Agricultural Journal 6 (5): 252-258, 2011
ISSN: 1816-9155

Resource Economic Efficiency Under Mangoes-Based Agroforestry Systems in Buzaya County, Kamuli District

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Abstract: This study analyzed the resource economic efficiency of mango (*Mangifera indica*) growers in Buzaya country, Kamuli district, Uganda. It estimated the existing scales of mango producers, their relative resource-use efficiency, the relative profitability of their operations and their determinants using the profit function. Results showed that the identified scales of producers are inefficient in their use of resources but the potentials still exist for increases in their levels of mangoes output. The hypothesis that the various scales of producers are equally efficient in their resource allocation was rejected at 5% probability level. The hypotheses that there was no significant difference in their level of profitability as well as the factors influencing their operations were also rejected at 5% probability level. It is recommended that micro-financial institutions should give credit preference to the mango producers because of their relatively higher profit margin which reflects their potentials for repayment. Necessary adjustments to be made in their levels of resource use for enhanced level of mangoes output and profitability were also recommended.

Key words: Mangoes production, farmers, resource efficiency, prefit, oputput, Uganda

INTRODUCTION

Mixed cropping was identified as a common practice among the peasant, resource-poor farmers in the tropics (Maxwell, 1995; Buyinza, 2008) and was argued to be a balanced farming practice. Its extensive practice was recognized in the Eastern region of Uganda. Varieties of fruits including mangoes, paw paws, avocadoes, bananas, jackfruit oranges, lemons and tangerines crops grown under the agroforestry-based system in the area are intercropped with root tubers such as cassava, sweet potatoes, leafy vegetables and a variety of cereals including maize, sorghum and finger millet, ground nuts, sim sim and other smallholder legumes (Otim-Nape *et al*., 1999; Mukadasi, 2007; Buyinza, 2008), not only in intensive small-holdings but also at the medium and large scales.

As a nutritious fruit, mangoes are widely accepted by the local farmers and identified as the most important among the fruit trees cultivated and consumed in Uganda followed by pineapples, paw paws, jack fruit and avocadoes (Mubiru, 1996; Nabbumba, 1998). Efforts had been made to enhance its utility (Otim-Nape *et al*., 1999) and to establish the influence of a number of variables on the yield performance of the crop under sole crop condition (Boesen *et al*., 2004). The influence of a number of other factors such as the labour supply and wage rate, amount and cost of capital available to the farmers, the cost of complementary inputs such as fertilizer, planting materials and insecticides have not being satisfactorily established empirically. This knowledge gap was inadequately addressed by previous policies of government resulting in failure to reflect its potentials for the transformation of the economy.

Following the expanded significance which the mango fruit has recently assumed in international trade circles, Uganda government made a bold policy shift that gave production of the fruit an unprecedented attention with particular emphasis on its large-scale production through the Farm income enhancement and forest conservation programme. It is however, not certain if this concern of government to reposition the status of mango fruit production can be realized in Kamuli district given the level of inefficiency in resource-use by the farmers (Buyinza and Nabalegwa, 2007). The situation is particularly worrisome in view of the comparative advantage of this geographical location in mango fruit production, evidenced by its abundant human and natural resources.

Mangoes are one of the most important tropical fruit trees brought very early to East Africa. In Uganda, it is widely cultivated in Northern and North Eastern regions. It does not tolerate flooding and prefers sand-loamy soil which is well drained but it can do quit well in dry areas.

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Roots penetrate deeply so, rocky subsoil should be avoided. The extensive shallow roots collect water and nutrients in upper soil levels. Its altitudinal range is from 700-1,800 m absl. Mangoes are used as firewood, charcoal, food (fruits,), bee forage ornamental, shade, windbreak, soil conservation and gum. Mangoes are propagated by direct sowing at site, grafting or seedlings. It is fast growing and for quicker growth and early production of fruits and fresh seeds are used.

Mangoes can be processed locally into juice that is sold fresh in homes, restaurants and on the streets. The most popular fruit for juices preparation are mangoes and passion fruit. Others are pineapple orange and banana. Banana juice is a special variety prepared through the local technology but its marketing is limited to village level. Currently, the demand for fruit juice exceeds production. The demand is met through import of fruit juices. There is a strong indication of existence of investment opportunities in fruit processing for local and export markets. A few industries have come up to utilise locally produced fruits to produce juice, for example, Reco industries in Kasese processes passion fruit juice concentrate and jam; Britannia Ltd., in Kampala deals in mango juice and passion fruit juice whereas Craft bazaar Ltd. in Kampala and Elgonia Ltd., in Mbale processes pineapple and passion fruit juice concentrates. There are investment opportunities in the fruit-subsector both for the local market and export.

Through, the Plan for Modernisation of Agriculture (PMA) and National Agricultural Advisory Services (NAADS), farmers have been encouraged to treat farming as a viable business. Findings from NAADS evaluation reports suggest that the existing scales of operation and level of resource-use efficiency cannot match the opportunities offered in international markets for mangoes production. They can not as well, cope with the expanded domestic market for the crop as a food staple unless the location and magnitude of resource-use inefficiency among the producers are identified for proper action by government. It is not known whether the reported level of resource use inefficiency and profitability profile are similar for the various scales of producers.

This study therefore, generally analyzed the resource management of mango fruit based mixed farm producers and more specifically, estimated the existing scales of mango fruit producers, their relative resource-use efficiency, the relative profitability of their operations and their determinants. It was warranted by the recent government policy emphasis of on mangoes production and the need to establish the relative potentials of the various scales of producers towards the achievement of the policy objectives of government. It was hypothesized that the various scales of mangoes farmers in the area are equally efficient in their resource allocation that they do not differ significantly in the level of profit from their operations and that their levels of profit are not significantly influenced by the scale of operation, their pattern of use of loans acquired for mango production, the wage rate, cost of capital, cost of such other inputs as fertilizer, planting materials and insecticides.

MATERIALS AND METHODS

Description of study area: Kamuli district (Fig. 1) is part Busoga region and one of the 84 districts of Uganda and is located in the South-Eastern part of the country with a population of 552,665 people of which 52% are females (UBOS, 2002). It is located in South-Eastern Uganda, it lies at an average altitude of 1083 m above sea level and extends from 00-56′ North/330-05′ East up to 01-20′ North/330-15′ East.

The district borders River Nile and Kayunga district in the West, Jinja district in the South, Iganga district in the Southeast, Kaliro district in the East and Soroti district and Lake Kyoga in the North. Kamuli district has a total land area of 3,444 km^2.

Buzaya county, the study area is found in Kamuli district, it lies between latitude 0°09′ and 0°11′N and longitude 31°50′E. Annual rainfall varies from 900-1200 mm with two marked dry seasons and the average temperature ranges between 22.6 and 24.6°C. Kamuli district is composed of three counties namely: Budiope, Bugabula and Buzaaya. Buzaya county was selected because it has characteristics typical of the diverse social, economic, cultural, rural and urban setting found in the Busoga region. It has a population density of 230 persons km^{-2} and the growth rate is 2.3% (UBOS, 2002). Subsistence agriculture is the major economic activity employing about 84% of the population. The bulk of agricultural production is from manually cultivated rain-fed crops. Inter-cropping is a prevalent practice. Mixed cropping is widely practiced with maize, cassava, sweet potatoes, sorghum and finger millet as the main crops and with bananas, rice as minor crops. Most households keep livestock including goats, poultry, pigs, sheep and rabbit thus, making them typical mixed farmers.

The multistage sampling technique was adopted in sample selection. The district was 1st stratified into three agricultural zones in line with Plan for Modernization of Agriculture (PMA) zoning. Three parishes of Bugulumbya, Kasambira and Nawandhyo were purposively chosen based on the intensity of mangoes production in mixed crop operations in the area following a pilot survey of the area. Using a stratified random sampling technique, two villages were selected in each parish giving a total of six villages. From each village 10

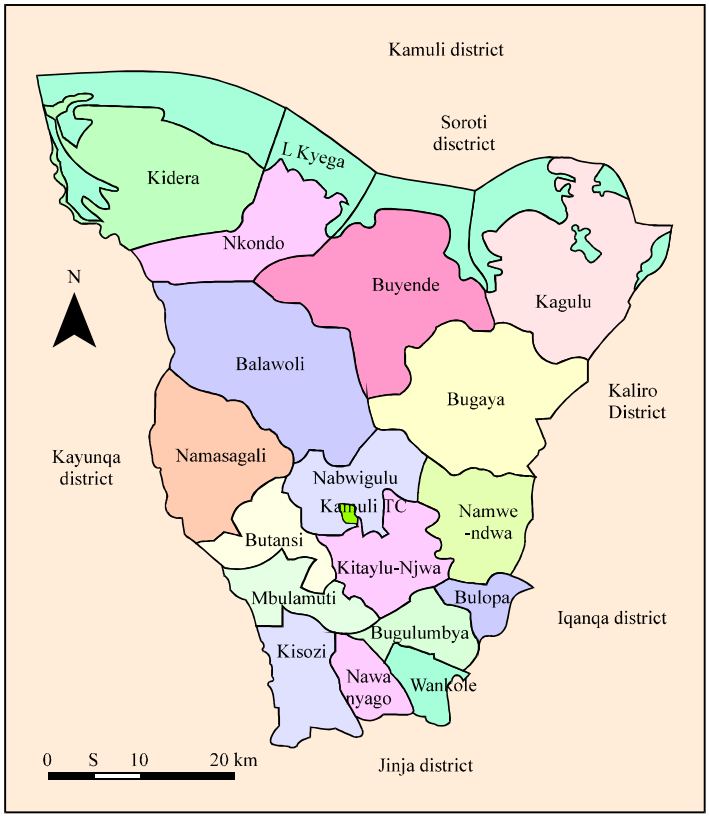

Fig. 1: Kamuli district

mango growers were selected and interviewed, giving a total of 60 respondents. The list of mixed crop farmers from each village was drawn with the assistance of the NAADS workers and from this sampling frame 10 mango growers were drawn from each selected village through simple random sampling thus 60 mango growers and other 80 respondents were drawn from mangoes juice processors (24), vendors (20) and consumers (20) giving a total of 144 respondents in all.

Data were collected using questionnaire surveys, focused group discussions, key informant interviews, participant observation and review of secondary literature and reports. Data were collected on such variables as the scale of operation, amount of loan advanced for mangoes production, the pattern of investments made by the farmers from loans acquired for mangoes production, wage rate for add farmer, quantity and costs of inputs such as fertilizer, planting materials, insecticides and herbicides.

Data were analyzed, using descriptive statistical tools such as means, percentages, frequency distribution as well as inferential statistical tools which included production and profit functions. To estimate the allocative efficiency of resource-use for the various scale of mango producers, an efficiency index was used, specified as (Bolton and Ockenfels, 2000):

$$K_i = P(MPP)_{ji} = (MVP)i/P_{ji} \quad (1)$$

Where:

K_i = Allocative efficiency index
P = Price of the output
MPP_{ji} = Marginal Physical Product
MVP = Marginal Value Product from the specific input used in production
P_{ji} = Price of specific input

Maximum or absolute allocative efficiency is established for a particular scale of operation with respect to a given input if $K_i = 1$. if $K_i > 1$, there is an indication that less than profit maximization level of that input is being utilized and therefore, efficiency could be increased by an increased use of that particular input. Conversely if $K_i < 1$, there is indication that more than profit maximization level of that input is being utilized, suggesting that a reduced use of that input is required to increase efficiency. The required level of input reduction or increase to attain profit maximization was estimated as:

$$D_i = (1 - Z_i)\ 100 \quad (2)$$

where, D_i is required percentage change to attain allocative efficiency or the percentage deviation from optimal use of the ith input for the jth scale of

operation. A negative value implies that an increased use of that input was needed while a positive value signaled that the reduction of that input was called for. A zero percentage indicated that the maximum or absolute efficiency was achieved. To test the hypothesis that the various scales of mango growers were equally efficient in resource allocation their mean allocative efficiency indices were compared using the Z-test at 1% probability level, specified as:

$$z - cal = \frac{k_i - k_j}{\sqrt{s_i^2 + s_{ji}^2 / n_i + n_j}} \quad (3)$$

Where:

k_i and k_j = Mean efficiency ratios for each category

$s^2_i+s^2_j$ = Variance of efficiency ratios in resource use by the corresponding category

n_i+n_j = Sample size of the respective categories

A pair of scale of operations was deemed to have equal allocative efficiency if the mean values for all the inputs obtained for k; J were equal, i.e.,

$$Ki_1 = Ki_2 = Ki_3 \quad (4)$$

A scale of operation was more allocatively efficient than the other if the mean value of K for that scale was greater than the Ki_j of the other scale. To establish their relative economic efficiency and the influencing factors a profit function was estimated (Lau and Yotopolous, 1972; McFadden, 1971; Foster *et al*., 1984) and modeled in linear form as:

$$\begin{aligned} \coprod = {} & b_0 + b_i x_i (i = 1,...,5) + \\ & b_i D_i (i = 1,...,2) + \\ & b_i D_i x_i (i = 1,...,5) + \ell_i \end{aligned} \quad 5)$$

Where:

$\coprod$ = Profitability index per farmer (Uganda shillings value of farm output less the farm cost)

x_1 = Wage rate (Uganda shillings per man-day for an adult farm worker)

x_2 = Cost of capital (amount of interest payment)

x_3 = Capital utilized (amount of loans and depreciated value of assets)

x_4 = Cost of other input (planting materials, fertilizers and other agro-chemicals)

x_5 = Pattern of loan use (of investment in current assets relative to total assets (%))

D_i = Dummy for scale of operation (i = 1 for small-scale and zero, otherwise i = 2 for medium scale and zero, otherwise; i = 3 assuming zero value for the excluded large scale group)

RESULTS AND DISCUSSION

Distribution of the scales of mangoes fruit producers: The distribution of the various scales of mangoes producers identified in the study area is as shown in Table 1. There were three categories of mango producers. About 66, 25 and 9% of the producers were small, medium and large-scale producers, respectively. This suggests that small-scale operation is still the dominant mode of production in this micro-economy followed by the medium-scale operation and then the large-scale operation.

This corroborates with the widely reported view that small-scale farmers constitute the back-bone of food production in the Ugandan economy (MFPED, 2000; Maxwell, 1995; Lusiba and Buyinza, 2008) with farm size ranging from 1-5 ha (MFPED, 2000).

This makes a strong case for small-scale producers and the imperative of using the participatory approach to bring them into sharp focus in any programme aimed at boosting mangoes production. This is probably, the most realistic option open to the government if this contemplated programme is to make the expected impact. This fits well in overall government policy to deliberately encourage and stimulate this vital sector through several micro schemes, extension services and direct government training services. If however, the policy is to be tilted in favour of large-scale producers as being contemplated by the designers, a number of factors must 1st be addressed to justify the government's intervention in the farming systems of producers in the area.

This may call for measures to ensure that the allocative efficiency of the large-scale producers, indexed by their marginal physical product, out-ways that of the small and medium-scale producers. The implications for the profitability and risk of financing the different scale of producers will need to be ascertained to ensure that the loss in earnings to be sustained by dropping other crops cultivated along with mangoes in the mixed cropping systems in the area will be sufficiently compensated for by the expected net-farm income arising from making mangoes the sole crop in large-scale operations. The frictional unemployment, arising from the greater number of farm labour that would be displaced and paraded in the labor market as surplus labour should also be given adequate consideration.

Table 1: Distribution of the scale of mangoes production

Scale of operation	Frequency	Percentage
Small	95	66
Medium	36	25
Large	13	9
Total	144	100

Resource-use efficiency of categories of mango growers: The estimated resource-use efficiency of the various scales of producers is as shown in Table 2. The index of allocative efficiency for land, labour, planting materials, capital and other inputs suggest that none of the three categories of producers was efficient in the use of their resources.

On a relative basis however, the medium-scale producers were more allocatively efficient in the use of land, planting materials and capital while the small-scale producers were more efficient in the use of labour and other inputs. These two categories were more allocatively efficient than the large-scale producers in the use of each of these specific resources. To attain the required efficiency, the small-scale producers need to reduce their use of land, planting materials, capital and other inputs by 439, 249, 266 and 197%, respectively and increase their use of labour by 91%. The medium-scale producers, on the other hand, need to reduce their use of land, planting materials, capital and other inputs by 159, 44, 139 and 114%, respectively and increase their use of labour by 90%. The large-scale producers need to reduce their use of land, planting materials, capital and other inputs by 314, 153, 473 and 214%, respectively and increase their use of labour by 60%.

The needed reduction in capital as suggested by this result is rather paradoxical since, large-scale operation is synonymous with increased use of capital. The behaviour of this variable needs to be further investigated to establish the extent the level of inefficiency in the use of the other resources has brought an overwhelming influence on its use. This not-withstanding, the result shows that potentials still exist for increasing the levels of mangoes output under existing resource base if the necessary adjustments are made in levels of their use.

Table 2: Estimated resource-use efficiency of various categories of mango growers

	Scale of producers (scale)		
Items	Small	Medium	Large
Production elasticity for			
Land (ha)	0.228	0.246	0.374
Labour (man-days)	0.314	0.217	0.213
Planting materials (1<1)	0.442	0.321	0.496
Capital (1<1)	0.702	0.524	0.798
Other inputs (1<1)	0.232	0.215	0.326
Sample means for			
Land (ha)	2.331	2.146	2.449
Labour (man-days)	225.36	206.11	108.21
Planting materials (l<I)	14820	19884	35792
Capital (1<1)	1243	22981	47694
Other inputs (1<1)	1356	4798	66794
Marginal value products for			
Land (ha)	60311	61323	77968
Labour (man-days)	324	378	219
Planting materials (NIN).	3.24	3.46	5.98
Capital (NIN)	2.66	2.39	4.73
Other inputs (NIN)	1.97	2.14	3.33
Factor prices of			
Land (ha)	13742	23674	24798
Labour (man-days)	3680	3976	4592
Planting materials (1'1)	1.3	2.4	3.9
Capital (1'1)	1	1	1
Other inputs (1'1)	1	1	1
Allocative efficiency indices			
Land (ha)	4.39	259	3.14
Labour (man-days)	0.09	0.1	0.4
Planting materials (qty.)	2.49	1.44	1.53
Capital (qty.)	2.66	2.39	4.73
Other inputs (qty.)	1.97	214	3.33
Mean allocative efficiency	2.32	1.73	2.63

Field summery (2008)

Table 3: Distribution of the MFI for the various scales of producers

Pairs of scales of producers	Null hypothesis	Computed Z-score	Critical Z-value at 1% sign. level	Decision
Small scale vs. medium	2.32 = 1.73	3.29	2.58	Reject
Small scale vs. large scale	2.32 = 2.63	2.66	2.58	Reject
Medium scale vs. large scale	1.73 = 2.63	3.34	2.58	Reject

Mean efficiency indices for categories of mango producers: The hypotheses that the various scales of mangoes growers were equally efficient in their resource allocation were rejected when examined in relation to the Mean Efficiency Indices (MFI) as specified in Eq. 3 and shown in Table 3. The computed Z-scores for each pair of producers was significantly different from their critical Z-values at 1% level, leading to the rejection of the null hypothesis in each case.

The analysis suggests that on the basis of aggregate resource use, the level of inefficiency was least among the medium-scale producers, followed by the small-scale producers and then, the large-scale producers. The index for the medium-scale producers was closest to unity followed by that of the small-scale producers and then by that of the large-scale producers. This means that the level of inefficiency needs to be reduced by 1.32, 0.73 and 1.63 for small, medium and large scale producers, respectively. This result is an early signal that the lofty ideals of government in promoting large scale production of mangoes may not be realized by reliance on the present large-scale producers. This result indicates that the best allocative efficiency of resources by the farmers would be obtained when they operate as medium-scale producers. So, unless adequate measures are urgently taken to improve the current level of resource-use efficiency of large-scale producers, the medium and small-scale producers as presently constituted, appear to offer a better alternative for the realization of the objectives of this policy. More enlightenment campaigns are needed for the large-scale producers to educate them on techniques for improving their performance in aggregate resource-use.

Economic efficiency of mango producers and their determinants: The estimated function for the economic efficiency of the various scales of producers and their determinants were found as follows:

$$\text{Ln}\prod = \underset{(3.22)}{78.14^{*}} + \underset{(0.34)}{0.68x_1} + \underset{(0.31)}{0.39x_2^{*}} + \underset{(0.03)}{0.58x_3^{*}} + \underset{(0.43)}{1.32x_4^{*}} + \underset{(0.02)}{0.87x_5^{*}} + \underset{(0.16)}{0.38D_6^{*}} + \underset{(0.22)}{0.69D_7^{*}}$$

where, R' is 0.78021 and n is 144, figures in parentheses are standard errors of estimates. The estimated function in Eq. 5 shows that the variables included in the function explained about 78% of the variations in the level of profit earned by the various scale of producers in the study area. The function shows that except for the wage rate (X_1) which was not significant at 5% probability level all the other variables including the Dummies were significant at 5% probability level. The variable D_1 however did not conform with the priori expectation being inversely related to farm profitability while D_2 conformed with the a priori expectation, being positively related to farm profitability.

This means that although, the scale of operation had significant influence on the level of profit earned by the different categories of farmers in the study area, it did not influence farm profitability in the same direction. In comparative terms, the intercept term for the small-scale producers (with Dummy, i = 1 for small-scale producers and zero otherwise) was least, decreasing by 38% per farmer followed by the medium-scale producers (with Dummy, i = 1 for medium-scale-producers and zero otherwise) which increases by 69% per operator. The estimated level of profitability was higher for the large-scale operator (the excluded category with Dummy, i = for all scales of producers). This translates, respectively to marginal rate of increase of ₦77.76, 78.83 and 78.14 per small, medium and large-scale producers. This suggests that the level of profitability is highest among medium-scale producers followed by the large-scale producers and then the small-scale producers. From the results of the Z-test as well as the F test conducted at 5% probability, the hypotheses of no significant difference in the level of profit earned by the various scale of producers as well as that of their influencing factors were rejected. The result showed that the medium-scale producers earned significantly high level of profit followed by the large-scale producers and then the small-scale producers. The result also showed that the level of influence of the determining factors followed the same profit trend for the various scale of producers. The result further shows that cost of capital (x_2) was significant and appropriately signed capital utilized (x_3) was positively signed showing that profitability was increased following increased use of capital. Although, this does not fall in line with the earlier result that suggested the need for these producers to reduce the use of capital, it conforms to economic theory and suggests the need for further, empowerment of these farmers by way of increased loan facilities to enable them acquire more farm assets.

Cost of other inputs (x_3) was significant and positively related to farm profitability among all scales of producers. This did not conform to the a priori expectation and suggests that profitability increased as cost of other inputs increased.

This would only mean that the returns earned from increased use of other inputs exceeded the cost of financing them. The pattern of investment made from loans obtained for mango production (x_4) significantly influenced the level of profitability of the farm producers in the study area. Results showed that the small, medium-scale and large-scale producers invested 65, 85 and 45% of their loan capital in current assets, respectively while the balance of 35, 15 and 35% of the loans were invested in fixed assets.

CONCLUSION

Although, some degree of inefficiency exists among the three categories of mango producers, the level of inefficiency was least among the medium-scale producers and highest among large scale producers.

The present level of resource-use efficiency, suggests that the lofty ideals of government in promoting large scale production of mangoes may not be realized by reliance on the present large-scale producers. Medium and small scale producers as presently constituted, appear to offer a better alternative for the realization of the objectives of this policy. The farmers would not attain the best level of efficiency unless they operate at a medium scale. The significant factors that affect profitability of mangoes production include the wage rate for an adult farm worker, the cost of capital, capital utilized, cost of other input and pattern of loan use.

RECOMMENDATIONS

To attain allocative efficiency, all categories of producers should make some necessary adjustments in their resource-use. The small scale mango growers should reduce their use of land, planting materials, capital and other inputs by 339, 149, 166 and 97%, respectively and increase their use of labour by 91%. The medium scale

producers, on the other hand, should reduce theeir use of land, planting materials, capital and other inputs by 159, 44, 139 and 114%, respectively and increase their use of labour by 90%.

The large-scale producers should reduce their use of land, planting materials, capital and other inputs by 214, 153, 373 and 114%, respectively and increase their use of labour by 60%.

More enlightenment campaigns should be carried out with particular reference to the large-scale producers, on modem farm management techniques that would enable them improve their performance in resource-use. Further, empowerment should be selectively extended to the farmers by way of enhanced loan facilities to enable them acquire more productive farm assets.

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