ECONOMICS OF RICE PRODUCTION
An Economic Analysis of Rice Production Systems in the Upper East Region of Ghana

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ABSTRACT

Local rice production is being promoted in Ghana to reduce the dependence on imports, ensure stable low-prices food for the population and also create employment. This paper examines three rice production systems; Upland, Valley Bottom and Irrigated, in the Upper East Region of Ghana with a view to establishing the production costs, returns and factors affecting rice output. Data were collected from a random sample of 105 small-scale farmers of three local government areas, Bolgatanga Municipal, Builsa District and Kassena-Nankana District, through a questionnaire survey. Data were analyzed using cost structures, net returns and Cobb-Douglas production function analyses. The data revealed that irrigated rice system had the highest total cost of production, followed by Valley Rice and then Upland. It was also found that higher yields on irrigated fields offset the higher cost. Hence, higher returns above variable cost for irrigated fields. The study revealed that sex of the farmer and number of years of experience in rice production, labor input, fertilizer input and number of years in formal education determined to a large extent rice yields in the study area. Fertilizer was the only variable that significantly influenced rice yields on all the production systems and also the largest contributor to total cost of production among the systems, thus, emphasizing the importance of fertilizer in rice production.

KEY DESCRIPTORS: Rice Production, Production Systems, Small-Scale Farmers, Production Cost, Fertilizer Use.

INTRODUCTION

Traditional small-scale agriculture dominates Ghana's agricultural sector. About 85% of Ghanaian farmers are smallholder operators, accounting for over 80% of total agricultural production in Ghana (MOFA, 2002). In 2002, the agricultural sector employed about 70% of the labor force, contributed about 39.5% to GDP and accounted for 35.5% of foreign exchange earnings (ISSER, 2003). The importance of rice in the Ghanaian economy is seen in its contribution to Gross Domestic Product (GDP) and employment. In 1996, rice contributed about 1.5% to agricultural GDP (MOFA, 1997).

Rice has been cultivated for a very long time in Ghana. In the 17th and 18th centuries, rice was already one of the major commercial food crops in the sub-region. However, it was not until 1960 that rice became an important crop in Ghana. The strategic nature of rice has drawn the attention of policy makers who view promoting domestic rice production as a means of reducing dependency on imports, lowering the pressure on foreign currency reserves, ensuring stable and low priced sources of food for people and generating employment and income for rice farmers (Randolph, 1995). Analyses of the competitiveness of domestic rice production since the mid-1980s suggest that liberalization policies under the Structural Adjustment Programme (SAP) have negatively affected the competitiveness of rice in Ghana (Asuming-Brempong, 1998). The erosion of profitability of rice production in the mid 1980s is demonstrated by the rice-fertilizer-price ratio. From 1989, when the liberalization policy was effected the nominal price of fertilizer increased much faster than increase in the price of rice, which negatively affected farmers' incentives to produce rice in Ghana (ibid).

Government has made several efforts towards promoting local rice production. Despite these, a lot of money is still being spent on importing rice. The challenge faced by the Ghanaian Governments is how to bridge gap between imports and local production. It is however, very crucial to understand the economics of the rice industry in Ghana to help map out strategies for increase rice production. This paper reports on a study that was aimed at finding ways to increase the level of rice production locally by analyzing the various rice production systems in the Upper East Region with a view to establishing the costs, returns and factors affecting rice output.

RICE PRODUCTION AND CONSUMPTION IN GHANA

Ghana has great potential to expand its present average annual rice production area of 89, 700 hectares by 200 percent if its vast area of inland valleys and swamps are fully exploited (Obeng, 1994). The greatest potential lies in the Interior Savannah Zone, which covers nearly the entire northern half of the country extending over nearly 9.32 million hectares. Non-irrigated rice farming is practiced in all the six districts of the Upper East Region but irrigated rice cultivation is restricted to farmers around Tono and Vea areas because of the irrigation projects there. The Upper East Region is a key rice-producing region in Ghana. In 1998, the Upper East Region was the largest producer of rice in the whole country contributing about 46% of the total rice produced in Ghana (SRID, MOFA, 2003). The Upper East Region can produce enough rice to cushion the country from the deficits if only serious attention is paid to rice farmers. Taken together, the three northern regions produced about 67% of the total rice produced in the country in 1998. This is a demonstration of the rice production potential of north Ghana.

The rice production systems practiced in the Upper East Region are Upland, Valley Bottom and Irrigated systems. Upland rice production system refers to rice grown on both flat and sloped fields that are not bunded, prepared and seeded under dry condition, and that depend on rainfall for moisture. Valley Bottom systems refer to large flat valleys, which are called lowlands and cover the vast area of land that stretches from the Builsa District of the Upper East to the north Volta Basin of the Northern Region, especially within Mamprusi West and Savelugu-Naton Districts. The Builsa District has a relief feature of fairly flat lowland. Irrigation is the application of water by human agencies to assist the growth of crops. Irrigated rice fields refers to low, flat, bunded areas that are prepared and seeded under wet conditions or irrigation and do not depend on rainfall for moisture but rather have available sources of water. Examples are the Tono, Vea and Bontanga Irrigation areas.

In Ghana, rice cconsumption is growing faster than production leading to over increasing imports. The increase in demand can be attributed to rapid urbanization and ease of cooking and storage (Bimpong, 1998). In 2002, about 280,000 metric tons of paddy rice was produced in Ghana. Out of this amount, the production available for human consumption was 135,000 metric tons. Meanwhile, the estimated national consumption was 280,000 metric tons (i. e, estimated on 19.4 million population) thus creating a deficit of 145,000 metric tons (SRID, MOFA, 2003). To meet the deficit and also provide extra, Ghana imported about 296,953 metric tons of rice valued at $ 68.85 million. Per capita consumption of rice increased from 13.3 kg/annum in 1999 to 14.5 in 2002 (ibid).

The issue about whether Ghanaians actually patronize and consume locally produced rice is a notion of the past. Bam, Anchirinah, Mmanful, Ansereh-Bio & Agyemang (1998) indicated that locally produced and parboiled rice is well patronized in the country especially in the Northern sector. A study conducted covering Tamale, Kumasi and Accra indicated that about 74% in Tamale, 40% in Kumasi and 38% in Accra of the respondents respectively, regularly patronize and consume locally produced parboiled rice.

METHODOLOGY

Research Design

Data used for the study was basically cross-sectional. However, some secondary data from Ministry of Food and Agriculture (MOFA) and Ministry of Trade and Industry (MOTI) were used to supplement field data collected. Data were collected using structured questionnaires administered to rice farmers. Focus group discussions preceded data collection. Checklists were also drawn to guide the interviewers. Selection of rice farmers was done by random sampling of rice farmers from three important rice producing districts in the Upper East region. Thirty-five (35) rice farmers were selected from each of the production systems in three Districts of the Upper East region in 2004. Upland rice farmers were selected from Bolgatanga (Bolgatanga Municipal Area), Valley Bottom farmers from Fumbisi (Builsa District) and irrigated rice farmers from Tono (Kasena-Nankana District). In all, 105 rice farmers from the three rice production systems were interviewed.

Data collected were basically inputs and outputs. Inputs costs were broken into two. That is variable cost (excluding labour) and labour input cost. Labour was measured in person-days used per hectare, taken into account household and hired labour. A person-day is about eight (8) hours of work per day. Family labour was expressed in monetary terms according to the current wage rate. There were no fixed costs since the items used by the farmers could hardly last a year. Hoes, sickles and knives were the tools used and these could hardly last a production year. The current cost of the items was therefore taken as the cost and used for the study. Seed rate was measured in kilograms per hectare. Fertilizer input was measured in kilograms used per hectare. The cost of accessing and using land was taken as land rent or cost of land. If land was not rented the prevailing rent rate of land in each system was assumed to be the cost of land. The average weight of a paddy bag of rice was taken. For the outputs calculations, the price at which the farmer sold a paddy bag was multiplied by the number of paddy bags sold to get the total revenue. Some of the farmers did not sell all the bags harvested or did not sell at all. In this case, the price of an average paddy bag of rice was multiplied by the number of bags harvested by the farmer to get the total value. The total value was then divided by the total number of bags (both sold and unsold) to get the weighted average price.

Estimation of Net Returns

Net returns were estimated following a similar technique employed by Olagoke (1991) in analysing net returns from three rice production systems namely; upland, swamp and irrigated in Anambra State, Nigeria. Net returns were calculated for each system by deducting the total cost of production from the total revenue of rice. Crop budgets of the various systems were prepared and used to establish cost structures for the systems. The estimation was done as given below:

Net returns = Total revenue - total cost of production.
$= P_iQ_i - å(P_1X_1, \ldots\ldots, P_nX_n)$

Total revenue was calculated by multiplying the weighted average price of a bag of paddy by the quantities (bags of paddy) harvested per hectare. Total cost of production included the cost of materials and transport (variable cost) and cost of labor in performing farm activities.
Model Specification

A Cobb-Douglas production function was employed for the estimation of the factors affecting rice yields in the various rice production systems. Many authors have utilized various approaches, which employed the Cobb Douglas production function to estimate the effects of the various inputs on production. Appiah-Baiden (1998), employed Cobb Douglas production functions for farmers' output and agriculture productivity function and estimated the functions using the Ordinary Least Squares (OLS) technique. Also, Olagoke (1991), in analysing the efficiency of resource use among three rice production systems in Anambra State, Nigeria, used a Cobb-Douglas and semi-logarithmic functional forms for the analysis. He assumed that the survey area was homogenous with respect to soil types, weather conditions, and human resources. This study employed a Cobb-Douglas production function because of its appropriateness in the analysis. The function was estimated using the Ordinary Least Squares (OLS) technique. The general form of a Cobb-Douglas production function is specified as;

$$Q = Ax_1^{\alpha} x_2^{\beta \cdots\cdots} x_m^{\eta}$$

Where:

Q = Output measured in kg of paddy

A = Constant parameter of efficiency

X = Explanatory variables

α, β, ..., .η are parameters that represent the output elasticity and $\alpha + \beta + \ldots\ldots + \eta = 1$ and $0 < \alpha, \beta, \ldots\ldots \eta < 1$.

The exponential functional form was transformed into linear equation by taking the natural logarithm of the equation. Following Olagoke (1991), the following socio-economic factors were considered. These included inputs (seed, fertilizer, labor) and socio-economic factors (gender of farmer and formal education level).

The gender of rice farmers was expected to affect rice yields. Ellis (1993) observed that some peasant farmers were more efficient than others therefore we should not try to generalize the non-generalizable. In the Upper East Region, males usually have more access to household resources such as land and labor than females. If these assertions hold, then women are likely to be less efficient and thus result in low yields compared to their male counterparts. The gender of farmer was assigned a dummy. A value of one (1) was assigned to male rice farmers and zero (0) to female rice farmers.

Labor input measured in person-days was expected to affect rice yields. It was expected that large families with large active labor force working on the farm or families who could hire more labor to work on the farm would realize higher yields than others, all other things being equal. The more person-days spent on farm activities may result in higher yields.

The number of years of farmer's experience in rice production is expected to affect rice yields. Farmers who had longer years in rice production would have gained knowledge through experience on the work and are therefore expected to achieve higher yields than those farming for a shorter period of time, all other things remaining constant.

The level of education of rice farmers was expected to influence rice yields. The effect could either be positive or negative. Generally, while it has been established that better educated workers earn higher wages in the modern sector (Fatchamps & Quisumbing, 1998), it remains a contentious issue whether education raises farm productivity. Evidence from Africa indicates otherwise, that low rates of returns to formal schooling and sometimes negative marginal effects (Appiah-Kubi, Nsowah-Nuamah, &Van, 2001). Lele (1990) observed that an improvement in farm human capital through education is essential for increasing agricultural productivity. The illiteracy of most farmers in Ghana creates communication problems and constraints, proper understanding, adoption and also application of modern and improved farm technologies (Nyanteng & Dapaah, 1997).

The rapid growth of the population has culminated in undue pressure on agricultural land and thus the issue of shifting from poor soils to fertile ones is a thing of the past. Thus, there is need to increase productivity given that land is fixed. The application of chemical fertilizer will increase yields given that other things are constant. It is expected that farmers who use more fertilizer (but not exceeding the required amounts) on their rice fields are likely to achieve better yields compared to those who do not.

The empirical model is specified as:

$$Ln\,Y = \beta_0 + \beta_1 GEND + \beta_2 Ln\,YEXP + \beta_3 LnLAB + \beta_4 LnFERT_4 + \beta_5 LnEDULEV_5 + U,$$

Where: *Ln* =Natural logarithm

Y= Output of paddy rice (Kilograms per hectare).

GEND=Gender of farmer GEND= 1, if male GEND = 0, if female

YEXP =Number of years of farmers experience in rice cultivation

LAB=Labor input (man-days per hectare).

FERT=Quantity of fertilizer used (Kilograms per hectare).

EDULEV=level of farmers' formal education in terms of physical years in school (e.g. primary six=6, J.S.S/middle school =9, S.S.S/Technical =12, and tertiary =15).

U = Error term.

β_0 = Intercept of the function, β_1 to β_5 are the coefficients.

STUDY RESULTS

Production Costs

Average costs were used for the analysis and all calculations were done on one-hectare basis. On the average, irrigated rice system recorded the highest total production costs per hectare. The average cost on irrigated system was ¢4,211,308.2 per hectare. Upland rice system ranked second in terms of production costs (¢ 2,650,256). The average cost for Valley Bottom was ¢2,451,368. There was no significant difference in the cost of production between the Upland and the Valley Bottom systems. However, there was significant difference in the cost of production between the two systems (Upland and Valley Bottom) and the irrigated system. This was found to be similar to the findings of Ayambila (2004) in comparing rice productions systems in the Upper East region. The high cost of production especially on irrigated rice fields scares poor but productive farmers who cannot afford to raise such funds.

Irrigated rice fields had the highest cost of production but were worth investing in considering the returns. Despite the high cost, the returns were the highest among the systems, thus offsetting the costs. The findings were similar to that of Baker and Herdt (1979) in their comparison of inputs and returns for a sample of rain fed and irrigated rice farms in three Philippine farming areas in which they found that in all the three systems, yield, input level and return per hectare were higher on irrigated rice farms than rain fed rice farms. However, higher yields on irrigated farms offset the higher cost hence, higher returns above variable cost for irrigated farms.

The total variable costs (excluding labor) averaged 79.2% of the total cost of production on Valley Bottom, 63% on irrigated rice system and 55.5% on Upland rice fields. The high percentage (variable costs excluding labor) on Valley Bottom fields is an indication that labor costs were very low. This is partly due to reduced cost in weeding as flooded fields control weeds. There was also no leveling cost and cost of applying ammonium fertilizer. The cost of fertilizer and ploughing were the major variable cost (excluding labor) that cut across all production systems. Thus, emphasizing the importance of fertilizer and land preparation (ploughing) in rice cultivation.

The cost of controlling weeds and harvesting were the major labor input costs that cut across all the production systems. Rice cultivation requires more labor compared to that of maize. Aggrey-Fynn (2002) indicated that lack of appropriate labor-saving technologies had caused the rice-sub-sector to require the highest level of agricultural labor at 200-300 man-days per ha of activity compared to 150 for maize. There were some activities specific to only the irrigated system. These included land clearing, nursing seedlings and bird scaring. Upland and Valley Bottom farmers did not clear the land before planting and also sowed directly on the fields without first nursing seedlings. This could have affected their rice yields. Details of the costs and returns are presented on Table 1 below.

Table 1: Average Production Costs and Returns per hectare for Upland, Valley Bottom and Irrigated Rice Farmers in the Upper East Region.

	Upland		Valley Bottom		Irrigated	
Item	Value (¢) /ha	Share of Cost %	Value (¢) /ha	Share of Cost %	Value (¢) /ha	Share of Cost %
Total Revenue (TR), (Price*quantity)	**1,686,000**		**3,690,750**		**¢6,524,270**	
Yield (paddy bags)	12 bags		28.5 bags		49.1bags	
Variable Cost (Excluding labor)						
Seed cost (Kg)	116788.8	4.4	158197.2	6.8	177660	4.2
NPK (Kg)	429000	16.2	757090.1	27.2	532808.43	12.6
Ammonium (Kg)	275000	10.4	-	-	276975.12	6.6
Land rent/irrigation	150000	5.7	200000	8.6	315500	7.5
Hoes, sickles, cutlasses	40921.4	1.5	47039	2.0	131517.9	3.1
Ploughing	244523.8	9.2	338095	14.5	368937.6	8.8
Cost of pesticides	-	-	-	-	105628	2.5
Fertilizer transport	15225	0.6	17625	0.8	19950	0.5
Transport of rice to sell	60685.2	2.3	87124.5	3.7	154321.3	3.7
Transport of rice home	60685.2	2.3	164131.5	7.1	218838.7	5.2
Bagging cost	77143.2	2.9	197875.5	8.5	354207.4	8.4
Total Variable Costs (TVC)	**¢ 1,469,973**	**55.5**	**1,967,177**	**79.2**	**¢2,656,344**	**63.1**
Labor input (in man days)						
Land clearing	-		-	-	133200	3.2
Levelling	94187.5	3.6	-	-	94965.8	2.3
Planting	180302.5	6.8	81200	3.5	238419.3	5.7
Nursing seedlings	-		-	-	19400.5	0.5
Weeding	566059.3	21.4	176492.3	7.6	457971.2	10.8
NPK application	8666.6	0.3	7427.1	0.6	13550.1	0.3
Ammonium application	8666.6	0.3	-	-	11919.6	0.3
Bird scaring	-		-	-	168639.2	4.0
Harvesting	205624.3	7.8	14298.9	6.1	228604.3	5.4
Threshing/winnowing	87993.54	3.3	49951.6	2.1	131437.8	3.1
Drying and bagging	28783.17	1.0	21753.4	0.9	56823	1.3
Total Labor Input (TLC)	**¢ 1,180,284**	**44.5**	**484,191.1**	**20.8**	**¢1,554,930**	**36.9**
Total Cost (TC) =TVC+TLC	**¢ 2,650,256**	**100**	**2,451,368**	**100**	**¢4,211,308**	**100**
Net returns (TR-TC)	**¢-964,256**		**1,239,381**		**2,312,962**	

Source: Authors computation, 2004.

Output and Net Returns

The average farm size on Upland was 0.5 hectares. Upland rice farms are not only small but are scattered and fragmented. Valley Bottom average farm size was 1.9 hectares. That of irrigated was 0.9 hectares. The average yield per hectare on irrigation was about 49.1bags. That on Valley Bottom was about 28.5 bags per hectare and 12 bags per hectare on Upland rice fields. Studies have indicated that rice yields are very low in Ghana despite the potential to increase yields. As a result of low yields, increased rice output in Ghana is positively correlated ($r = 0.94$) with increased area cultivated (Vordzorgbe, 1985). Farmers being risk averse will prefer irrigated fields, where risks are lowest but the issue then is whether they would be able to finance the high production costs associated with the system. An average paddy bag of rice weighed about 85kg and sold for ¢140,500 by Upland rice farmers. The same quantity was sold by Valley bottom farmers for ¢129,500. Irrigated rice farmers sold the same quantity for ¢132,877.

On the marketing aspect of the crop, farmers indicated that low price during harvesting is a major problem. This phenomenon also applies to most crops. Less than 40% of the Upland rice farmers sold their rice within seven days and six months. About 62% of Valley Bottom rice farmers began selling their produce within six months and a year after harvest. More than 90% of irrigated rice farmers sold their produce within few weeks after harvest to six months. Tono irrigated rice farmers sold their produce to ICOUR. ICOUR normally supply the farmers with seeds, fertilizer, pesticides and farm machinery for production. Farmers usually agree that ICOUR should deduct the costs of inputs supplied from the sale of their rice.

The returns to investment were negative 36% on Upland rice system. This implies that for every one hectare of land cultivated, farmers incurred losses of up to 36%. The price received by Upland rice farmers for a bag of paddy was the highest and yet the net returns were negative. This was as a result of low yields and high production cost. There is high risk associated with Upland and Valley Bottom. One farmer remarked, "if the rains fail, there will be a total loss of crop". Farmers on both Valley Bottom and irrigated rice fields made gains of up to 50%. Farmers under the irrigation systems had fewer risks to contend with compared to Upland and Valley Bottom systems, which depend entirely on rainfall. Farmers being risk averse will prefer irrigated fields where risks are lowest if only they can afford considering the high production costs

Use of Chemicals and Fertilizer

All the production systems applied nitrogenous fertilizer. NPK was applied first and then followed by sulphate of ammonium or urea. Irrigated rice farmers used a chemical called "Karate" to control pests on farm. Upland and valley Bottom farmers did not use chemicals. Upland and Valley Bottom rice farmers usually begin farming as soon as the rains start in May/June. Irrigated rice farmers begin land preparation between January and February. Nursery beds are prepared during land preparation. Seeds are nursed for at least a month. Out of the total production costs, fertilizer cost was the single largest input cost (that is putting the cost of NPK and sulphate of ammonium/urea together). Gerner, Asante, Owusu-Bennoah, & Marfo, (1995) indicated that the removal of subsidies on chemical fertilizer has resulted in a wide gap between current levels of fertilizer use and the required level mainly because most farmers cannot afford chemical fertilizer due to high cost.

Access to Credit and Farmer Associations

Upland rice farmers did not have farmer associations. Valley Bottom and Tono irrigated rice farmers had farmer associations. The main benefits derived from these associations include the provision of farm inputs such as seeds and fertilizer. The associations also help members in accessing credit. About 90% of the farmers in the study area used their own resources for rice production. Only few Valley Bottom and irrigated rice farmers had secured loans from friends, banks and non-governmental organizations. The amount of loan ranged from two hundred thousand to two million cedis (¢200,000 to ¢2,000,000). The Agricultural Development Bank gave loans to less than 10% of the farmers and the interest rate was between 30-35%. The repayment period was usually between six months and one year. Those who obtained credit from friends did not pay interest. They were expected to pay back the amount borrowed after production.

Factors Affecting Rice Production in the Various Systems

The double log model employed for the analysis means that the coefficients are elasticities. The regression results showed that on Upland rice fields, about 68% of the variations in rice output were explained by explained by the sex of the farmer, years of experience in rice production, number of years in formal education, labor input and quantity of fertilizer used. Labor input and quantity of fertilizer used were both significant at 1%. The coefficient for labor input was 0.788. This means that one percent increase in person days will add 0.788 percent to output. Similarly, one percent increase in fertilizer use will result in 0.488 increases in output.

On Valley Bottom rice fields, 54% of the variations in rice output were explained by the variables specified in the model. The results showed that the number of years of experience in rice cultivation, the quantity of fertilizer applied and the number of years of formal education of rice farmers significantly influenced rice output. A coefficient of 0.88 for the number of years of experience in rice cultivation means that one percent increased in the number of years of experience in rice cultivation will result in 0.88 percent increased in output. Similarly, one percent increase in fertilizer use will result in 0.139 percent increase in output. However, the number of years of formal education had a negative effect on rice output. This could be attributed to the fact that as farmers spend more years in formal education, they may begin to diversify into other crops or businesses to cushion themselves against production losses and risks. Valley Bottom rice production in the area is risky because the system solely depends on rainfall

On irrigated rice fields, 56% of the variations in outputs were explained by the sex of the farmer, years of experience in rice production, number of years in formal education, labor input and the quantity of fertilizer used. Quantity of fertilizer used and the number of years in formal education were significant at 1% and 5% respectively. Fertilizer coefficient of 0.191 means a one percent increase in fertilizer use will result in 0.191 percent increase in output. Quantity of fertilizer used was positive and significant in all the production systems thus emphasizing the importance of fertilizer in rice production. Results from the regression are presented in Table 2.

Table 2: Rice output (Kg per hectare) as a function of socio-economic factors.
Estimated Parameters

Sample Fields	Sample Size	Constant	GEND (X_1)	YEXP (X_2)	LAB (X_3)	FERT (X_4)	EDULEV (X_5)	F-ratio	R^2
Upland	35	0.820	0.173	0.125	0.788***	0.488***	0.025	12.369	0.68
			(0.173)	(0.144)	(0.207)	(0.155)	(0.016)		
Valley B.	35	0.302	-0.056	0.188*	0.013	0.139*	-0.013**	6.78	0.54
			(0.073)	(0.110)	(0.072)	(0.075)	(0.005)		
Irrigated	35	1.986	0.077	0.089	0.019	0.191***	0.017**	7.248	0.56
			(0.058)	(0.088)	(0.071)	(0.079)	(0.006)		

Functional form= Double log
Figures in parenthesis are standard errors
*** = 1% significance level. ** = 5% significance level. * = 10% significance level

Description of variables used
GEND (Gender of respondent)
YEXP (Number of years of farmers experience)
LAB (labor input in man-days per hectare)
FERT (fertilizer input in Kg per hectare)
EDULEV (Number of years of formal education)

CONCLUSION

Farm sizes were smaller on Upland compared to Valley Bottom and irrigated. Smaller and fragmented farm sizes do not allow for mechanization and thus will force farmers to use traditional methods of farming. It was realized that few farmers had access to credit for farming in the 2004 crop year. However, since rice farming is capital intensive, most farmers cannot afford to expand their farms. Access to adequate and timely credit facilities, could lead to expansion in cultivated area and hence higher outputs.

The study revealed that the irrigation system had the highest cost of production per hectare and also achieved the highest net returns and therefore most profitable. High cost of production under irrigation system is an indication that it is capital intensive. Thus farmers require finances to enable them cultivate rice. It was realized from the analysis that fertilizer cost constituted more than 25% of the total cost of production on Upland and Valley bottom fields. This implies that any effort to boost rice output should also aim at reducing fertilizer price, which is going beyond the reach of poor farmers. The use of fertilizer was directly responsible for increase rice yields in the study areas.

The absence of improved rice varieties for Upland and Valley Bottom farmers could constitute a setback and result in low yields because rice may require different soils and environment for proper growth and development. The study revealed that the sex of the farmer, number of years of experience in rice production, labor input, fertilizer input and number of years in formal education determined to a large extent rice yields in the study area.

RECOMMENDATIONS

The provision of grain banks for farmers to store and sell later in for better prices. Guarantee minimum price fixed at the import parity price for paddy will encourage rice production and ensure efficiency. Farmers should employ ways of improving soil fertility than relying on fertilizer since the cost of fertilizer is high and increasing over the years. Alternatively, the use of organic manure could be encouraged to reduce the cost of fertilizer. The general public should be sensitized on the advantages of consuming locally produced rice. Local rice should be supplied to all government assisted schools to create demand for it.

Upland rice farmers did not have farmers associations and this could affect them in pricing their produce and access to credit. Farmers should be encouraged to form farmer associations to enable them have access to credit for farming, given the capital-intensive nature of rice production coupled with fact that farmers are poorly resourced. There is the need for agencies and organizations to support farmers with appropriate credit products and also monitor the way credit obtained is used.

In order to reduce high cost of weeding, farmers should be encouraged to look for cheaper ways of controlling weeds. Good husbandry practices must be adhered. The cost of tractor services was very high especially on Valley Bottom system. Government, private sector actors and other stakeholders in agriculture should support the establishment of tractor-hiring units in the study area and also monitor the use and maintenance of the tractors to reduce the cost of land preparation.

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