International Journal of Natural and Social Sciences
ISSN: 2313-4461

Profitability and technical efficiency of Boro rice (BRRI dhan29) cultivation in Dinajpur and Bogra of Bangladesh

Kazi Tamim Rahman[1], Md. Rafiul Bari[2], M Kamruzzaman[3]

[1]Department of Agricultural Economics, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur-1706, Bangladesh
[2]Irrigation Extension Officer, Bangladesh Water Development Board, Dhaka, Bangladesh
[3]Department of Agricultural Economics, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur-1706, Bangladesh

ARTICLE INFO

Article history

Accepted 03 May 2016
Online release 11 May 2016

Keyword

Profitability
Technical efficiency
Rice (BRRI dhan29)
Bogra, Dinajpur

***Corresponding Author**

KT Rahman
✉ tamim104@yahoo.com

ABSTRACT

The focus of the study was to estimate the profitability and technical efficiency of BRRI dhan29 rice in the northern part of Bangladesh. Primary data were collected from 60 farmers comprising Dinajpur (30 farmers) and Bogra (30 farmers) districts using a structured interview schedule in the year of 2010. Descriptive and inferential statistics as well as Cobb Douglas production function were used to analyze the data. Descriptive study revealed that the rice farmers in the areas are male of about 30-50 years aged, having medium-scale farm size and no higher education. The socioeconomic conditions of the rice growers were not so much impressive in the study areas. Considering all farms, total costs were BDT 63048 ha-1 and BDT 67352 ha-1 in Dinajpur and Bogra districts, respectively. The yield of rice was found higher in Dinajpur compare to Bogra. Therefore, gross return from Dinajpur was much higher (BDT 80069 ha-1) than that of Bogra (BDT 74032 ha-1). Benefit cost ratio of rice implying that rice (BRRI dhan29) cultivation in Dinajpur region was more profitable than Bogra region. The empirical results indicated that the coefficients of human labor, seed cost, MP, gypsum, and irrigation cost were positive and significant which implied that an increase in the magnitudes of these variables would result the positive impacts on rice production in Dinajpur region. On the other hand, some coefficients were positive (human labor, seed, and urea) and some were negative (land preparation, and gypsum), but both had significant effect on the yield of rice in Bogra region.

INTRODUCTION

Bangladesh has made remarkable progress in food production and achieving its food security. Since independence in 1971, production and consumption of food grains grew substantially over time. Even though, there were ups and downs, production of food grains generally experienced an upward trend. An all time high production of food grains (32.16 million tons) was attained in Fiscal Year (FY) 2007-08 which was more than three times of production in FY1972-73 (9.99 million tons). At present, agriculture as a whole accounts for 21% of Gross Domestic Product (GDP), 32% of export earnings and 48% of labor employment (BER, 2009). Although the contribution of agriculture sector to GDP has gradually been declining in recent years but still it is playing a major role in the economy of Bangladesh. About 62.3% of the total national labor forces are employed by the agricultural sector and about 80% people are indirectly involved with this sector (BBS, 2010).

Rice is the most strategic commodity in Bangladesh accounting for 70% calorie intake and about 35% of household expenditure. Rice plays a significant role in the overall economy of

How to cite this article: Rahman KT, Bari MR and Kamruzzaman M (2016). Profitability and technical efficiency of Boro rice (BRRI dhan29) cultivation in Dinajpur and Bogra of Bangladesh. International Journal of Natural and Social Sciences, 3(2): 04-11.

Bangladesh. It is the main cereal crop as well as the staple food in Bangladesh. It is the most important cereal crop which occupies about 75.03% of the total cropped area in Bangladesh and 82.04% of the total irrigated land is under this crop (BBS, 2010). About 72% of the total production of agriculture sector comes alone from rice. Bangladesh possesses fourth position among the rice producing countries in the world after China, India and Indonesia. In the past, the country was largely dependent on importation of food grains with its deficit production. This was due to the pressure of increasing population. However, now-a-days the population growth rate (1.24%) runs behind the growth rate of food grains which was found to increase at the rate of 15.66% during last decade (BER, 2009). Due to the introduction of sustainable seed-fertilizer-irrigation technologies in agriculture of Bangladesh, food grains production has almost been triple since independence.

Bangladesh has a subtropical monsoon climate which may be described as unstable and unpredictable. There are six seasons in a year of which three namely winter, summer, and monsoon are prominent. Rice is grown in three seasons namely Aus, Aman and Boro in Bangladesh. Among these three seasons of rice, Boro rice is dominant for its higher production capability and its important role in gaining self-sufficiency in food grain. BRRI dhan29 is the most popular variety cultivated in Boro season in Bangladesh. Several studies have been done about rice production in the normal topography including cost, return, profitability and technical efficiency analysis of rice cultivation but no specific studies were done in the Northern part of Bangladesh for BRRI dhan29. Mustafi and Azad (2009) estimated the comparative profitability of BRRI dhan28 and BRRI dhan29 where the average yields of BRRI dhan28 and BRRI dhan29 were 5980 and 6670 Kg per hectare, respectively. The author also found that BRRI dhan29 appeared to be more profitable compared to BRRI dhan28. However, the dimensions of structural changes occured in cost and returns of HYV (High Yielding Variety) Boro paddy over time in Bangladesh (Jahan and Jaim, 2002). It is reported that the growth parameters of HYV Boro were significantly different in early nineties and late nineties but in case of HYV Aman growth parameters were not significantly different between the sub periods of nineties (Khan and Mustafi, 2002).

Bangladesh is a densely populated country having small land, high unemployment rate and no scope of increasing rice cultivation area. It is more important to increase the yield per unit area in order to meet the growing need for food security. The importance of agriculture, specially the crop sector, to the economy needs no emphasizing. The crop sector, representing mainly rice and wheat, adds about 76% value to agriculture (BER, 2009). Therefore, the government started looking for higher technology for augmenting rice production and it was about that time, IRRI, in the Philippines developed HYV of rice varieties. After that, different types of HYVs have been developed BRRI dhan29 in Boro season is one of the most important popular high yielding varieties in Bangladesh. The rate of expansion of BRRI dhan29 in Boro season (hectares and production) depends on the profitability of its production. In this regard, the structure of costs and returns of BRRI dhan29 cultivation is more important for investigation. Keeping this idea in mind, this study has been undertaken to get a deep insight into the profitability and technical efficiency of Boro rice (BRRI dhan29) cultivation. Hence, the findings of the study would help the planners and policy makers in making rational production plan and the researchers to conduct further research on rice cultivation in future.

MATERIAL AND METHODS

Selection of the study area

In order to select the study area, at first the areas where rice is extensively grown was explored from secondary sources. Dinajpur and Bogra were selected as study areas where rice (BRRI dhan29) is extensively grown. Kashil and Bathuli villages of Shajahanpur Upazila of Bogra district and Dhakhin Kotoali and Keoatkhali villages of Dinajpur Sadar Upazilla of Dinajpur district were selected as the study areas based on the following characters: i) There were large numbers of Boro rice (BRRI dhan29) growers in the area, ii) The area had relatively homogenous soil type and topographical condition, iii) No study of this type

was done previously in that area, and iv) Researcher was familiar with the language and socio-economic characteristics of the villagers and easy accessibility and communication facilities.

Samples and sampling technique

Considering time, availability of fund and manpower, a limited number of farmers were selected randomly. For sampling, at first a list of rice (BRRI dhan29) growers in a village was prepared and from the list 15 farmers per village were randomly selected. Thus, 60 farmers were selected from the four villages. Profitability of any enterprise varies due to managerial capacities of different farmers. Therefore, farmers were classified into three groups, such as, i) small (below 1 hectare), ii) medium (having 1.01 to 3 hectares), and iii) large (above 3 hectares) of cultivable land. In total, 60 farmers were randomly selected from Dinajpur and Bogra region for the study in which 11 were small, 13 were medium and 6 were large from Dinajpur district, whereas 10 were small, 16 were medium and 4 were large from Bogra district. Data were collected for the year of 2010.

Analytical technique

Profitability Assessment

As most farms try to receive maximum profit in a perfectly competitive situation, conditions responsible for maximum profit were given emphasis in the present study. Profit or net return is the difference between total revenue (gross return) i.e. total value product (TVP) and the total factor cost (TFC). Total factor costs included all kinds of variable and fixed costs concerned with the production process. A farm will not know its maximum profit unless the TVP is compared with TFC. Farmer's profit was also shown by gross margin (GM) analysis, where only variable costs were deducted from total revenue.

The TVP was the value of output and was given by

$TVP = py = p*TPP = g(y)*[f(x_i)]*f(x_i)$ ……..(1)

Where, P is the price of output; y is the quantity of output and x_i stands for ith input. On the other hand, total factor cost (TFC) of a product includes all kinds of variable and fixed cost items involved in the production process; and was given by

$TFC = rx_i + b = h(x_i)*x_i + b$ ……..(2)

Where, r is the factor price, which in general is a function of the quantity of the factor used [i.e. $r = h(x_i)$] and b is the fixed costs. Given the definition of total value product (TVP) and total factor cost, the profit equation can be defined as follows:

$Profit, \pi = TVP - TFC$ ……..(3)

The analytical procedures involves the arrangement of the collected data in systematic ways, consisting of the input used, quantifying the effect of inputs on yield, etc. the following analytical procedures were followed in the present study.

Gross margin analysis

The performance of rice production was compared on the basis of gross margin. Gross margin is difference between gross return or total return and total variable cost. Reason to choose this analysis is that the farmers of Bangladesh are very eager to know their return over total variable cost. This calculated as follows:

$GM = GR - TVC$ ……..(4)

Where, GM= Gross margin (BDT), GR= Gross return (BDT), TVC= Total variable cost (BDT)

Net return analysis

The performance of rice production was compared on the basis of net return. Net return is difference between gross return or total return and the total cost that means combination of variable cost and fixed cost. This is calculated as follows:

$NR = GR - TVC - TFC$ ……..(5)

Where, NR= Net return (BDT), GR= Gross return (BDT), TVC= Total variable cost (BDT), TFC= Total fixed cost (BDT)

Efficiency analysis

Cobb-Douglas stochastic production frontier model was used to measure technical efficiency, and inefficiency of resources. The approach specifies the relationship between output and input levels using two error terms. One error term is the traditional normal error term with a mean zero and constant variance. The other error term represents

the technical inefficiency which is subsequently estimated via Maximum Likelihood Estimation method (MLE) (Aigner, Lovell and Schmidt 1977, Rahji, 2005).

$Y=F(Xai\ \beta)e^{E}$ ……(6)

Where, Y = Gross returns from BRRI dhan29 rice cultivation (BDT ha^{-1}), Xa = is a vector of input quantities, β = is a vector of parameter and E is a stochastic disturbance term consisting of two independent elements u and v where E = u + v

Rice output function is linearized by transforming logarithmic (Double log) form:

$Ln\ Yi = ß_0 + ß_1\ lnX_1 + ß_2\ lnX_2 + ß_3\ lnX_3 + ß_4\ lnX_4 + ß_5\ lnX_5 + ß_6 lnX_6 + ß_7\ lnX_7 + ß_8\ lnX_8 + ß_9\ ln\ X_9 + Vi - UI$ ……(7)

Where, Y= Gross returns from BRRI dhan29 rice cultivation (TK/ha), $ß_0$= constant or intercept value X_1= Cost of Pesticide (Tk./ha), X_2= Cost of MoP (Tk./ha), X_3= Cost of TSP (Tk./ha), X_4= Cost of Urea (Tk./ha), X_5= Cost of Seed (Tk./ha), X_6 = Total family labor cost (Tk./ha), X_7 = Total hired labor cost (Tk./ha), X_8= Irrigation cost (Tk./ha), X_9= Mechanical power cost (Tk./ha), Ln= Natural logarithm, $ß_1$… $ß_9$ = Coefficients of the respective explanatory variables to be estimated. Vi= random error due to misspecification of the model and variation in output due to exogenous factors outside the farmer's control. Ui = inefficiency component of the error term.

The Ui's were non negative random variables, assumed to be independently distributed such that the technical inefficiency for the ith farmer, ui were obtained by truncation of normal distribution with mean zero and variance σ^2 such that

$U\ i = \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i}$....(8)

Where, Z_{1i} =Ln operated land of the i-th farm operator (ha), Z_{2i} =Farming experience of the i-th farm operator (year), Z_{3i} =Farmers education of the i-th farm operator, $Z_{4\ I}$ = Family size of the i-th farm operator δ_0, δ_1…… δ_4 = parameters to be estimated.

Since the dependent variable of the inefficiency model represents the mode of inefficiency, a positive sign of an estimated parameter implies that the associated variable has a negative effect on efficiency but positive effect on inefficiency and vice versa. The econometric computer software package FRONTIER 4.1 was applied to estimate the parameters of stochastic frontier models using the MLE method.

RESULTS AND DISCUSSION

Socio-Economic characteristics of the farmers

Family size includes wife, sons, unmarried daughters, parents, brothers etc. The permanent hired labor was not included as a member of the family. The study revealed that the average family size was estimated at 5.6 persons and 5.5 persons for Dinajpur and Bogra districts respectively.

The age of the respondents ranged from 25 to 60 years. Based on age, the farmers were classified into three categories such as, young aged, middle aged and old aged categories. Most of the farmers were middle aged followed by old and young aged people in the region of Dinajpur and Bogra districts. These young to middle aged people had great potentials to uplift their livelihood-status. If they were trained, motivated and guided properly, they would be able to fight against poverty by creating self employment opportunity.

Education plays an important role in facilitating modernization of farm business activities. Education was defined as the ability of an individual to read and write, or formal education received up to a certain standard. The results revealed that 23% and 37% rice farm's owner were illiterate in Dinajpur and Bogra districts respectively. In the case of primary education, 30% and 47% of the respondent were primary educated each of Dinajpur and Bogra regions. At a glance, most of the respondents were primary educated in both Dinajpur and Bogra regions.

Agriculture was the main occupation of the farmers in the study areas. Results revealed that 57% farmers of Dinajpur district were involved in agriculture, whereas in Bogra district 77% farmers were in agriculture. Accordingly, 13% and 10% farmers were related with business and 13% and 30% were related with other activities in two districts respectively.

Farm size is the amount of land which is operated by a farmer. It is computed by adding the area of

land owned, rented in and mortgaged in from others and subtracting the area rented out and mortgaged out to others. It was found that 52%, 45% and 60% farmers were belong to small, medium, and large size in Dinajpur region, whereas 48%, 55% and 40% were small, medium and large in Bogra region, respectively. Therefore, in 60 farmers most of the medium and small farmers were more interested to grow BRRI dhan29 in both regions.

Economic profitability of BRRI dhan29 cultivation

Profitability is one of the major criterions for determination of acceptance of a crop. For the calculation of total cost of production both fixed and variable costs were considered in this analysis. Family supplied human labor and land rent costs were considered as fixed costs. A perusal of table revealed that the total variable costs were calculated as BDT 42274 ha^{-1} and BDT 42727 ha^{-1} for Dinajpur and Bogra respectively. This constituted about 66% of total cost. The highest total cost of production was incurred by the farmers at Bogra (BDT 67352 ha^{-1}) compared to Dinajpur (BDT 63048 ha^{-1}). The fixed costs were constituted about 28% of total cost.

Return was calculated by multiplying yield with its price per kilogram. Return per hectare of BRRI dhan29 cultivation was shown in Table 1. Average gross return was calculated as BDT 80069 ha^{-1} for Dinajpur and BDT 74032 ha^{-1} for Bogra. The average price of BRRI dhan29 in Dinajpur and Bogra region was found to be BDT 14.5 and BDT 14 per kilogram as well as average yield was 5.52 ton ha^{-1} and 5.28 ton ha^{-1}, respectively. Result showed that Dinajpur rice producer got higher production as well as higher price compare to Bogra farmers.

Gross margin was estimated as the difference gross return and total variable cost. Table 1 showed that, considering all farms, gross margin form rice cultivation was BDT 3634 and BDT 3949 ha^{-1} for Dinajpur and Bogra, respectively. Accordingly, per hectare net return of rice cultivation for two districts were BDT 14049 and BDT 8054 ha^{-1} respectively which indicates that net return were much higher in Dinajpur districts than Bogra district farmers. The differences incurred from the process of production costs. It was observed that overall BCR was 1.21 and 1.13 in two locations. Between the locations, the BCR was higher in Dinajpur farmers (1.21) compared to Bogra (1.13) rice farmers. This indicated that farmers at Dinajpur earned comparatively higher gross return from rice cultivation compared to Bogra.

Estimation of technical efficiency of rice cultivation

For producing BRRI dhan29 different types of variables were employed by the farmers. Estimated values of co-efficient and related statistics of Cobb-Douglas production function are presented in the table. Nine major variables were taken into consideration in the production functions for BRRI dhan29 in Boro season (Table 2 and 3). The positive and negative signs imply that selected inputs contributed positively and negatively.

Table 1
Economic profitability of rice cultivation.

Location (District)	Yield (Kg ha^{-1})	Total cost (BDT ha^{-1})	Gross return (BDT ha^{-1})	Gross margin (BDT ha^{-1})	Net return (BDT ha^{-1})	BCR
Dinajpur	5522	63048	80069	36342	14091	1.21
Bogra	5288	67352	74032	32949	8054	1.13

Source: Field survey, 2010

Table 2
Maximum Likelihood Stochastic Cobb-Douglas frontier production function and technical inefficiency model for Dinajpur District.

Independent variables	Parameters	Co-efficient	Standard error	t-ratio
Stochastic frontier:				
Constant	β_0	0.918	0.208	4.41
Human labor (X_1)	β_1	0.619**	0.300	2.06
Land preparation (X_2)	β_2	-0.815	0.785	-1.03
Seed (X_3)	β_3	0.787***	0.271	2.90
Urea (X_4)	β_4	0.727*	0.415	1.75
TSP (X_5)	β_5	-0.423	0.847	-0.49
MoP (X_6)	β_6	0.323	0.871	0.36
Gypsum (X_7)	β_7	0.496*	0.301	1.64
Manure (X_8)	β_8	0.738	0.990	0.73
Pesticides (X_9)	β_9	0.176	0.300	0.56
Irrigation (X_{10})	β_{10}	0.810**	0.335	2.45
Technical inefficiency model:				
Constant	δ_0	0.342	0.126	2.69
Farmers Age(Z_1)	δ_1	-0.900**	0.360	-2.50
Farmers education (Z_2)	δ_2	-0.195	0.418	-0.47
Family size (Z_3)	δ_3	0.132	0.477	0.27
Farm Size(Z_4)	δ_4	0.176	0.559	0.31
Variance parameters:				
Sigma-squared	σ^2	0.005***	0.002	2.5
Gamma	γ	0.711***	0.194	3.67
Log likelihood function			56.2	

***, ** and * indicate significant at 1%, 5% and 10% level of probability, respectively
Source: Field survey, 2010

The Maximum Likelihood Stochastic Cobb-Douglas frontier production function and technical inefficiency model for Dinajpur district is presented in the Table 2. The empirical results indicated that the coefficients of human labor, seed, urea, gypsum, and irrigation were positive and significant which implied that an increase in the magnitude if these variables would result the positive impacts on rice production in Dinajpur district. In order to quantify determinants of technical inefficiency in rice production socio-economic or managerial variables, viz. farmer's age, educational level, family size and farm size were included in the inefficiency effect model. Similarly, the production function and technical inefficiency model for Bogra district is presented in the Table 3. Results revealed that the coefficients of human labor, seed, and urea were positive and significant, but gypsum and irrigation were insignificant whereas these were significant for the location of Dinajpur district. At the same time, technical inefficiency in rice production was also estimated considering the variables of farmer's age, educational level, family size and farm size.

Table 3
Maximum Likelihood Stochastic Cobb-Douglas frontier production function and technical inefficiency model for Bogra District.

Independent variables	Parameters	Co-efficient	Standard error	t-ratio
Stochastic frontier:				
Constant	β_0	1.316	0.966	1.36
Human labor (X_1)	β_1	0.271**	0.120	2.25
Land preparation (X_2)	β_2	-0.334**	0.142	-2.35
Seed (X_3)	β_3	0.374**	0.174	2.14
Urea (X_4)	β_4	0.584***	0.187	3.12
TSP (X_5)	β_5	0.118	0.923	1.27
MoP (X_6)	β_6	-0.725	0.998	-0.72
Gypsum (X_7)	β_7	-0.815***	0.224	-3.63
Manure (X_8)	β_8	0.216	0.377	0.57
Pesticides (X_9)	β_9	0.108	0.281	0.38
Irrigation (X_{10})	β_{10}	0.221	0.990	0.22
Technical inefficiency model:				
Constant	δ_0	-0.238	0.141	1.68
Farmers Age(Z_1)	δ_1	0.230	0.176	1.30
Farmers education (Z_2)	δ_2	0.293	0.575	0.50
Family size (Z_3)	δ_3	-0.220**	0.105	-2.09
Farm Size(Z_4)	δ_4	0.024	0.021	1.14
Variance parameters:				
Sigma-squared	σ^2	0.005***	0.002	2.5
Gamma	γ	0.999***	0.260	3.84
Log likelihood function			53.82	

***, ** and * indicate significant at 1%, 5% and 10% level of probability, respectively
Source: Field survey, 2010

Table 4
Technical efficiency of rice producers.

Location	No. of farmers	Technical efficiency		
		Mean	Maximum	Minimum
Dinajpur	30	0.87	0.98	0.80
Bogra	30	0.83	0.88	0.76

Source: Field survey, 2010

Technical efficiency and its distribution

The mean value of technical efficiency among the farmer of Dinajpur and Bogra districts was 0.87 and 0.83 respectively. This implied that, on average rice producers in the study areas were producing rice about 87 and 83% of the potential (stochastic) frontier production levels, given the levels of their inputs and the technology currently being used. This also indicated that there existed an average level of technical inefficiency of 13 and 17% for Dinajpur and Bogra districts

respectively. Finally, It can be concluded that the rice producers of Dinajpur district were more efficient in resource usages in compare with the producers of Bogra district (Table 4).

CONCLUSION AND RECOMMENDATION

The present study revealed that Boro rice cultivation in the northern areas is profitable. As the Dinajpur and Bogra districts are suitable for rice cultivation so those areas may be made more productive to increase their contribution to the national rice production by taking appropriate steps. On the basis of the major findings of the study the following recommendations may be cited to improve the technical efficiency and profit.

- Literacy level of the farmers should be improved which will help the farmers to become more efficient in rice cultivation. As a result farm productivity will be increased.
- To increasing the profitability of Boro rice, the easy availability of all necessary inputs like seed, fertilizer and insecticides should be ensured with low price.
- To minimize the irrigation cost, electricity may be supplied with subsidy to reduce the dependency on high cost of diesel.
- Most of the farmers used own seed and market seeds, as a result farmer's plant seeds at higher rate than recommended. Supply of quality seeds to the farmers should be ensured by strengthening seed production and distribution system both in public and private sectors.
- Most of the farmers used imbalanced dose of fertilizer and insecticides in their plot. Excess or insufficiency of an element reduces the effectiveness of the other elements and consequently reduces the yield. Therefore, farmers should be encouraged to use balanced dose fertilizers and allocate their resources optimally and timely for increasing rice yield by maintaining soil health. Farmers should be given short-term training on proper applications of inputs. It will help to increase the resource use efficiency of the farmers in Boro rice cultivation.
- Lower price of rice was observed at the harvesting period in the study areas. Reasonable steady market price of rice should be ensured by the concerned authority at the harvesting period so that the rice growers would get their expected return from rice.

REFERENCES

Aigner DJ, Lovell CAK and Schmidt P (1977). Formulation and Estimation of Stochastic Frontier Function Models. Journal of Econometrics, 6: 21-27.

BBS (2010). Statistical Yearbook of Bangladesh. Bangladesh Bureau of Statistics. Statistical Division, Ministry of Planning, Government of the people's republic of Bangladesh.

BER (2009). Bangladesh Economic Review. Department of Finance, Ministry of Finance, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh.

Jahan and Jaim WMH (2002). Dimensions of Structural Changes in cost and return of HYV Boro paddy over time in Bangladesh and Determinations of the change. The Bangladesh Journal of Agricultural Economics, Vol.25, No.1.

Khan M and Mustafi BAA (2002). Production and Yield of Boro and Aman Rice: Growth and Trend Analysis. Pakistan Journal of Biological Science, 5(4): 502-505.

Mustafi BAA and Azad MAS (2009). Adoption of Modern Rice Varieties in Bangladesh. Agricultural Economics Division, Bangladesh Rice Research institute, Gazipur, Bangladesh.

Rahji MAY (2005). Determinant of efficiency differentials in lowland rice production systems in Niger State, Nigeria. Ibadan Journal of Agricultural Research, 1(1): 7-17.