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RESOURCE USE EFFICIENCY IN SMALLHOLDER BULRUSH MILLET PRODUCTION IN NAROK DISTRICT, KENYA

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Abstract

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The main objective of the study was to establish the efficiency of resource use in bulrush millet production among smallholder farmers in Narok district, Kenya. A multi-stage stratified random sampling procedure was employed in selecting farmers interviewed. A structured questionnaire was administered to 300 smallholder farmers selected. For analysis, the farmers were sub-divided into two groups based on ownership and use of draft animals (oxen) on farm. The Yotopoulus and Lau non-frontier model was used to evaluate efficiency of the two groups of bulrush millet farmers. In the model, a Cobb-Douglas production function was fitted to the cross-sectional data generated from the survey. The ratio of marginal value product (MVP) to marginal factor cost (MFC) for all inputs was found to be greater than unity among all groups of farmers implying under-utilization of resources. Bulrush millet farmers were found to experience increasing returns to scale meaning use of additional inputs in bulrush millet production would result in higher yields. The null hypothesis, which stated that smallholder farmers in Narok district are not allocating their farm resources efficiently in millet production, was tested and rejected at 5% level of significance. It was therefore concluded that bulrush millet farmers in Narok district were sub-optimally allocating resources in their production system.

Key words: Non-frontier model, efficiency, bulrush millet, Kenya

Introduction

With a population of 40 million, growing at the rate of 2.8% per annum, the demand for food has been rapidly increasing in the country. To meet this rapidly growing demand there is need for increased food production in the country based on regional comparative advantage. In the earlier years and up to the early part of 1970s, millets played a major role in the diets of many Kenyans especially in the western parts of the country. However, by the end of the decade their role had decreased giving way to maize as the main staple grain (Heyer et al., 1976). Despite this major shift in tastes and preferences favoring maize in places of millet, most small-scale farmers in Narok district have continued to produce millet either in pure stands or in an intercrop with maize and other crops. It is estimated that farmers in the district devote about 40% of their land to millet (Wanyama et al., 1995). The ability of millet to thrive in adverse environmental

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conditions makes it a dependable crop to farmers facing unreliable weather conditions (ICRISAT, 1990). This characteristic of the crop has endeared it to the hearts of many farmers in Narok district.

The production of millet in Kenya has been more or less stagnant throughout the 1980s and up to the mid-1990s. Recently the production has taken a declining trend, recording a production of 76, 000 tons in 1996/97 crop year (Odhiambo, 1997). In Narok district, millet production has been on the decline too, not only in terms of total output but also in terms of yields per hectare. Recorded production declined from 7.806 tons in 1991 to 3.306 tons in 2005. Yields per hectare have also declined from 1.61 tons to 1.01tons in 2005 (GOK, 2007a). This backward trend in the production of this cereal crop despite its' vital role in food security among most people in this area is of great concern to planners and policy makers in the district. What therefore ails the production system of millet in the Kenya? Are farmers' allocaticating their resources efficiently in millet production? The specific objective of this study was to analyze the efficiency of bulrush millet production in the district. It was hypothesized that smallholder farmers in Narok district are allocating their farm resources efficiently in millet production.

H_O:

$$MVP_{X_i} = MFC_{X_i} \text{ or the opportunity cost of } X_i \quad (1)$$

$$MVP_{X_i} \neq MFC_{X_i} \quad (2)$$

Materials and Methods

Types and Sources of Data

The study used both primary and secondary data. Primary data was obtained from a farm survey of smallholder farmers in Narok district. The survey covered a sample of 300 small-scale farmers within the district. A structured questionnaire was used to extract information from the respondents. Secondary data were used particularly where time series data was obtained from past research works and government reports.

Sampling Procedure

Multi-stage stratified random sampling procedure was used in selecting the study zones. All the four administrative divisions of Narok district were included in the survey due to the fact that the millet growing areas, that is agro-ecological zones LM_3-LM_4, transverse all the divisions. The multi-stage sampling procedures were followed in each division. A list of all the locations in the relevant agro-ecological zones (LM_3-LM_4) was obtained, and from it, two locations were randomly selected. In each location selected, a list of all the sub-locations was again drawn and one sub-location was selected for sampling. All the villages in the selected sub-locations were listed and one village was randomly selected. Finally, a list of all the farmers in each village selected was compiled with the help of the village elders, and the farmers to be interviewed were randomly selected from such villages. This same process was repeated for all the four divisions. A minimum of sixty farmers were selected and interviewed in each division.

Data Analysis

A non-frontier production function was fitted to the data to measure the technical efficiency of smallholder sorghum farmers. Following the works of (Lau, 1971), a Cobb-Douglas form was estimated. The model used was specified implicitly as follows:

$$Q = f(x_i, d, u) \quad (3)$$

In an explicit Cobb-Douglas form

$$Ln\,Q = A_i x_1^{b_1} x_2^{b_2} x_3^{b_3} e^{b_4 d_1} e^{b_5 d_2} e^{u} \quad (4)$$

$(i = 1,2)$

In log linear form

$$Ln\,Q = ln\,A_1 + b_1 lnx_1 + b_2 lnx_2 + b_3 lnx_3 + b_4 d_1 + b_5 d_2 + u \quad (5)$$

$$Ln\,Q = ln\,A_2 + b_1 lnx_1 + b_2 lnx_2 + b_3 lnx_3 + b_4 d_1 + b_5 d_2 + u \quad (6)$$

Where: Q = Quantity of bulrush millet output (80 kg Bags./acre)

x_1 = Value of capital inputs except labour (Kshs./acre)

x_2 = Labour used in millet production (man days/acre)

x_3 = Experience of the farmer (No. of years in farming)

d_1 = Dummy for bulrush millet planted (1= improved varieties; 0= local varieties)

d_2 = Dummy for formal education of the farmer (1= educated, 0 = otherwise)

A_1 = Efficiency parameter for farmers who own oxen

u = Random error term (Statistical 'noise')

b_1 = Regression coefficient (i=1,2,.....,5)

The ordinary least square (OLS) estimation of the above model was done using the Statistical Package for Social Sciences (SPSS).

The hypothesis posits that smallholder farmers in Narok district allocate their farm resources efficiently in bulrush millet production. Economic theory states that for optimal resource allocation in any production process, inputs should be applied at the point where the marginal value product (MVP) is equal to the price/opportunity cost (MFC) of the input (Henderson and Quandt, 1971). This implies that for efficiency in resource allocation to exist, the MVP per shilling spent on a resource, is unity. Before testing the hypothesis, the MVPs of the resources used in millet production were calculated. To arrive at the MVP, the marginal physical product (MPP) of the resource was calculated and the resultant figure multiplied by the average unit price of millet that prevailed during the survey year. The MPP refers to the change in output resulting from a 1% increase in an input ***ceteris paribus.***

For the cob-Douglas form (Chiang, 1984; Heady and Dillon, 1972);

$$mpp = \frac{\delta Q}{\delta x_i} = b_i \cdot \frac{Q^*}{x^*} \quad (7)$$

Where: Q = Estimated output of bulrush millet

x_i = The quantity of input I,

x^* = Geometric mean of x_i

Q^* = Geometric mean of Q_i

b_i = The estimated coefficients of x_i

And form economic theory for efficient resource allocation for MVP must be equal to the MFC of the resource; MPP multiplied by the price of output gives the MVP. Therefore in order to establish any difference between the MVP and MFC, the following t-test formula was used:

$$t = \frac{mvpx_i - mfcx_i}{s.e(mvpx_i)} \quad (8)$$

Where: $mvpx_i$ = Estimated MVP of input x_i or $\frac{p_i \partial y}{\partial x_i} = (mpp) * (p_i)$

$mfcx_i$ = Price (opportunity cost) of input x_i

s.e.($mvpx_i$) = Standard error of the sample regression coefficient associated with resource x_i

The null hypothesis (H_o) was rejected or accepted at 5% significance level

Results and Discussion

Allocative Efficiency in bulrush millet production

To determine the allocative efficiency of resource use in millet production in the study area, the marginal physical product (), marginal value product () and the ratio of to marginal factor cost) were calculated. The (price or opportunity cost) of the inputs, labour and capital were taken to be Kshs. 100 and 15% respectively. The cost of labour (Kshs. 100) is the daily wage rate recommended by the district department of labour for casual employment in the district. The price of capital used is the opportunity of capital taken to be the savings interest rate that prevailed during the survey year. The result of equation 7 above was then multiplied by the average price per 80 kg bag of millet for the period to arrive at the MVP for each factor input. The price per a 80 kg bag of sorghum used in the study is the mean price received by farmers who sold their bulrush millet grains during the survey year. The price of bulrush millet stood at Kshs. 1500 per a kg- bag for the 2009/2010 crop year. The results of these analyses are presented in Table 1 below.

Table 1
Factor Marginal Physical Product (MPP) and Marginal Value Product (MVP) and Ratio of MVP to Marginal Factor Cost (MFC)

Variable	Farmers who own oxen			Farmers without oxen		
	MPP (80 kg Bags)	MVP (Kshs.)	MVP/MFC	MPP (80 kg Bags)	MVP (Kshs.)	MVP/MFC
Capital (x_1	0.00095	1.14	9.48	0.000642*	0.77	6.42
Labour (x_2	0.06223	74.69	1.24	0.121381	145.66	2.43

Source: Author's calculations, 201026.9.2010; Note: *non-significant

Our results show that for the farmers who own oxen the MPP for capital (x_1) and labour (x_2) are 0.001 80-kg bags and 0.06 80-kg bags of bulrush millet per acre respectively. This suggests that, on average, and with all other factors held constant, a unit increase in capital and labour utilization by the oxen owners would increase bulrush millet yields by 0.001 80-kg and 0.06 80-kg bags per acre respectively. In terms of kilograms, an additional unit of labour and capital used in bulrush millet production by an oxen owner would increase yields by about 5 kg and 0.07 kg of bulrush millet respectively. For farmers without oxen, a unit increase in capital and labour employment would result into 0.000642 80-kg bags and 0.12 80-kg bags increase in bulrush millet output per acre respectively (Table 1). Implying that a unit increase in labour use among farmers without oxen, *ceteris paribus,* would produce about 10 kg of bulrush millet while that of capital would result into 0.05kg. The MPP for the management proxy variables included in the model were not calculated since a part from being none significant determinants of bulrush millet production among farmers in the study area, such variables would not make any economic sense. The manager of the farm (exploiting his/her managerial ability) is expected to adjust farm inputs in order to meet farm goals and in so doing it is very unlikely to see him/her substituting managerial ability for other inputs during farm production decisions.

According to the MVP, figures derived for each input by farmer category, an additional one shilling (Kshs. 1) used in bulrush millet production would bring a return of about Kshs. 1.14 to an oxen owner and Kshs. 0.77 to a non-oxen owner farmer. The return from an additional person-day of labour input employed in bulrush millet production is approximately Kshs. 74.69 and Kshs. 145.66 to oxen and farmers without oxen respectively. These results suggest that farmers without oxen receive relatively higher returns to labour input than the oxen owners do. The receipt of relatively higher returns from the labour input by the farmers without oxen is attributable to the higher labour demand occasioned by none use of oxen to alleviate labour bottlenecks. Oxen owners received the highest return to capital from bulrush millet production (Table 1). Among the farmers without oxen, capital input is an insignificant factor in bulrush millet production.

To determine whether the farm resources were being used at efficient levels (allocative efficiency), the MVP's for each input was divided by the input's marginal factor cost (MFC). All the resulting ratios are greater than unity for all resources (capital and labour), indicating that these resources were being under-utilized on the sample farms by both groups of farmers during the survey year. The ratio for the labour resource is relatively higher for farmers without oxen than those for oxen owners' farms (Table 1). The implication is that although both oxen owners and farmers without oxen are under-utilizing labour, there exists greater underemployment of this resource in bulrush millet production among the farmers without oxen. This state of affairs is attributable to the reduced labour demand among oxen owners due use of oxen on bulrush millet farms. The evidence of under-employment of labour in bulrush production by both groups of farmers expounds the widely held belief that bulrush millet production is labour intensive. The under-utilization of labour among oxen owners can also be explained by below capacity utilization of oxen on bulrush millet farm operations. This further implies that the rise in labour productivity due to use of owned oxen has not been fully exploited by the farmers who own oxen. In general the below capacity utilization of resources (labour and capital) is attributable to the fact bulrush millet production among farmers in the study area is taken as a way of life with most producers only concerned with maximizing varied social objectives. In concluding this section it is worth noting that although farmers who own oxen are relatively technically efficient in bulrush millet production, there tends to be sub-optimal allocation of resource within all the sample farms in the study area.

Analysis of Returns to Scale in Bulrush Millet Production

The concept of returns to scale was employed in the analysis of the economics or diseconomies of size. Returns to scale is a long run concept, which refers to the change in output resulting from proportionate change in all inputs (Chiang, 1984). Increasing, constant or decreasing returns to scale prevail at a given point on the production surface depending on whether a small proportional increase in all inputs leads to a more than proportionate, proportionate, or less than proportionate increase in output. In a Cobb-Douglas production function the sum of the estimated coefficients (b_i) has been taken as an indicator of the returns to scale (Heady and Dillon, 1972). Therefore from equations 5 and 6, v$\sum b_i$ would be a measure of increasing, constant or decreasing returns to scale depending on whether v$\sum b_i$ or $\sum ɔ_i$=1 respectively.

From the estimated functions for the oxen owners and bulrush millet farmers without oxen, the sums of the exponents ($\sum b_i$) are 2.66219 and 3.1994 respectively. These figures suggest that the bulrush millet production system in the study area exhibits increasing returns to scale. This echoes the theory that small firms experience increasing returns to scale in their production process. The implication is that there exists a greater return to scale in their production process. The implication is that there exists a great potential for increasing productivity in sorghum production through the application of additional inputs by farmers. An additional increase in all resources in bulrush millet production will on average, result in greater returns to farmers.

The test for the hypothesis done using equation 8 reveal that the difference between the MVP_{x1} and (for capital) is significant at 5% for the farmers who own oxen. For the labour input the difference between the MVP_{x2} and MFC_{x2} for both the oxen owners and farmers without oxen is also significant at 5%. The existence of a significant difference between the MVP and the MFC of these resources means the rejection of the null hypothesis (H_o) and hence the acceptance of the alternative hypothesis (H_1). The rejection of the null hypothesis implies that the farmers in the study area are inefficiently allocating their farm resources in the production of bulrush millet.

Conclusion and Recommendations

The over-riding objective of this study was to establish resource use efficiency in bulrush millet production among smallholder farmers in Narok district. Our analyses show that the labour input is a statistically significant positive determinant of smallholder bulrush millet production for the two groups of farmers. Capital is only a significant determinant of sorghum production among the oxen owners although it has a positive influence on production for both farmer groups. All the management proxy variables (experience and education) are statistically non-significant factors in smallholder bulrush millet production.

The technical efficient for the oxen owners was found to be relatively higher than that of the farmers without oxen. The ratio of MVP to MFC for all inputs was found to be significantly greater than unity for all groups of farmers implying underemployment of resources. Both farmers who own oxen and farmers under utilize the two farm resources (labour and capital) without oxen operating in the study area. Both farmers' groups of farmers were found to be experiencing increasing returns to scale in bulrush millet production. The null hypothesis advanced and tested in the study was rejected and hence the acceptance of the alternative hypothesis at 5% level of significance.

From the foregoing, we conclude that bulrush millet farmers in Narok district are sub-optimally allocating resources in their production system. Both labour and capital are under-utilized by all farmers. Technically oxen owners are relatively more efficient than the farmers are without oxen meaning that the use of oxen on bulrush millet farms raises farm-firm efficiency in bulrush millet production. Nevertheless, there exists a potential for increasing bulrush millet output levels by all farmers in the district through the application of additional inputs. Being a labour intensive food crop, increased production would help in meeting the twin objectives of food security and employment creation in an area with unreliable weather patterns such as Narok district.

For an optimal resource allocation and enhanced efficiency in bulrush production, farmers who own oxen should be encouraged to intensify oxen usage through employment in millet field operations such as weeding and planting of bulrush millet farms. Farmers who do own oxen and are unable to hire the services should be encouraged to increase their labour use levels in bulrush millet production. This will ensure full exploitation of the potential that exists for increasing bulrush millet productivity in the district.

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