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Resource Management on Cassava-Based Mixed Cropping Systems in Imo State, Nigeria

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Abstract: This study analyzed the resource-use efficiency of cassava-based mixed crop farmers in Imo State, Nigeria. It estimated the existing scales of cassava 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 cassava output. The hypothesis that the various scales of operators are equally efficient in their resource allocation was rejected at 5% probability level. The hypotheses of no significant difference in their level of profitability as well as the factors influencing their operations were also rejected at 5% probability level. It was recommended, among others that in advancing credit to these farmers lending institutions in the state should give preference to the medium and small-scale operators because of their relatively higher margin of profit which reflects their potentials for repayment. Necessary adjustments to be made in their levels of resource-use for enhanced level of cassava output and profitability were also recommended.

Key words: Resource, management, cassava-based, mixed cropping systems, Imo State, Nigeria

INTRODUCTION

Mixed cropping was identified as a common practice among the peasant, resource-poor farmers in the tropics (Mutsaers *et al*., 1986; Okigbo and Greenland, 1976) and was argued to be a balanced farming practice (Ikeorgu *et al*., 1984; Mutsaers *et al*., 1993; Harwood and Price, 1975; Osiru and Wiley, 1972). Its extensive practice was recognized in the southeastern states of Nigeria by Unamma *et al*. (1985) and Odurukwe *et al*. (1996). About 50% of the crops grown under the system in the area is intercropped with Maize, Egusi-Melon, leafy vegetables (Unamma *et al*., 1985; Odurukwe *et al*., 1996) and a variety of food-crops such as Yam and Cocoyam cultivated not only in intensive small-holdings but also at the medium and large scales. Insufficient food supply from these sources was attributed to the inefficient use of farm inputs as explained by Afolabi and Falusi (1999), Farrell (1957), Essang (1977) and Bravo-Ureta and Evenson (1994). As a root tuber, cassava is widely accepted by the local farmers in the area and identified as the most important, among the tuber crops cultivated and consumed in Nigeria, followed by Yam and then, Cocoyam (Udealor *et al*., 1996; Onyenweaku and Nwaru, 2005). Efforts had been made to enhance its utility (Obioha *et al*., 1985; Okeke *et al*., 1985; Udedibie *et al*., 2004) and to establish the influence of a number of variables on the yield performance of the crop under sole crop condition (Olojede *et al*., 2002; Dixon *et al*., 1994). 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, insecticides have however, 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 crop has recently assumed in international trade circles, the Federal Government of Nigeria made a bold policy shift that gave production of the crop an unprecedented attention, with particular emphasis on its large-scale production. It is however, not certain if this concern of government to reposition the status of cassava production can be realized in the state given the level of inefficiency in resource-use by the farmers reported by Ohajianya (2006), Onyenweaku and Nwaru (2005) and Oguoma and Ohajianya (2007). The situation is particularly worrisome in view of the comparative advantage of this geographical location in cassava production, evidenced by its abundant human and natural resources. Findings from these studies suggest that the

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existing scales of operation and level of resource-use efficiency cannot match the opportunities offered in international markets for cassava production. They cannot as well, cope with the expanded domestic demand for the crop as a food staple unless the location and magnitude of resource-use inefficiency among the operators 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 operators. This study, therefore, generally analyzed the resource management of cassava-based mixed farm operators and more specifically, estimated the existing scales of cassava producers; their relative resource-use efficiency; the relative profitability of their operations and their determinants. It was justified by the recent policy emphasis of the Federal Government of Nigeria on Cassava production and the need to establish the relative potentials of the various scales of operators towards the achievement of the policy objectives of government. It was hypothesized that the various scales of cassava 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 that their levels of profit are not significantly influenced by the scale of operation, their pattern of use of loans acquired for cassava production, the wage rate, cost of capital, cost of such other inputs as fertilizer, planting materials, insecticides.

MATERIALS AND METHODS

Imo State is one of the 36 States of Nigeria and located in the South-Eastern part of the country with a population of 2,485,499. It lies within Latitudes 5°40' and 7°5' North and Longitudes 6°35' and 8°30' East. The State is divided into three Agricultural Zones, namely Owerri, Orlu and Okigwe and a total of 27 Local Government Council Areas. It generally, has an undulating topography with visibly high level of soil loss due to gully erosion. Mixed cropping is widely practiced with Yam, Cassava, Cocoyam as the main crops and with Telfair, Pepper, Plantains, Bananas, Amaranthus and Okra as minor crops. Most households keep such livestock as sheep, goat, poultry, pigs and rabbit, thus making them typical mixed farmers. The multistage sampling technique was adopted in sample selection. The area was first stratified into three agricultural zones in line with the ADP Zoning system in the State. Two Local Government Areas (LGAs) were purposively chosen from each zone based on the intensity of cassava production in mixed crop operations in the area. The LGAs chosen were Ngor-Okpala and Mbaitoli from Owerri Zone; Isiala Mbano and Obowo from Okigwe Zone, Oru-East and Ideato North from Orlu Zone. The list of communities within each selected LGA was collected from their respective Headquarters. Two communities were purposively selected from each LGA, based also on the intensity of mixed crop operations following a pilot survey of the area, giving a total of twelve communities from the Zones. The list of mixed crop farmers from each community was drawn with the assistance of the extension agents and from this sampling frame twelve mixed crop farmers were drawn from each selected community through simple random sampling, given a total of 144 respondents in all. Data were collected on such variables as the scale of operation, amount of loan advanced for cassava production, the pattern of investments made by the farmers from loans acquired for cassava production, wage rate for adult farmer, quantity and costs of inputs such as fertilizer, planting materials, insecticides, herbicides. Structured questionnaire were used for data collection and the exercise lasted from March-September, 2008. Data were analyzed using descriptive statistical tools such as means, percentages, frequency distribution as well as inferential statistical tools such as production and profit functions.

To estimate the allocative efficiency of resource-use for the various scale of operators an efficiency index was used, specified as:

$$K_{ij} = P\,(MPP)_{xi} = (MVP)_{xi}/P_{xi} \quad (1)$$

Where:

K_{ij} = The allocative efficiency index
P = Unit price of the output
MPP_{xi} and MVP_{xi} = Respectively the Marginal physical product and the marginal value product from the specific input used in production
P_{xi} = Unit price of the specific input

Maximum or absolute allocative efficiency is established for a particular scale of operation with respect to a given input if $K_{ij} = 1$. If $K_{ij}>1$, 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 $K_{ij}<1$, 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:

$$D_{ij} = (1 - K_{ij})\,100 \quad (2)$$

where, D_{ij} 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 cassava farmers were equally efficient in resource allocation their mean allocative efficiency indices were compared using the Z-test at 1% probability level, specified as:

$$Z\text{-cal} = \frac{K_i - K_j}{\sqrt{S^2_i + S^2_j/n_i + n_j}} \quad (3)$$

Where:

K_i and K_j = Mean efficiency ratios for each category
S^2_i and S^2_j = Variance of efficiency ratios in resource use by the corresponding category
n_i and 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_{ij} were equal, i.e.,

$$K_{i1} = K_{i2} = K_{i3} \quad (4)$$

A scale of operation was more allocatively efficient than the other if the mean value of K_{ij} for that scale was greater than the K_{ij} of the other scale.

To establish their relative economic efficiency and the influencing factors a profit function was estimated, following Lau and Yotopolous (1972), McFadden (1971) and Olayide and Heady (1982), modeled in linear form as:

$$\Pi = b_o + b_iX_i (_i=1\ldots5) + b_iDi (\ i = 1\ldots2) + b_iD_i.X_i\ (_i =1\ldots.5) + e_i \quad (5)$$

Where:

Π = Profitability index per farmer (naira value of farm output less the farm cost)
X_1 = Wage rate (Naira 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 agrochemicals)
X_5 = Pattern of loan use (percentage 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)
b_o = Intercept term
b_i = Coefficients of the variables
e_i = Stochastic error term

It was hypothesized, a priori that X_1 and X_2 will be negatively signed, while X_3, X_4, X_5 D_1 and D_2 would be positively related to profitability.

The Z-test (adjusted from Eq. 3 to compare profits rather than mean efficiency ratios) and an F-test (as specified in Eq. 6) were used respectively to test the hypotheses of no significant difference in the profit earned by the various categories of operators (the Z-test) and the factors affecting the level of profit of the various scales of operators (the F-test). The F-test statistic was specified, in line with Olayemi (2005) and Gujarati (1995) as:

$$F = \frac{(SSRa - SSRb)/(a\text{-}b)}{SSEa/(n\text{-}a)} = \frac{(R^2a - R^2b)\ (n\text{-}a)}{(1 - R^2a)\ (a\text{-}b)} \quad (6)$$

Where:

SSRa = Regression sum-of-squares when Π is regressed on all explanatory variables
SSRb = Regression-sum-of-squares when Π is regressed on non-dummy variables only
SSEa = Sum-of-squares of error when Π is regressed on all explanatory variables
a = Total number of parameters estimated
b = Total number of non-dummy parameters only
R^2 = Co-efficient of Multiple Determination
n = Number of observations in the entire sample

RESULTS AND DISCUSSION

Distribution of the scales of cassava farm operators in the study area: The distribution of the various scales of cassava producers identified in the study area is as shown in Table 1. The Table 1 shows that three categories of operators were represented in Cassava production in the area. About 66, 25 and 9% of the operators were small medium and large-scale operators, 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 the widely reported view that small-scale farmers constitute the nerve-center of food production in the country (Olayide and Heady, 1982), with farm size ranging from 0.1-5 ha (Okigbo, 1985). This makes a strong case for small-scale operators and the imperative of using the participatory approach to bring them into sharp focus in any programme aimed at boosting cassava production.

This is, probably, the most realistic option open to the government if this contemplated programme is to make the expected impact. If, however, the policy is

Table 1: Distribution of the respondents according to their scales of operation

	Agricultural zone			
Scale of operators	Owerri	Orlu	Okigwe	Total
Small-scale	36	25	34	95 (65.97%)
Medium-scale	10	15	11	36 (25%)
Large-scale	02	08	03	13 (9.03%)
Total	48	48	48	144

Field Survey Data, 2008

to be tilted in favour of large-scale operators, as being contemplated by the designers, a number of factors must first be addressed to justify the government's intervention in the farming systems of operators in the area. Measures must be put in place to ensure that the allocative efficiency of the large-scale operators, indexed by their marginal physical product, out-ways that of the small and medium-scale operators. The implications for the profitability and risk of financing the different scale of operators will need to be ascertained to ensure that the loss in earnings to be sustained by dropping other crops cultivated along with cassava in the mixed cropping systems in the area will be sufficiently compensated for by the expected net-farm income arising from making cassava 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.

The estimated resource-use efficiency of the various scales of producers is as shown in Table 2. The Table 2 shows that for the small-scale operators, the index of allocative efficiency for land, labour, planting materials, capital and other inputs were 4.39, 0.09, 2.49, 2.66 and 1.97, respectively. For the medium-scale operators the corresponding values were 2.59, 0.1, 1.44, 2.39 and 2.14, while for the large-scale operators the respective values were 3.14, 0.4, 1.53, 4.73 and 3.33. These figures suggest that in terms of allocative efficiency, none of the three categories of operators was efficient in the use of their resources. On a relative basis, however, the medium-scale operators were more allocatively efficient in the use of land, planting materials and capital, while the small-scale operators were more efficient in the use of labour and other inputs. These two categories were more allocatively efficient than the large-scale operators in the use of each of these specific resources. To attain efficiency the small-scale operators need to 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 operators 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

Table 2: Estimated resource-use efficiency of various categories of respondents

	Scale of operator		
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 (₦)	0.442	0.321	0.496
Capital (₦)	0.702	0.524	0.798
Other inputs (₦)	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 (₦)	14820	19884	35792
Capital (₦)	1243	22981	47694
Other inputs (₦)	1356	4798	66794
Marginal value products for:			
Land (ha)	60311	61323	77968
Labour (Man-days)	324	378	219
Planting materials (₦/₦)	3.24	3.46	5.98
Capital (₦/₦)	2.66	2.39	4.73
Other inputs (₦/₦)	1.97	2.14	3.33
Factor prices of:			
Land (ha)	13742	23674	24798
Labour (Man-days)	3680	3976	4592
Planting materials (₦)	1.3	2.4	3.9
Capital (₦)	1	1	1
Other inputs (₦)	1	1	1
Allocative efficiency indices			
Land (ha)	4.39	2.59	3.14
Labour (Man-days)	0.09	0.1	0.4
Planting materials (₦)	2.49	1.44	1.53
Capital (₦)	2.66	2.39	4.73
Other inputs (₦)	1.97	2.14	3.33
Mean allocative efficiency	2.32	1.73	2.63

Field Survey Data, 2008

operators need to 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%. 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 behavior 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 the potentials still exist for increasing the levels of cassava output under existing resource base if the necessary adjustments are made in levels of their use. The hypotheses that the various scales of cassava farmers 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 Table 3 shows that the computed Z-scores for each pair of operators was significantly different from their critical Z-values at 1% level, leading to the rejection of the null hypothesis in each case. This suggests that on the basis of aggregate resource use, the level of inefficiency was least among the medium-scale operators,

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

Pairs of scale of operators	Null hypothesis	Computed Z-score	Critical Z-value at 1% level of significance	Decision
Small-scale versus medium	2.32 =1.73	3.29	2.58	Reject
Small-scale versus large-scale	2.32 = 2.63	2.66	2.58	Reject
Medium-scale versus large-scale	1.73 = 2.63	3.34	2.58	Reject

Field Survey Data, 2008

followed by the small-scale operators and then, the large-scale operators. The index for the medium-scale operators, was closest to unity followed by that of the small-scale operators and then by that of the large-scale operators. 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 operators, respectively. This result is an early signal that the lofty ideals of government in promoting large-scale production of cassava 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 operators. So, unless adequate measures are urgently taken to improve the current level of resource-use efficiency of large-scale operators, the medium and small-scale operators, 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 operators to educate them on techniques for improving their performance in aggregate resource-use.

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

$$\begin{aligned} \text{Ln } \Pi = {} & 78.14^{*} - 0.68X_1 - 0.39X^{*}_2 + 0.58X^{*}_3 + \\ & (3.22) \quad (0.34) \quad (0.31) \quad (0.03) \\ & 1.32X8_4 + 0.87X^{*}_5 - 0.38D^{*}_1 + 0.69D^{*}_2 \\ & (0.43) \quad (0.02) \quad (0.16) \quad (0.22) \end{aligned} \tag{7}$$

$R^2 = 0.78021$; n = 144 are the figures in Parentheses which 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 operators 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 a 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 operators (with Dummy, i =1 for small-scale operators and zero otherwise) was least, decreasing by 38% per farmer, followed by the medium-scale operators (with Dummy, i = 1 for medium-scale-operators 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 operators). This translates respectively to marginal rate of increase of ₦77.76; 78.83 and 78.14 per small, medium and large-scale operators resp. This suggests that the level of profitability is highest among medium-scale operators, followed by the large-scale operators and then, the small-scale operators. 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 operators as well as that of their influencing factors were rejected. The result showed that the medium-scale operators earned significantly high level of profit, followed by the large-scale operators and then the small-scale operators. The result also showed that the level of influence of the determining factors followed the same profit trend for the various scale of operators.

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 operators to reduce the use of capital, it conforms with 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 operators. 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 cassava production (X_4) significantly influenced the level of profitability of the farm operators in the study area. Results showed that the small, medium-scale and large-scale operators 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.

This study estimated the existing scales of cassava producers in Imo State, Nigeria; their relative resource-use efficiency; the relative profitability of their operations and their determinants. The study found that about 66, 25 and 9% of cassava farmers in the study area are small, medium and large-scale operators, respectively. This means that small-scale operation is still the dominant mode of production in this micro-economy followed by the medium-scale operators and then, the large-scale operators.

A high level of inefficiency was confirmed among the three categories of operators. However, on the basis of aggregate resource use, the level of inefficiency was least among the medium-scale operators followed by the small-scale operators and then, the large-scale operators. The reduction required to reduce the level of inefficiency in aggregate resource-use is 132, 73 and 163% for small, medium and large-scale operators, respectively. In terms of specific resources the medium-scale operators were more allocatively efficient in the use of land, planting materials and capital, while the small-scale operators were more efficient in the use of labour and other inputs. These two categories were more allocatively efficient than the large-scale operators in the use of each of these specific resources.

To attain efficiency the small-scale operators need to 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 operators 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 operators need to 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%. The estimated regression function 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 operators.

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 a priori expectation, being inversely related to farm profitability, while D_2 conformed with the a priori expectation, being positively related to farm profitability. The intercept term for the small-scale operators was least, decreasing by 38% per farmer, followed by the medium-scale operators which increases by 69% per operator. This translated respectively to marginal rate of increase of ₦77.76, 78.83 and 78.14 per small, medium and large-scale operators.

This suggested that economic efficiency was highest among medium-scale operators, followed by the large scale operators and then, the small-scale operators. The result further shows that cost of capital (X_2), Capital utilized (X_3), Cost of other inputs (X_3), the pattern of investment made from loans obtained for cassava production (X_4) were among the factors that significantly influenced the level of profitability of the farm operators.

CONCLUSION

Although, some degree of inefficiency exists among the three categories of farm operators, the level of inefficiency was least among the medium-scale operators, followed by the small-scale operators and then, the large scale operators. The present level of resource-use efficiency, suggests that the lofty ideals of government in promoting large-scale production of cassava may not be realized by reliance on the present large-scale producers. Medium and small-scale operators, 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 between 5 and 10 ha of farmland. The significant factors that affect profitability of cassava production in the study area 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 operators should make some necessary adjustments in their resource-use. The small-scale operators 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 operators on the other hand, should 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 operators 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 operators on modern 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, beginning from the medium-scale operators, followed by the large-scale operators and then, by the small-scale operators to enable them acquire more productive farm assets

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