ALLOCATIVE EFFICIENCY, EMPLOYMENT AND RICE PRODUCTION RISK: AN ANALYSIS OF SMALLHOLDER PADDY FARMS IN THE UPPER EAST REGION OF GHANA

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Abstract

A production function analysis was used to investigate resource use efficiency by smallholder rice farmers in the Upper East Region of Ghana and its impact on employment. Data was collected from a random sample of 440 farmers during the 2001/2002 cropping seasons. Empirical results show that smallholder rice farmers are allocatively inefficient in the use of labour, bullock and fertilizer. Non-irrigators created more job opportunities in the study area than irrigators. Smallholder farmers have developed coping mechanisms in order to minimize the negative impact of rice production risks. A programme to accelerate the provision of education and credit is needed. The education programme should include both formal and non-formal elements. This is important for the improvement of farmers' abilities to retrieve and process information regarding modern agricultural technology. Effective farmer-centered technical training programmes are needed to build the capacities of small-scale farmers in resource mobilization and use. Research is also needed in areas of reducing rice production risks.

Key words: Allocative efficiency, employment, gender, production risks, coping strategies.

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1.0 Introduction

Agriculture is the main economic activity in the Upper East Region (UER) of Ghana, employing over 80% of the economically active population. The main farming systems are rain-fed and mixed cropping with a majority of the crop farmers also engaged in livestock production. Principal crops grown on the upland rain-fed soils are sorghum (guinea corn), groundnuts and millet. The Region is also an important rice–producing area, grown on about 20% of the total arable land (MOFA, 2000). Rice is grown during the rainy season in the valleys or in swampy areas and the dry season. The Upper East region has the largest number (220) of water-retaining structures in Northern Ghana. Tono and Vea are the two major irrigation projects in the Region with irrigating areas of 2,450 and 850 hectares, respectively. Non-irrigated rice farming is practiced across all the six districts in the region.

As Ghana struggles to achieve accelerated growth in food production, increasing the output of rice has become an important goal. This is because of the importance of rice as a major food crop. Rice consumption in Ghana is growing, particularly among urban dwellers. Rice contributes 9% of the food requirements of the country. The utilisation and productivity of labour is also a key element in increasing rice output and incomes of small farmers. Despite the role of rice as a major food crop in the UER its production is beset with several bottlenecks. Risks and uncertainties such as severe or unusual weather (droughts and sometimes floods), disease, pest infestations and output and input price volatility, high input costs and lack of incentives are major obstacles to rice production. The withdrawal of subsidies in 1990 and poor access to long-term capital are also responsible for low domestic rice supply. Less than 10% of total land cultivated under various crops is irrigated (ISSER, 2002). The problem with non-irrigated rice production system is that it generates unstable output thereby making the incomes of rice growers unpredictable. More importantly, the country's agricultural sector is producing below economic potential (at about 20%) suggesting unemployment and underemployment in the sector and the potential for increasing output, employment and incomes of farmers.

Efficiency has three components: technical, allocative and economic. Technical efficiency can be defined as the ability to produce a given level of output with a minimum quantity of inputs under certain technology. Allocative efficiency involves choosing optimal input levels for given factor prices and describes the adjustment of inputs and outputs to reflect relative prices, the technology of production already having been chosen. Economic or total efficiency is the product of technical and allocative efficiency. The ability of smallholder rice farmers to adopt new technologies for sustainable small-scale production depends on the level of farmer resource use efficiency. Efficient resource use will not only enable farmers to increase the employment of productive resources, but also give direction of adjustments required in the long run to achieve food sustainability.

There is evidence in Africa concerning the efficiency of resource use by smallholder farmers in Kenya, Sierra Leone, Cote d'Ivoire, Nigeria, Ethiopia and Malawi (Adesina & Djato 1996, 1997; Byiringiro & Reardon, 1996; Abdulai & Huffman, 1998; Chirwa, 2001; Sarpong & Asante 2001). The main assumption underlying these previous studies is that smallholder farmers are efficient.

Production functions or primal approaches have generally been used to examine efficiency of farmers in Africa. One of the important criticisms leveled against studies that rely on the production function method for assessing allocative and economic efficiency is that the method suffers from problems of simultaneity bias because input levels are endogenously determined (Quisumbing 1994). Quisumbing notes that such problems of endogeneity can be avoided by estimating profit or cost functions instead of production functions. An advantage for using the profit function approach is that when input and output prices are exogenous to farm household decision-making, they can be used to explain input use and output supplied.

The resulting parameter estimates will in general be statistically consistent (Abdulai & Huffman 1998).

Studies by Adesina and Djato (1996) and Sarpong and Asante (2001) have measured technical and allocative inefficiencies using dual approaches involving the use of profit or cost functions. There are, however, four problems associated with estimating a profit function. Firstly, because agricultural production is subject to significant amount of uncertainty, the duality results, which facilitate the attainment of a profit function, break down as the production function becomes specific as a stochastic function. Secondly, separating costs of technical and allocative inefficiencies (in terms of foregone profit) from a profit function is not always possible (Kumbhakar 1994). Thirdly, measures of farmer performance based on the profit maximization approach invariably lead to conclusions that small-scale farmers allocate resources inefficiently (Phiri 1991). In the fourth place, the difficulty in computing fixed costs together with the use of family labour which does not have cost attached, suggest that alternative approaches need to be used instead of profit per se for means of comparison (Phiri 1991).

Labour is the major factor of production in the traditional farming systems of West Africa and as such the utilisation and productivity of labour is a key element in increasing the agricultural output and incomes of small farmers. To the extent that there is underemployment of labour in agriculture, the potential exists for increasing output, employment and incomes (Spencer & Byerlee 1977).

Agricultural production, particularly in less developed countries, is widely regarded as risky. The production of subsistent crops in those economies largely accounts for economic inefficiency. When farmers produce subsistent crops, they may be prevented from reaching the efficiency frontier. This is because scarce inputs are

[17] In the profit function approach, economic efficiency can be defined as the ability of a firm to achieve potential maximum profit, given the level of fixed factors and prices faced by the firm.

often allocated to various uses on the basis of their marginal shadow values. Marginal shadow values and marginal value productivities can differ for each of the inputs so that inefficiency may result (Parikh et. al. 1995). Smallholder farmers attempting to manage the various forms of risks and uncertainties are often described as risk-averse (Sasmal 1993; Kumbhakar 2002). If smallholders are risk-averse, then their predominant goal is economic survival (designing of coping strategies), by which adequate stability of output and income, and the avoidance of major short-run losses, take precedence over profit-maximisation.

The importance of women farmers in the agriculture of developing countries is widely documented and yet the efficiency of women farmers in the agricultural sector in these economies is passively debated. An argument often used against female farmers is that they are less efficient than male farmers. However, most estimates of male-female differences in technical efficiency from production function studies show that male and female farmers are equally efficient farm managers in controlling levels of inputs and human capital (Bindish & Evenson 1993; Adesina & Djato 1997). Elsewhere, it has been shown that plots controlled by women have significantly lower yields than similar plots within the household, which were controlled by men (Udry 1994). A study by Chabayanzara (1994) shows that irrigation increases the demand for labour by increasing net cropped area. Mandel et al. (1995) note, however, that farm labour employment differs with farm size or farming system.

A number of empirical studies by Sasmal (1993) Saha (1994) Horowitz and Litchtenberg (1994) and Torkamani and Hardaker (1996) have also addressed the impact of farmer risk aversion on production practices. Studies that focused on tropical rice production by Brosen et. al. (1987) and Sasmal (1993) show that risk aversion is not an impediment to resource allocation, whereas works by Saha (1994) and Torkamani and Hardaker (1996) claim that it has an important effect on farmer decisions. If risk aversion is part of farmer decision-making process, it implies that farmers will have to design important coping strategies for the production risks and uncertainties that surround their agricultural activities.

This paper evaluates resource use efficiency with specific reference to smallholder rice farmers (irrigators, non-irrigators, male and female) and its implication for employment, using the Upper East Region of Ghana as a case study. Furthermore, the study aims to examine how rice farmers in the Region cope with production risks and their effect on productivity and employment. The rest of the paper is organized as follows: Section 2 looks at the data and selection of farmers. The empirical model is presented in Section 3 followed by the study results in Section 4. Section 5 contains the conclusions and recommendations.

2.0 Data and selection of farmers

Data were drawn from primary and secondary sources. In all, 440 farmers consisting of 220 irrigators and 220 non-irrigators were interviewed. The sample included 306 and 134 male and female farms, respectively. The data covered the gender and age of the farmer, family size, total number of years of schooling, off-farm work, extension service contact, access to credit and distance of farm from farmer's residence. Data on farm features including farm size, location, input and output totals, farming method, farming system, yield and use of agro-chemicals were collected. Further, data on production risks involving the type of risks, seasonality, source of risk and effects and coping strategies were also collected with the aim of measuring how farmers cope with these risks. The sample was stratified into two groups based on irrigation usage. Irrigating rice farmers were drawn from Bolgatanga, Bongo and Kassena-Nankana districts using the ratio of rice output for Tono and Vea during the 2001 dry season farming period. The specific communities visited were Chulchulga, Korania, Bui, Wuru, Bonia, Goore and Bongo. Sampling of non-irrigated rice farmers was based on production output of rice (paddy) in the Upper East Region by district during the 2000-farming season. A list of rice growing communities from which sampled communities were drawn was compiled from

MOFA, Bolgatanga. Sample sizes from various districts were allocated based on the contribution of the district to rice output for the period 1998 to 2001.

3.0 Empirical model

Economic theory postulates that an efficient use of an input requires the equation of the marginal value product of the input to its marginal factor cost. A farm is said to be price efficient if it maximizes profit by equating the value of the marginal product of each variable input to its price. Thus, the allocative efficiency index for a farm producing output j using input i can be shown as follows:

$MVP_i = P_j MPP_i = s_i k_i$ (1) $k_i = MVP_i / s_i$; (2) where MVP_i is the marginal value product of input i, MPP is the marginal physical product of the input, s_i is the price of input i, P_j is the output price and k_i is the allocative-efficiency parameter of the input i.

Following Olagoke (1991), Khandaker (1993), Onyenwaku (1994) and Byiringiro and Reardon (1996), this paper uses the marginal condition (marginal value product is equal to marginal factor cost) approach to measure allocative efficiency of the sampled farms. The equi-marginal condition approach is chosen because it is simple and straightforward, involving the direct estimation of resource use efficiency ratios from the following translog production function with respect to the variable inputs in the analysis:

$$\ln Y = \beta_0 + \beta_1 \ln Lb + \beta_2 \ln Ld + \beta_3 \ln A + \beta_4 \ln F + \beta_5 \ln C + \delta_1 (0.5 \ln Lb)^2 + \delta_2 (0.5 \ln Ld)^2 + \delta_3 (0.5 \ln A)^2 + \delta_4 (0.5 \ln F)^2 + \delta_5 (0.5 \ln C)^2 + \phi_1 \ln Lb * \ln Ld + \phi_2 \ln Lb * \ln A + \phi_3 \ln Lb * \ln F + \phi_4 \ln Lb * \ln C + \phi_5 \ln Ld * \ln A + \phi_6 \ln Ld * \ln F + \phi_7 \ln Ld * \ln C + \phi_8 \ln A * \ln F + \phi_9 \ln A * \ln C + \phi_{10} \ln F * \ln C + e, \quad (3)$$

where, ln = natural logarithm; Y = rice output (kg/ha); Lb = amount of labour (man-days/ha); Ld = land (farm size) in hectares; A = animal power expressed by bullock days per hectare; F = chemical fertilizer input in kg/ha; C = capital input in cedis (¢) per hectare. Capital input includes all cash expenditures for transporting and storing, fertilizer, seed, machine hire and irrigation facilities. βs are parameters of the linear terms, δs are parameters of the quadratic terms, and ϕs are parameters of the cross-product or interactive terms and *e* is a disturbance term.

The a priori signs of the parameters are as follows: $\beta_i > 0$; $\delta_j < 0$; and $\phi_m > 0$, where i = 1, 2,...,5; j = 1,2,...,5; and m = 1,2,...,10. The parameters of the transformed translog production frontier were estimated separately for each farm group (irrigators, non-irrigators, male, female). The factor elasticities (E) and marginal products (MP) were calculated from the OLS estimates of the translog production function with respect to each farm group using equation (3). Labour, bullock and fertilizer elasticities were obtained as follows:

Labour: $E = \frac{\partial \ln Y}{\partial \ln Lb} = \beta_1 + \delta_1 \ln Lb + \phi_1 \ln Ld + \phi_2 \ln A + \phi_3 \ln F + \phi_4 \ln C$ (4)

Bullock: $E = \frac{\partial \ln Y}{\partial \ln A} = \beta_3 + \delta_3 \ln A + \phi_2 \ln Lb + \phi_5 \ln Ld + \phi_8 \ln F + \phi_9 \ln C$ (5)

Fertilizer: $E = \frac{\partial \ln Y}{\partial \ln F} = \beta_4 + \delta_4 \ln F + \phi_3 \ln Lb + \phi_6 \ln Ld + \phi_8 \ln F + \phi_{10} \ln C$ (6)

where lnY, lnLb, lnLd, lnA, lnF and lnC are evaluated at their means. Equations (4) to (6) was employed for the computation of input elasticity for irrigators, non-irrigators, male and female farms. Finally, the marginal product for each input was computed using equation (7).

$$MP_{ij} = \left| \frac{\bar{Y_i}}{\bar{X_{ij}}} * (E_{ij}) \right. \quad (7)$$

where and represent arithmetic means (logs) of crop output of the ith farm group and the jth input for the jth farm group, respectively, and E_{ij} is the factor elasticity of the ith output of jth input. Using the above specifications as well as the output and input prices, the marginal value products (MVPs) and allocative efficiency ratios, R, were then derived using equation 8 as shown below:

$$MVP_i = MP_{ij} * P_y \quad (8)$$

$$R_i = \frac{MVP_{ij}}{P_x} \qquad (9)$$

where P_y and Px are respectively per unit price of output and price of the factor input (MFC). The decision rule is based on the value of R_i. If R_i is equal to one ($R_i = 1$), then the factor input is efficiently utilized (the farmers are allocative efficient). R_i value less than one ($R_i < 1$) implies over utilisation while that of more than one ($R_i > 1$) suggests underutilization of factor inputs.

To examine the impact of resource use by irrigators and non-irrigators on employment and productivity, total family and hired labour are considered separately and the following inverse Cobb-Douglas production function specification is used. The linear function is chosen because of its simplicity.

$$\ln Lb = b_o + b_1 \ln Y + b_2 \ln Wapr + b_3 DUM^F + b_4 DUM^G + e \qquad (10)$$

where, Lb = total labour used per hectare; Y = yield per hectare; Wapr = wage output price ratio; DUM^F = farming system dummy (1= non-irrigated, 0 = otherwise), DUM^G = a dummy for gender (1 = male; 0 = otherwise) and e = error term. Labour productivity, defined as value added per unit of labour (person-days) is also calculated for each farm group for purposes of comparison. To assess the significance of a difference between means, difference-between-means test is used.

Coping strategies are the rice farmers management activities or behaviour for absorbing the shocks from rice production risks. Questionnaires, observation and focus group discussions were used to elicit information on farmers' coping mechanisms to rice production risks. Responses on types of production risks and coping strategies to production risks are analyzed using frequencies and cross-tabulations.

4.0 Results

Ordinary least squares (OLS) estimates of the parameters in equation (3) for the pooled sample farms are presented in Table 1. The

R^2 is 0.99, which means that the explanatory variables used in the model were able to explain 99% of the variation in rice production for the sample farms in the Upper East Region. The various farming systems results are not presented. Their allocative efficiencies are, however, presented in Table 2.

Table 1: OLS estimates of pooled sample using translog production function

Variables	Parameters	Coefficients	t-statistic
Constant	β_0	1.049	2.587**
Ln Lb	β_1	1.752	3.193**
Ln Ld	β_2	0.775	9.335***
Ln A	β_3	1.883	10.477***
Ln F	β_4	0.557E-01	11.012***
Ln C	β_5	0.529E-01	9.878***
Ln Lb * Ln Lb	δ_1	-0.795	-2.145*
Ln Ld * Ln Ld	δ_2	-0.517	-4.448***
Ln A * Ln A	δ_3	-1.833	- 10.477***
Ln F * Ln F	δ_4	0.023E-01	5.307***
Ln C * Ln C	δ_5	-0.660E-04	-0.400
Ln Lb * Ln Ld	ϕ_1	-0.335E-03	-2.633**
Ln Lb * ln A	ϕ_2	-1.026	-22.043***
Ln Lb * Ln F	ϕ_3	0.266E-01	5.793***
Ln Lb* Ln	ϕ_4	-0.051	-9.373***
Ln Ld * Ln A	ϕ_5	0.949	77.852***
Ln Ld * Ln F	ϕ_6	-0.105	-26.876***
Ln Ld * Ln C	ϕ_7	-0.720E-03	-1.578
Ln A* Ln F	ϕ_8	0.284E-03	2.655**
Ln A * Ln C	ϕ_9	0.262E-01	5.671***
Ln F * Ln C	ϕ_{10}	-0.618E-03	-5.165***
R^2			0.99
N			440

Note: Mean of ln labour = 1.578, mean of ln land = 0.362, mean of ln Animal power = 0.259, mean of ln fertilizer = 2.274 and mean of ln capital = 2.466. ***, ** and * represent 1%, 5% and 10% level of significance, respectively. **Source:** Field survey, 2003.

Estimates of all the coefficients for the linear terms have the expected signs whilst the interactive terms for the variable inputs under consideration is mixed. The results signify that rice output in the study area is positively related to labour, land, animal power, fertilizer and capital. From Table 2, the allocative efficiency ratios for labour are above unity for irrigators, non-irrigators and female farmers whereas it is below unity for male farmers. The results show that irrigators, non-irrigators and female farmers under-utilised labour whereas male farmers over-utilised the same input.

Table 2: Marginal value products (MVPs), Marginal factor costs (MFCs) and Allocative Efficiency ratios (R) for various farm groups

Farm Group	Variable	MVP	MFC	R=MVP/MFC
Irrigators (N=199)	Labour	8,470.03	6,430.51	1.3
	Bullock	11,410.58	25,318.18	0.5
	Fertilizer	3,153.43	684.93	4.6
Non-irrigators (N=199)	Labour	8,451.6	7,118.00	1.2
	Bullock	32,743.26	45,000	0.7
	Fertilizer	2,443.13	1,551.27	1.6
Male (N=302)	Labour	4,715.80	7,014.21	0.7
	Bullock	45,289.48	74,600	0.6
	Fertilizer	1,386.65	1,252.53	1.1
Female (N=125)	Labour	19,643.91	7,531.31	2.6
	Bullock	113,604.99	67,857.41	1.7
	Fertilizer	24,726.60	1,324.60	18.7
Total Sample (N=439)	Labour	7,331.35	5,988.86	1.2
	Bullock	2,432.23	3,519.09	0.7
	Fertilizer	4,996.99	1,039.08	4.8

***Source:** Field survey, 2003.*

Allocative efficiency ratio of 0.1 for sample farms signifies that sample farmers under-utilised labour in the study area. We conclude that labour use by smallholder farms is inefficient. The figures in the table further reveal that female farmers under-utilised bullock power. Allocative ratios of 0.5, 0.7 and 0.6 respectively for irrigators, non-irrigators and male farmers also show that farmers over-utilised bullock power. The coefficient of bullock use being lower than unity for non-irrigators implies bullock under-utilisation. One plausible explanation for this finding is that during the land preparation stage, the price of animal power is very high. Since most of the non-irrigator farmers own animal power, they sell it to others to earn cash. However, the coefficient of bullock use being 0.7 for sample farms signifies that the input was over-utilised. The results of the focus group discussions showed that bullock was over-utilised because most of the farmers could not afford to pay for high tractor charges during the farming season. This finding supports MOFA's (1997) documentation that over 50% of farmers in the region rely on bullock services compared to only 8% who use tractor services.

The allocative efficiency ratio for fertilizer is above unity for farmer categories (Table 2) implying that sample farmers inefficiently utilize fertilizer. The allocative efficiency for males is 1.1 and almost unity. This shows that, except male farmers, the other sampled farmers inefficiently utilize fertilizer. Fertilizer under-utilization by female farmers might be due to their inability to purchase the input and the biasedness against women with regards to extension agents' contact with farmers about fertilizer use. Field observations indicate that 80% of the extension officers in the study area are men.

4.1. Farming system, Gender and Employment

In this section, we measure the extent to which different farming systems and gender of farmer contribute to employment in the study area using a simple regression linear model. The results are shown in Table 3. All the coefficients had the expected signs. The positive and significant coefficient of yield indicates that higher yield increases the demand for labour in rice farming in the study area. Higher yield increases labour demand in two ways. First, farmers use more labour input if they can foresee higher yield. Second, higher yield requires more labour for harvesting and threshing. The negative and significant coefficient of ratio of wage to producer price is consistent with the employment theory, in that as the wage rate increases relative to producer price, the demand for labour decreases and vice versa. Wage-price ratio has the expected sign for total labour, but it is not significant. The non-significance may be attributed to the use of family labour by both irrigators and non-irrigators, which does not necessarily follow employment theory or market conditions. Family labour constitutes about 65% of total labour in the study area.

Table 3: OLS estimates of employment parameters

Independent Variable	Labour	
	Hired (Man-day)	Total (Man-day)
Constant	-6.926 (-3.316)**	0.949 (1.235)
Yield (Kg)	10.677 4.154)***	0.802 (0.829)
Wage to price ratio	-8.820 -0.191 (-3.327)**	(-3.327)**
Farming System dummy (Non-irrigated)	0.222 5.175)***	0.305 0.049
Sex dummy (Male)	(0.412) (0.048)	0.049 (1.993)
R^2	0.234	0.381
F-ratio	29.687***	67.057***
Number of observations	392	440

Source: *Field survey, 2003. Figures in parentheses are t-statistics. ***, ** and * indicate level of significance (LOS) at 1, 5 and 10 percent level, respectively.*

In the case of both family and total labour, coefficients of non-irrigated rice farming systems are positive and significant, meaning that non-irrigators created more employment opportunities in the study area. One possible explanation to this finding is that average family size is large (16) for non-irrigators compared with irrigators (13) suggesting a greater source of employment for family members by non-irrigators. The finding is at variance with the conclusion of Chabayanzara (1994) that irrigating farmers employed more family and hired labour than non-irrigating farmers in Zimbabwe.

The coefficient of male farmers is positive but not significant implying that the amount of hired labour in the study area does not depend on the sex of the farmer. However, it is positive and significant in the case of total labour suggesting that male rice farmers create more employment opportunities than women in the case of total labour. This can be interpreted to mean that male farmers used more family labour than female farmers because the majority of the former were found to be household heads.

Estimates of mean labour productivity are presented in Table 4 below. Labour productivity for irrigators, non-irrigators, male and female farmers are 7.5, 2.5, 4.2 and 4.6 kg/ha respectively. Labour productivity for irrigators is significantly less than that achieved by non-irrigators at the 5 percent probability level, whereas mean labour productivity difference for male and female farmers is statistically insignificant.

Table 4: Labour productivity

Farm Group	Labour productivity		
	Mean output (kg/ha)	Mean labour (person-days)	Labour Productivity Kg/man-day
Irrigators	239	32	7.5
Non-irrigators	149	59	2.5
t-value	-	-	2.470**
Male farmers	208	49	4.2
Female farmers	184	40	4.6
t-value	-	-	0.144
Sample	194	46	4.2

Source: *Field survey data, 2003. ** is significant at 5 percent level*

4.2. Production Risks and Coping Mechanisms

This section discusses and presents findings on the types, nature and effects of production risks, and rice farmer coping strategies against production risks in the UER. Usually, sources of risk in agriculture are categorized into production and marketing. Producer ability to cope with any particular type of risk is very important in input allocation decisions, which in turn affect output supply. However, farmer ability to cope with any particular type of risk depends on the nature and intensity, as well as the frequency of occurrence of the risk. The emphasis here is on production risk because it directly affects the technical and allocative efficiencies of farms and is more pronounced in the Upper East Region than marketing risk.

Focus group discussions revealed erratic rainfall, crop disease, worms, bushfires, birds and grasshoppers as the six major kinds of production risks in rice farming. Farmers encounter more than one type of production risk in a particular cropping season. In terms of intensity, 52% of the respondents said they encounter the problem of birds followed by 13% who indicated that they face crop disease problems annually. Seven percent said they face the risk of poor rainfall and grasshopper invasion whereas 5% said they face worm invasion annually. Only 2% of the responses reported that bushfires occur yearly.

The effects of the above mentioned production risks on rice production and how farmers react to these risks are presented in Table 5. The table shows that in the short run, production risks cause low output, poor rice quality, and lower chances of borrowing from external sources. For example, on the impact of erratic rainfall on rice cultivation, a farmer from Chaania remarked as follows: "*We are not given loans because those who are supposed to give us the loans say rainfall is not reliable*". Thus, production risks make rice output unpredictable, hence the volatility in farmers' incomes. In the long run, production risks discourage increased investment in large-scale rice farming.

Table 5: Effects of production risks and farmers' coping strategies

Production Risk	Nature	Effect	Coping strategies
Erratic rainfall	Poor rainfall pattern. The rains either set in too late or stop very early. This type of risk is characterized by flood or drought.	- Soil erosion - Low output - Low yield - Poor rice quality - Reduces farmers' chances of borrowing from banks - Disincentive to production	- Bunding - Formation of farmers' groups - Borrow food or money from relatives - Sale of livestock and small ruminants
Crop disease	Crop disease retards rice growth and maturity rates and is caused mostly by insects and other living organisms	- Low rice output - Low quality of rice -Retards rice growth and maturity - Disincentive to production	- Use of agro-chemicals - Report to MOFA
Worms, grass-hoppers	Living organisms that attack rice on the ground	- Destroy rice seeds/ seedlings - Poor yield	- Use of agro-chemicals - Use of ash to spray farms - Report to MOFA
Bushfires	Wild or uncontrolled fires that destroy rice farms	- Low output - Reduces soil fertility - Confusion and mistrust among community members	- Monitoring farms constantly - Creation of farm belts - Early harvest - Report to community opinion leaders
Birds	Flying creatures that destroy rice plants or grains	- Destroy seeds after planting - Suck rice fluid during maturation - Low output - Time consuming	- Early planting - Early harvest - Employ children to drive away birds - Use of scare crows

***Source:** Field survey, 2003*

[18] This may include the Chief, the Assemblyperson, Youth leader, Farmers' group executives and religious leaders (Imams and pastors).

Formation of farmer groups or associations, borrowing from relatives, sale of livestock, especially small ruminants, use of agro-chemicals, use of scarecrows and constant monitoring of farms among others, are the coping strategies for production risks. Production risks such as crop diseases and problems of worms and insects that require special skills are usually reported to MOFA for assistance or advice. However, in situations where farmers feel helpless, they throw up their hands in despair and allow those risks to take their fair share of the crop.

5.0 Conclusion

Smallholder rice farmers in the Upper East Region are generally inefficient in the allocation of labour, bullock and fertilizer. Except male farmers, in the application of fertiliser, farmer categories appeared allocatively inefficient in the use of all variable inputs. Labour and fertilizer inputs are underutilized whereas bullock was overutilised by sampled farmers. A possible explanation to this is the abundance of family labour for rice cultivation and also low farmer educational level that might prevent them from applying the right quantities of fertilizer at the right time. Bullock overuse can be attributed to the sale of bullock services by the owners during land preparation period in order to earn extra income. This finding agrees with the results of Mandel et. al. (1995) and Adesina and Djato (1996) that small-scale farmers are inefficient in the allocation of resources.

Employment generation differed across farmer groups. Non-irrigators created more job opportunities in the study area than did irrigators whereas male farmers employed more total labour (family and hired labour) than female farmers. However, labour productivity analysis shows a higher productivity index for irrigators compared to non-irrigators. Labour productivity is similar for male and female farmers.

Rice production in the region is threatened by various rice production risks and small holder farmers have developed coping mechanisms or strategies in order to reduce the negative impact of rice production risks. Rice farmers also draw upon the services of MOFA for coping with rice production risks such as crop diseases and problems of worms and insects, which appear to require special skills and sometimes, large amounts of capital.

6.0 Recommendations

Rice farms in the Upper East Region are allocatively inefficient and as such a more accelerated programme to provide education is needed. The education programmes should include both formal and non-formal elements. This is important for the improvement of farmer ability to retrieve and process information regarding modern agricultural technology. There is also the need to develop effective farmer-centered technical training programmes in order to build the capacities of small-scale farmers in areas such as resource mobilization, resource use (allocation) and how to operate and maintain irrigation facilities. Extension agents should intensify farmer education with regards to input use. Extension contact with farmers in the study area is mostly supply-driven. This means that in order to improve farmer allocation and employment skills, contacts should be based on farmer needs. Also, given the limited number of trained extension personnel and the relatively high proportion of males in the extension service, the need to recruit more female agents to work with women farmers is urgent.

Field observations indicate the need to pay attention to the negative impact of production risks on rice farming. One such risk is erratic rainfall, which can be addressed with irrigation. Besides, irrigation farmers are able to achieve higher levels of technical efficiency. Therefore, major irrigation projects in the Upper East Region (Tono and Vea) which are medium-sized irrigation projects should be improved upon by way of providing irrigation facilities such as pumping machines, construction of water canals, among others. Small irrigation projects such as the Binaba Irrigation Project should be revamped by repairing the defunct pumping machine. New irrigation projects should also be constructed in rice growing potential areas (e.g., around the Fumbisi and Basiyonde Valleys). In order to derive the full benefits of irrigation and maintain project sustainability, the expansion of small holder irrigation should emphasize community-managed small holder irrigation schemes (Chabayanzara 1994).

Research is needed in the areas of reducing rice production risks. In particular, such efforts should aim at developing fast-maturing and high-yielding rice varieties that are drought resistant. More importantly, attention should be paid to the development of rural infrastructure because the benefits obtainable from the provision of credit and investments in education and agricultural extension may be limited if the complementary investments in infrastructure are not made. There is also the need to shift part of the rice production risks to the public sector. This may require the establishment of institutions of crop insurance, disaster payments and emergency loans to farmers.

Employment-related policies should not be biased towards irrigators and male farmers because non-irrigators and female farmers are equally important in creating job opportunities. Thus, research efforts should not neglect those groups. The right kind, quantity and timely provision of credit must be emphasized. This is because mere increase of credit or other variable inputs to smallholders might not bring desirable results. Credit support to farmers could be achieved by way of improving rural banking and credit support systems. It is also important for the government to collaborate with non-governmental organizations operating in those areas with the aim of alleviating poverty. Participatory approaches involving all stakeholders should be applied in the design and implementation of credit schemes to rice farmers. This may require a thorough beneficiary needs assessment (BNA) prior to the disbursement of credit.

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