vegetables, maize and other crops are grown. Other crops include cassava, yam, taro, etc., and sometimes vegetables or maize are mix-cropped, but there is no case where they are mixed with rice.

This paper classifies lowland use in the Kumasi area also into five patterns as shown in Figure 2: (p) tree or no-use (tree plantation, fallow land, or virgin land), (q) rice mono cropping, (r) vegetable mono cropping, (s) rice-vegetable multiple cropping, and (t) other crops (yam, taro, cassava, etc. sometimes mixed with maize or vegetables). Note that maize is not considered in the classification since it is planted in many lowlands, and therefore all the five cropping patterns may include maize. As shown in Table 1, most of the cases of "tree or no-use" are tree plantations in the Kumasi area, and this category is considered to be the least intensified land use as tree plantation requires less labor and non-labor inputs. On the other hand, multiple cropping is considered to be more intensified than mono cropping, but among mono cropping patterns, it is not possible to determine *a priori* which mono cropping is more intensified than others.

3) Lowland Ownership

In both study sites all land is under customary land ownership, and there are two distinct types of customary land ownership: village (i.e., public) and private (Sakurai [22] for the Bouaké area, and Tachibana, Shinagawa and Sakurai [24] for the Kumasi area).[3] It is said

that uncultivated forestland is owned by village in the custody of village chief, and hence is considered to be village land and kept open access for the community members. Once the land is cultivated, it belongs to the cultivator's family and hence it is privatized as family land. Note that private family land is often regarded as communal land for the members of extended family. In the two study sites, the majority ethnic groups do not have the tradition of lowland cultivation, and consequently lowlands have long remained public, and even after cultivation a significant number of lowlands have remained as village land (Sakurai [22]).

In the Bouaké area 108 out of 317 sample lowlands, or 34.1 percent of the sample lowlands are found to be village land, and about one third of the village lowlands are currently cultivated (Table 2). In the Kumasi area, on the other hand, among 188 sample lowlands 29 (or 15.4 percent) are village property, and all of the village lowlands except one are currently utilized for agriculture (Table 3). Considering the historical process how village-owned land (or open access land) has been converted to private property, the lower frequency of village ownership in the Kumasi area is consistent with the observation that the current lowland utilization rate is higher in the Kumasi area as shown in Table 1. Nevertheless, as shown in Tables 2 and 3, there are a significant number of village-owned lowlands that are currently cultivated in both sites, whereas a large number of family-owned lowlands are currently under fallow or have never been cultivated. Therefore, this paper is to investigate if the lowland ownership has any influence on farming practice in lowlands. It is critical to examine if the

village ownership is a constraint to the development of intensified lowland agriculture, particularly from the policymakers' point of view.

4) Hypotheses

While a standard view on land tenure is that private property rights enhance investment incentive in comparison with open access or public property rights, empirical evidence in Sub-Saharan Africa does not necessarily support this view (Brasselle, Gaspart, and Platteau [5]). The mixed evidence is now known to be caused by the endogeneity of customary property rights in Sub-Saharan Africa, that is, investment in land is sometimes encouraged to strengthen the property rights when land tenure is insecure (Besly [4], Brasselle, Gaspart, and Platteau [5], and Otsuka et al. [17]). Thus, following the literature, it is generally hypothesized that farmers will have an incentive to invest in land with insecure property rights if such investment enhances the property rights.

In the case of village land ownership, as is described by Quisumbing et al. [19], village forestland has been appropriated by clearing and continuous cultivation in Ghana, because cultivators will be able to obtain the property rights or to strengthen the property rights by investing in the land as far as land is abundant. If the conversion of public village land into private property continues, village land would disappear in the end. Hence, it is true that public village land generally exists in land-abundant area. However, we can observe public village land even in the area where land has become scarce. Particularly, lowland area tends to be

intentionally kept public because of the availability of water as reported by Sakurai [22]. In this case, although cultivators are allowed to cultivate in the village land, investment in the land does not change the property rights from village to family and hence investment will be discouraged compared with family land. In fact, Sakurai [23] found that relatively less investment in publicly-owned lowlands observed in the urban area of Bouaké city where lowlands are scarce resources.

As discussed in the previous sections, lowlands are more frequently utilized in the Kumasi area, and consequently are considered to be scarcer than in the Bouaké area. Thus, it is hypothesized that investment in village lowlands is discouraged more in the Kumasi area than in the Bouaké area. Rather, in the Bouaké area, investment in village lowlands will be encouraged due to the incentive of appropriation. Since agricultural intensification that requires a large amount of labor and non-labor inputs should have a medium-term impact on agricultural productivity, village ownership of lowland will have either negative or positive influence on it depending on the scarcity of land as hypothesized above. Moreover, although tree plantation is regarded as less intensified land use, it will also be negatively affected by village ownership because it requires a long-term investment. In the case of annual crop production especially extensive cropping, village ownership will have little impact on it or even an impact opposite from that in the intensive case. The hypotheses are summarized in Table 4.

4. Empirical Analyses

1) Empirical Model

In order to econometrically test the hypotheses given above, this paper estimates an empirical regression model consisting of a system of equations as below.

$$I_i^* = X_i'\alpha + \beta R_i + \varepsilon_i \quad (1)$$

$$I_i = 1 \quad \text{if } I_i^* > 0; \quad 0 \text{ otherwise,} \quad (2)$$

where I_i is a binary dummy variable for land use in i^{th} lowland: for example, in the case of rice mono-cropping, the value of I_i is 1 if rice mono-cropping is practiced in the i^{th} lowland, and the value is 0 otherwise. The binary choice of I_i is assumed to be dependent on a vector of exogenous variables X_i (including the constant term) and a dummy variable R_i representing lowland ownership, through a latent continuous variable I_i^* as shown in the system of equations (1) and (2) where α represents a vector of parameters to be estimated, β is the coefficient of the dummy variable for land ownership, and ε_i is a residual term. The latent variable I_i^* is measuring unobservable benefits from the particular land use in i^{th} lowland.

As discussed in the previous section, lowland ownership would be endogenous in the system of equations (1) and (2). Hence, R_i is assumed to be determined in another system of equations given below.

$$R_i^* = Z_i'\delta + v_i \quad (3)$$

$$R_i = 1 \quad \text{if} \quad R_i^* > 0; \quad 0 \quad \text{otherwise}, \tag{4}$$

where R_i is a dummy variable of lowland ownership with value 1 when i^{th} lowland is owned by village and value 0 when i^{th} lowland is owned by family. R_i^* is a latent continuous variable and is defined as a function of Z_i, a vector of exogenous variables including the constant term, whereas δ is a vector of parameters to be estimated and v_i is a residual term. The latent variable R_i^* measures unobservable benefits from public ownership of i^{th} lowland.

Since I_i and R_i are binary dummy variables, the standard two-stage least squares (2SLS) method does not provide unbiased estimation (Rivers and Vuong [20]). Brasselle, Gaspart, and Platteau [5] consider a similar model and apply two-stage conditional maximum likelihood (2SCML) estimation, where the first stage is estimated as a linear probability model and the second stage is estimated by a probit model incorporating the residuals obtained from the first-stage regression. Sakurai [22] also adapts this method to investigate the effect of public ownership of lowland on the adoption of water control technologies in Côte d'Ivoire using the same data as this paper uses. However, the linear approximation of the first-stage of 2SCML is still a potential source of bias, and therefore this paper estimates all the equations simultaneously by maximum likelihood, or endogenous switching probit regression following Miranda and Rabe-Hesketh [16].

2) Determinants of Village Ownership of Lowlands

Although the system of equations is simultaneously estimated to test the hypotheses,

the first-stage probit is separately estimated to investigate the determinants of lowland ownership in this section. The dependent variable is a binary dummy variable for village ownership of lowlands, and it is explained by the variables listed in Table 5 for Bouaké and for Kumasi respectively. There are two levels of explanatory variables: village level and lowland level. In the case of lowland level variables, all of them are lowland physical characteristics and hence are considered time-invariant. On the other hand, some of the village level variables may be changing over time such as village population and wage rate. For this analysis, the most recent values (or values at the time of survey) are used because they are to explain existing village ownership which not only has been kept but also is currently being kept from conversion to family ownership.

Table 6 shows the regression results. In both sites, distance to regional capital (Bouaké and Kumasi respectively) has a significant influence on the village ownership: lowlands located away from the center tend to remain public although such tendency becomes weaker as the location becomes further. This is interpreted that a better market access increases the value of lowlands, which then enhances the incentive to convert the land into family property, that is, the benefit exceeds the transaction cost of the conversion of ownership. In addition to the distance, disintegration with ethnic minorities significantly reduces the probability of village ownership in both areas. Considering that there is a kind of norm to keep lowland public in some villages, ethnic disintegration would increase the cost of enforcing such

a norm and hence lowlands are more likely to be privatized.

In addition, in the Kumasi area, lowlands tend to be public in villages relatively well developed, i.e. villages that have older primary schools. Such ancient and developed villages seem to keep public ownership intentionally, although the reason itself is not known from the analysis. But according to the casual conversations with villagers, tax collection for the village revenue would be one of the reasons why they maintain village-owned lowlands.

3) Expansion of Rice Cultivation

Among the sample lowlands, the share of lowlands that have ever been used for rice cultivation is 82.6 percent in the Bouaké area and 85.6 percent in the Kumasi area respectively although rice is not currently grown in some of such lowlands. Particularly in the Bouaké area rice cultivation has been abandoned in a large number of lowlands. With respect to the expansion of rice cultivation, its determinants will be identified by comparing lowlands ever utilized for rice cultivation with those never utilized for rice cultivation, and the results will tell if lowland ownership has any influence on the expansion. Based on the empirical model given in the previous section, a binary dummy variable for "lowland with rice experience" is used as the dependent variable (I_i): lowlands ever utilized for rice cultivation take the value of 1, while lowlands never utilized for rice cultivation take the value of 0. Explanatory variables are given in Table 5.

Table 7 presents the regression results. In the Bouaké area village ownership of

lowlands has significantly positive effect on the experience of rice cultivation, while in the Kumasi area it has no effect. Although any attempts of rice cultivation in lowlands are not necessarily involved in intensification or long-term investment in lowlands, the incentive of appropriation seems to encourage lowland use for rice cultivation in land-abundant Bouaké area.

Village population density has a positive, significant effect on the rice experience whereas male/female population ratio has a negative, significant effect on it in the Bouaké area. Thus, population pressure induces rice cultivation in lowland in the Bouaké area, but the negative effect of immigrant indicator suggests that the population pressure is not associated with immigrants settled in the village.[4] Rather, the negative effect implies that villages whose male members tend to out-migrate for working are more likely to cultivate rice in lowlands. Moreover, distance from Bouaké has a negative effect, which suggests that market access may have promoted the expansion of rice cultivation and/or lowland rice cultivation has been disseminated from the capital, either informally or formally through extension agency.

On the other hand, in the Kumasi area the regression analysis fails to identify any determinant of the experience of lowland rice cultivation, except for village population density. Unlike the case of Bouaké area, population density has a negative effect of rice cultivation in the Kumasi area. This result is due to the fact that rice is very often grown under tree plantation in the Kumasi area as discussed above and such tree plantations tend to be located in less

populated area. Other than population density, no significant factors are identified because quite different lowland rice production systems (i.e., mono cropping and intercropping with trees) coexist in the Kumasi area.

4) Intensification of Lowland Use in Bouaké

In the Bouaké area, lowland use is classified into 5 major patterns based on the crop choice with different degree of intensification in the previous section. Now in order to see the impact of lowland ownership on those cropping patterns the following dependent variables are created for regression analyses. (i) A dummy variable for food production, which includes lowlands with rice, vegetables, and other food crops but excludes those uncultivated or with tree plantations. The number of such lowlands is 115 (i.e., (b) + (c) + (d) + (e) in Figure 2). (ii) A dummy variable for mono-cropping of either rice or vegetable. The number of lowlands falling in this category is 86 ((b) + (c) in Figure 2). (iii) A dummy variable for lowlands with rice-vegetable multiple cropping. The number of such lowlands is 26 ((d) in Figure 2). For all the three dependent variables, "non-use or tree plantation" is used as the default reference since it is the least intensified land use, whose number is 184 ((a) in Figure 2). Note that the first dependent variable includes perfectly both the second and third dependent variables, while the second and third dependent variables are mutually exclusive, as presented in Figure 2.

The system of equations (1) – (4) is estimated for each dependent variable separately using explanatory variables provided in Table 5, and the regression results are given in Table 8.

Concerning the effect of lowland ownership, it is found that village ownership has no effect on food production, a negative significant effect on mono-cropping, and a positive significant effect on rice-vegetable multiple cropping. The results imply that cultivation generally takes place regardless of land ownership in lowlands, but that mono-cropping prefers family-owned lowlands, while rice-vegetable multiple cropping tends to select village-owned lowlands. Considering that land is abundant in the Bouaké area, investment in village land, i.e. intensive land use, may allow the cultivator to privatize the land and therefore the most intensified cropping is likely to be practiced in village lowlands. On the other hand, mono-cropping, a standard crop choice in lowlands in the Bouaké area, is not associated with such privatization of village land, but is practiced in family-owned lowland.

Lowland use for food production is found to be induced by population pressure since village population density has a positive significant effect on "Food Crops" and "Mono Cropping." But as for intensification, judging from the result of "Rice-Vegetable Multiple Cropping," it is not the population pressure that promotes it.

Except for the land ownership and village population density, only a few significant determinants of cropping pattern are found from the regression analyses. But the regression results commonly indicates that lowlands with better water sources, i.e. permanent stream or seasonal stream, are likely to be used for food production relative to unutilized lowlands.

5) Intensification of Lowland Use in Kumasi

In the Kumasi area, based on the 5 distinct cropping patterns presented in the previous section, 3 dummy variables are created. (i) A dummy for food crop cultivation, which includes lowlands producing any food crops excluding those uncultivated or with tree plantations. There are 71 lowlands in this category ((q) + (r) + (s) + (t) in Figure 3). (ii) A dummy variable for lowlands with rice or vegetable mono cropping. The number of lowlands falling in this category is 31 ((q) + (r) in Figure 3). (iii) A dummy variable for lowlands where rice/vegetable multiple cropping. The number of such lowlands is 26 ((s) in Figure 3) As is the case of Bouaké, for all the three dependent variables, "non-use or tree plantation" is used as the default reference since it is the least intensified land use, whose number is 117 ((p) in Figure 3). Note that the first dependent variable includes perfectly both the second and third dependent variables, while the second and third dependent variables are mutually exclusive, as presented in Figure 3.

Using one of the three dummy variables as the dependent variable and explanatory variables in Table5 the system of equations (1) – (4) are estimated to investigate the effect of lowland ownership is examined for the Kumasi area. The regression results are shown in Table 9. "Food Crop" regression indicates that village lowland ownership significantly increases the probability of food crop production in lowlands. Since most of the lowlands without food crop production are used for tree plantation, the result implies that trees tend to be planted in family-owned lowlands (or because of tree planting in the past, the land was converted to

family land). Then, the results of "Mono Cropping" and "Rice-Vegetable Multiple Cropping" regressions show that those cropping systems are negatively affected by village ownership of lowlands, and the effect is statistically significant in the case of mono cropping. Considering that lowland is already scarce in the Kumasi area, village land does not provide incentive to privatize the land by farming and therefore intensified cropping such as mono cropping and multiple cropping is likely to be practiced in family-owned lowlands. Hence, the three regression results suggest that village ownership of lowlands is a constraint to the intensification of lowland agriculture in the Kumasi area.

Table 9 also shows that all the three cropping patterns are negatively affected by male wage rate. It means that any food crop production requires more labor input than tree plantations. Distance from the central market has also a negative effect on the food cropping and mono-cropping, while villages on the highways are more likely to practice rice-vegetable multiple cropping. These results indicate the importance of market access to promote food crop production compared with tree plantation.

6) Comparison of the cases of Bouaké and Kumasi

By comparing the cases of Bouaké and Kumasi, it is found that village ownership has a positive effect on the intensification of lowland cropping in the Bouaké area, whereas it has a negative effect on the intensification of lowland cropping in the Kumasi area. As discussed, lowland is relatively more abundant in the former area than in the latter area. Therefore, it can

be concluded that the overall hypothesis concerning the effect of lowland ownership is empirically supported.

5. Conclusions

This paper investigates the effect of land ownership on agricultural intensification in West Africa's lowland, particularly focusing on village land ownership. The village-owned public land used to be open-access, uncultivated forestland in West Africa, and has been converted to family-owned private land after cultivation. But a significant number of lowlands are still owned by village even after cultivation. Because of the urgent necessity of the intensification of lowland agriculture, the question is if such public ownership be a constraint to the intensification.

Using data collected in the area around two large inland markets in Côte d'Ivoire (Bouaké) and Ghana (Kumasi), the analyses reveal that village ownership has a positive effect on the intensification of lowland cropping in the Bouaké area, while it has a negative effect on the intensification of lowland cropping as well as investment in tree plantation in lowlands in the Kumasi area. Considering that land is relatively scarcer in the Kumasi area than in the Bouaké area, the results support the overall hypothesis. It means that village ownership is not a constraint to agricultural intensification, or even it can encourage the intensification, but it becomes a constraint to the intensification once land scarcity takes place.

The results of this paper do not necessarily imply that village ownership of lowland should be maintained or promoted to induce the intensification of lowland agriculture. Rather, the implication is that the privatization of public land is necessary to induce intensification as agricultural land is getting scarcer in many parts of Sub-Saharan Africa due to population growth. And if informal privatization does not take place automatically even though land becomes scarce, policy intervention would be necessary to support the conversion. On the other hand, if land is still abundant, privatization policy will have no impact, or will be even harmful to agricultural development.

Footnote

[1] The sampling rate for each stratum in the Kumasi area is summarized in the table below. The number of villages along the highways is much lower than that of villages off the highways. But since one of the objectives of the data collection was the investigation of the impact of infrastructure and market accessibility on agricultural intensification, the two types of villages were equally sampled so that the number of each type of villages would be sufficient for quantitative analyses. Please note that all the descriptions of the Kumasi data (Figure 2 and Tables 1, 3, and 5) are adjusted by the sampling weight given in the table below. In addition, all the regression analyses using the Kumasi data (Tables 6, 7, and 9) use the sampling weight to correct standard errors.

	Along the highways		Off the highways	
Stratum	Number of villages in the Stratum	Number of sample villages (sampling rate)	Number of villages in the Stratum	Number of sample villages (sampling rate)
10 - 20km	35	6 (17.4%)	138	6 (4.3%)
20 - 40km	114	12 (10.5%)	534	12 (2.2%)
40 - 60km	106	12 (11.3%)	564	12 (2.1%)
Total	255	30 (11.8%)	1236	30 (2.4%)

[2] As noted in the text, half of the 80 villages initially sampled have no accessible lowland. Therefore, assuming that half of the 60 sample villages have access to lowlands, the average number of lowlands is estimated as 188/(60+60).

[3] In both sites the private ownership can be further classified as either familial or individual, but the present paper treats them together as opposed to the public ownership because the focus is the effects of the public ownership. The two types of informal private ownership could be distinguished by the way of inheritance in matrilineal societies like the Akan language group, to which Baoulé, the dominant indigenous ethnic in the Bouaké area and Ashanti, the dominant indigenous ethnic in the Kumasi area belong. Land inherited from the father to his son(s) is regarded more individualized than that inherited from the uncle on the mother side to his nephew. The individualized land ownership is a response to the scarcity of land resource in matrilineal system and the impact of the individualization of land ownership on technology adoption (Sakurai [23]) and tree planting (Otsuka et al. [17]) have been studied in the context of West Africa's agriculture.

[4] The male/female population ratio at village level is used as a proxy for immigrant population:

a village that receives a lot of temporarily immigrants should have a high male/female ratio, whereas a village that loses population because of temporarily emigration should have a lower male/female ratio because males moves for work more frequently than females.

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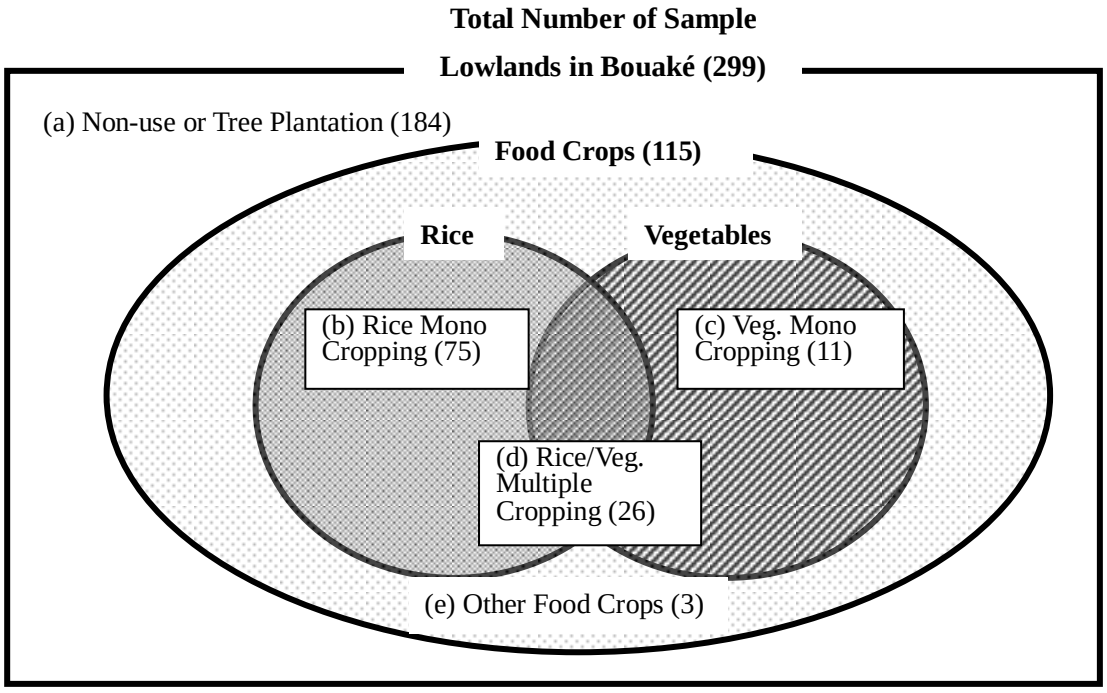

Figure 1. Lowland Use in the Bouaké area

Note: Total number of sample lowlands is 317 in the Bouaké area, but 13 lowlands with modern irrigation facilities and 5 lowlands with imperfect data are excluded from the analyses.

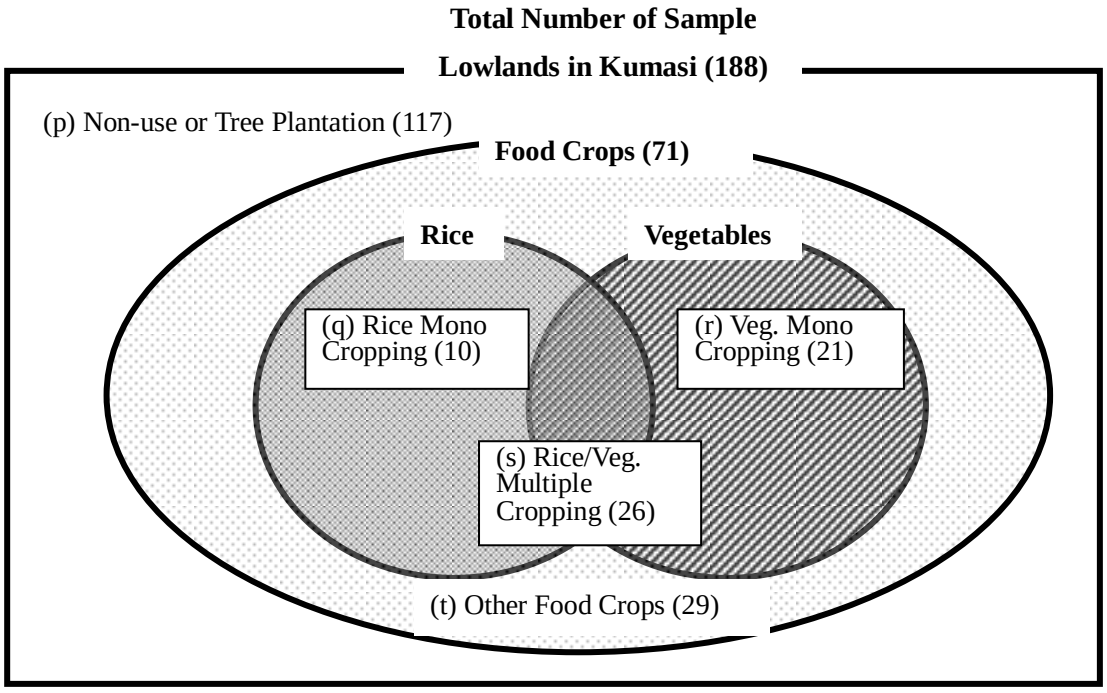

Figure 3. Lowland Use in the Rainy and Dry Seasons in the Kumasi Area

Table 1. Current Lowland Use in Bouaké and Kumasi[1)]

	Bouaké area	Kumasi area
Food Crop	115 (38.5)	71 (37.8)
Rice/vegetable mono crop[2)]		
Rice only	75	10
Vegetable only	11	21
Rice/vegetable multi crop[2)]	26	26
Other food crops[3)]	3	14
Tree Crop	6 (2.0)	111 (59.0)
Tree only	5	15
Mixed with food crops[4)]	1	106
No Use	178 (59.5)	6 (3.2)
Total Number	299 (100)[5)]	188 (100)

[1)] The figures are the number of lowlands of each land use. Percentage shares are in the parentheses.

[2)] Since maize is planted many parts of lowland in the Kumasi area, maize is ignored in the classification of cropping pattern into mono crop and multi crop in the Kumasi area.

[3)] Other crops may include the cases of mixed cropping with rice or vegetables.

[4)] Out of 106 lowlands where food crops are cultivated in tree plantation in the Kumasi area, rice is planted in 78 lowlands and vegetables are planted in 77 lowlands.

[5)] Total number of sample lowlands is 317 in the Bouaké area, but 13 lowlands with modern irrigation facilities and 5 lowlands with imperfect data are excluded from the analyses.

Table 2. Public Ownership and Lowland Use in Bouaké[1)]

	Lowlands Currently Unused[2)]	Lowlands Currently Used[3)]	Total Number
Lowlands Publicly-Owned	76 (24.0)	32 (10.1)	108 (34.1)
Lowlands Privately-Owned	107 (33.8)	102 (32.2)	209 (65.9)
Total Number	183 (57.7)	134 (42.7)	317 (100)

[1)] The figures are the number of lowlands in each category and percentages of total number are in parentheses.

[2)] Lowlands that were not used both in the rainy season and in the dry season during the survey year.

[3)] Lowlands that were used at least either in the rainy season or in the dry season during the survey year.

Table 3. Public Ownership and Lowland Use in Kumasi[1)]

	Lowlands Currently Unused[2)]	Lowlands Currently Used[3)]	Total Number
Lowlands Publicly-Owned	4 (2.1)	26 (13.8)	30 (16.0)
Lowlands Privately-Owned	2 (1.1)	156 (83.0)	158 (84.0)
Total Number	6 (3.2)	182 (96.8)	188 (100)

[1)] The figures are the number of lowlands in each category and percentages of total number are in parentheses.

[2)] Lowlands that were not used both in the rainy season and in the dry season during the survey year.

[3)] Lowlands that were used at least either in the rainy season or in the dry season during the survey year.

Table 4. Summary of the Hypotheses on the Effect of Public Land Ownership

	Bouaké Land Abundant	Kumasi Land Scarce
Agricultural Intensification	Positive	Negative
Extensive Land Use	No Effect / Negative	No Effect / Positive
Tree Plantation	Positive (?)[1)]	Negative

[1)] Since tree plantations are very few in the Bouaké area, this hypothesis cannot be tested.

Table 5. Variables Constructed for Regression Analyses[1)]

Variables	Unit	Description	Bouaké	Kuamsi
Village Level Variables				
Village population	10^3 persons	1998 census (Côte d'Ivoire). Our own survey as of 2000 (Ghana)	0.59 (0.57)	1.29 (1.22)
Immigrant indicators				
Ratio of male to female	-	Male population divided by female population in the village. 1998 census data are used (Côte d'Ivoire only)	0.90 (0.18)	na
Cocoa producing village	dummy	If the village produces cocoa, the value is 1 (Ghana only)	na	0.79
Dominant ethnic group				
Baoulé	dummy	If the dominant ethnic group in the village is Baoulé (Côte d'Ivoire only)	0.75	na
Tagbana	dummy	If the dominant ethnic group in the village is Tagbana, the value is 1 (Côte d'Ivoire only)	0.04	na
Origin of the village[2)]	dummy	If the ancestors came from outside the region (the Bandama Valley region in Côte d'Ivoire or the Ashanti region in Ghana), the value is 1	0.16	0.69
Disintegration with ethnic minorities[2)]	index/ dummy	If ethnic minorities live separately in the village, the value is 2, if ethnic minorities live mixed with the majority, the value is 1, and if there is no ethnic minorities in the village, the value is 0 (Côte d'Ivoire). If ethnic minorities form hamlets in the village, the value is 1 (Ghana).	0.95 (0.94)	0.35
Years since village establishment[2)]	10^3 years	Côte d'Ivoire only	0.26 (0.14)	na

Village with higher chief (*Ohene*)[2)]	dummy	Such villages are considered to be older than other satellite villages (Ghana only)	na	0.32
Years since school establishment	10^2 years	Number of years since the establishment of the first primary school in the village	0.16 (0.17)	0.31 (0.27)
Male agricultural daily wage rate	10^3 currency	FCFA in Côte d'Ivoire and cedi in Ghana	0.97 (0.26)	5.15 (0.82)
Location of the Village				
Regional capital	10^2 km	Distance to the village from Bouaké in Côte d'Ivoire and from Kumasi in Ghana	0.48 (0.28)	0.49 (0.21)
Sub-prefectural capital	10^2 km	Distance from the sub-prefectural capital to the village. There are 11 sub-prefectural capitals (Côte d'Ivoire only)	0.14 (0.09)	na
Village along a highway	dummy	If the village is located along a highway, the value is 1. There are 6 highways from Kumasi (Ghana only)	na	0.17
Lowland Level Variables				
Access to the village	10 km	Distance from the lowland to the village center	0.23 (0.21)	0.23 (0.29)
Acreage of lowland area	10^2 ha	Estimated acreage of lowland area (Côte d'Ivoire only)	0.24 (0.67)	na
Water source				
Permanent stream	dummy	If the water source is a permanent stream, the value is 1 (Côte d'Ivoire only)	0.13	na
Seasonal stream	dummy	If the water source is a seasonal stream, the value is 1 (Côte d'Ivoire only)	0.76	na
Number of Sample Lowlands			317	188

[1)] The figures are sample means and the standard deviations are given in the parentheses.

[2)] Variables used only for switching lowland ownership regimes.

Table 6. Determinants of Village Ownership of Lowlands[1)]

Explanatory Variables	Bouaké[2)]	Kumasi[2)]
Village Level Variables		
Village population Density (10^3)	-2.95 (2.65)	-1.73 (2.75)
Immigrant indicators		
Ratio of male to female population	1.02 (0.85)	na
Cocoa producing village (dummy)	na	0.22 (0.61)
Dominant ethnic group in the village		
Baoulé	0.44 (0.25)*	na
Tagbana	-0.16 (0.35)	na
Origin of the village is outside (dummy)	-0.10 (0.22)	0.07 (0.53)
Disintegration with ethnic minorities	-0.41 (0.14)***	-0.22 (0.11)**
Village with higher chief (*ohene*)	na	-0.02 (0.28)
Years since village establishment (10^3)	0.34 (0.46)	na
Years since primary school establishment (10^2)	-1.11 (1.12)	1.48 (0.54)***
Male agricultural labor daily wage rate (10^3)	0.25 (0.51)	-0.11 (0.25)
Location of the village		
Distance to regional capital (10^2)	2.30 (1.25)*	22.6 (4.39)***
Distance to regional capital, squared (10^4)	-2.53 (0.91)***	-23.2 (5.17)***
Distance to sub-prefectural capital (10^2)	2.97 (6.26)	na
Distance to sub-prefectural capital, squared (10^4)	4.46 (18.2)	na
Village on highways (dummy)	na	0.40 (0.27)
Lowland Level Variables		
Distance from village center (10)	-0.48 (0.40)	-1.22 (0.44)***
Size of lowland area (10^2)	-0.03 (0.08)	na
Water Source		
Permanent stream (dummy)	0.32 (0.31)	na
Seasonal stream (dummy)	0.26 (0.23)	na
Constant	-2.32 (1.14)**	-5.67 (1.21)***
Total number of sample lowlands	299[3)]	188
Number of publicly-owned lowlands	105	30
Pseudo R^2	0.15	0.22
Fraction of correct predictions	0.74	0.86

[1)] Robust standard errors are in the parentheses. *, **, and *** indicate that the coefficient is estimated at significance level of 10%, 5%, and 1% respectively.

[2)] Dependent variable is a binary dummy for lowland ownership. Probit model is used to estimate the coefficients for the case of Bouaké and the case of Kumasi separately. The Kumasi regression is adjusted by the sampling weight given in footnote 1.

[3)] Thirteen lowlands with modern dam irrigation facilities are excluded from the 317 lowlands identified, and additionally five lowlands are dropped due to imperfect information.

Table 7. Determinants of Rice Cultivation Experience in Lowlands[1)]

Explanatory Variables	Bouaké[2)]	Kumasi[2)]
Endogenous Varianle		
Village ownership of lowland	0.70 (0.24)***	-0.02 (2.88)
Village Level Variables		
Village population density (10^3)	12.4 (2.72)***	-3.17 (1.61)**
Immigrant indicators		
Ratio of male to female population	-1.52 (0.53)***	na
Cocoa producing village (dummy)	na	0.50 (0.50)
Dominant ethnic group in the village		
Baoulé	-0.91 (0.52)*	na
Tagbana	-0.40 (0.63)	na
Years since primary school establishment (10^2)	0.23 (0.60)	0.17 (0.67)
Male agricultural labor daily wage rate (10^3)	-0.37 (0.37)	0.11 (0.19)
Location of the village		
Distance to regional capital (10^2)	-3.53 (1.28)***	1.86 (6.41)
Distance to regional capital, squared (10^4)	2.97 (1.24)**	-1.40 (6.42)
Distance to sub-prefectural capital (10^2)	7.29 (3.69)**	na
Distance to sub-prefectural capital, squared (10^4)	-33.4 (10.9)***	na
Village on highways	na	-0.13 (0.24)
Lowland Level Variables		
Distance from village center (10)	0.51 (0.40)	-0.00 (0.00)
Acreage of lowland area (10^2)	0.41 (0.41)	na
Water Source		
Permanent stream (dummy)	0.33 (0.35)	na
Seasonal stream (dummy)	01	na
Constant	3.19 (0.95)***	0.13 (1.48)
Total number of sample lowlands	299[3)]	187[4)]
Number of lowlands ever-used for rice cultivation	249	158
Wald test for all the parameters being 0 (χ^2)	124***	98.1***

[1)] Robust standard errors are in the parentheses. *, **, and *** indicate that the coefficient is estimated at significance level of 10%, 5%, and 1% respectively.

[2)] Dependent variable is a binary dummy for rice cultivation experience: the value is 1 if rice has ever been cultivated in the lowland, and 0 if rice has never been grown in the lowland. Endogenous switching probit regression is used for the case of Bouaké and the case of Kumasi separately. The Kumasi regression is adjusted by the sampling weight given in footnote 1.

[3)] Thirteen lowlands with modern dam irrigation facilities are excluded from the 317 lowlands identified, and additionally five lowlands are dropped due to imperfect information.

[4)] One lowland is excluded due to imperfect information.

Table 8. Determinants of Lowland Use in Bouaké[1)]

Explanatory Variables	Food Crops[2)]	Mono Cropping[2)]	Rice-Veg Multiple[2)]
Endogenous Varianle			
Public ownership of lowland	-0.51 (0.68)	-0.98 (0.55)*	0.51 (0.26)*
Village Level Variables			
Village population density (10^3)	4.47 (2.38)*	4.32 (2.60)*	1.21 (3.75)
Immigrant indicators			
Ratio of male to female population	0.13 (0.51)	0.14 (0.55)	0.10 (0.79)
Dominant ethnic group in the village			
Baoulé	0.66 (0.45)	1.18 (0.55)**	-0.48 (0.59)
Tagbana	0.53 (0.57)	1.07 (0.64)**	na[4)]
Years since primary school establishment (10^2)	-0.61 (0.65)	-0.93 (0.63)	-0.70 (0.77)
Male agricultural labor daily wage rate (10^3)	-0.20 (0.39)	-0.27 (0.43)	-0.16 (0.77)
Location of the village			
Distance to regional capital (10^2)	-1.38 (1.27)	0.61 (1.38)	-2.63 (2.01)
Distance to regional capital, squared (10^4)	1.05 (1.22)	1.02 (1.37)	0.33 (1.80)
Distance to sub-prefectural capital (10^2)	3.27 (3.25)	3.42 (3.51)	1.64 (4.40)
Distance to sub-pref. capital, squared (10^4)	-13.4 (9.05)	-12.9 (9.72)	-11.4 (12.5)
Lowland Level Variables			
Distance from village center (10)	-0.10 (0.34)	-0.15 (0.34)	0.18 (0.55)
Acreage of lowland area (10^2)	0.37 (0.24)	0.43 (0.23)*	-0.09 (0.45)
Water Source			
Permanent stream (dummy)	0.68 (0.30)**	0.42 (0.32)	1.08 (0.57)*
Seasonal stream (dummy)	0.56 (0.26)**	0.54 (0.26)**	0.69 (0.56)
Constant	-1.04 (0.87)	-1.70 (0.95)*	-0.71 (1.26)
Total number of lowlands[3)]	299	270	210
Number of lowlands in this category	115	86	26
Wald test for the parameters being 0 (χ^2)	92.4***	92.6***	105***

[1)] Robust standard errors are in the parentheses. *, **, and *** indicate that the coefficient is estimated at significance level of 10%, 5%, and 1% respectively.

[2)] Dependent variables are binary dummies for lowland use in the rainy season. Endogenous switching probit regression is used for each land use separately.

[3)] Thirteen lowlands with modern dam irrigation facilities are excluded from the 317 lowlands identified, and additionally five lowlands are dropped due to imperfect information.

[4)] No lowland with rice-vegetable multiple cropping is observed in Tagbana villages.

Table 9. Determinants of Lowland Use in Kumasi[1)]

Explanatory Variables	Food Crops[2)]	Mono Cropping[2)]	Rice-Veg Multiple[2)]
Endogenous Varianle			
Public ownership of lowland	0.78 (0.33)**	-1.02 (2.02)*	-0.58 (0.58)
Village Level Variables			
Village population density (10^3)	0.23 (0.12)	-0.24 (1.50)	-1.54 (1.81)
Immigrant indicators			
Cocoa producing village (dummy)	-0.21 (0.33)	-0.20 (0.39)	0.24 (0.43)
Years since primary school establishment (10^2)	-0.00 (0.59)	0.41 (0.64)	-0.70 (0.84)
Male agricultural labor daily wage rate (10^3)	-0.60 (0.19)***	-0.81 (0.30)***	-0.42 (0.26)
Location of the village			
Distance to regional capital (10^2)	-12.4 (3.57)***	-11.9 (4.92)**	-9.35 (7.28)
Distance to regional capital squared (10^4)	11.6 (3.24)***	11.1 (4.55)**	8.57 (7.08)
Village on highways	0.39 (0.23)	0.57 (0.29)**	0.66 (0.34)*
Lowland Level Variables			
Distance from village center (10)	0.82 (0.48)*	0.92 (0.57)	0.51 (0.63)
Constant	5.27 (1.42)***	5.71 (2.18)***	3.29 (2.25)
Total number of lowlands[3]	188	148	143
Number of lowlands in this category	71	31	26
Wald test for the parameters being 0 (χ^2)	59.0***	103***	58.3***

[1)] Robust standard errors are in the parentheses. *, **, and *** indicate that the coefficient is estimated at significance level of 10%, 5%, and 1% respectively.

[2)] Dependent variables are binary dummies for lowland use in the rainy and dry seasons. Endogenous switching probit regression is used for each land use separately, adjusted by the sampling weight given in footnote 1.