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Production relationships among compound and non-compound farms in Imo state, Nigeria

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The objective of the study are to examine and identify the pattern of resource allocation, compare the productivity and efficiency in compound and non-compound farms, and make recommendations for enhanced performance in the two farm types. The sample size comprised 240 farmers who were sampled using the multi-stage sampling technique. Structured questionnaires were used in the collection of primary data. The Chow F-test and profit function analysis were adopted in determining and comparing the pattern of resource allocation, productivity and efficiency among the two groups of farmers. The results show that more aggregate resources were allocated to non-compound farms. Resources such as labour and capital have higher marginal value products in non-compound farms while seeds, fertilisers and agro-chemicals were equally productive in two farm types. The existence of resource use disequilibria was apparent in the two farms. Farmers were not equally technically efficient in both farm types. However, the farmers were economically more efficient in the compound farms. It is recommended that a bio-waste hitherto not being utilised to the non-compound farms to increase their fertility and hence economic efficiency be formulate

Key words: Compound farms, productivity, profit-function

According to Mbagwu (1974), compound farms are relatively small portions of land immediately surrounding the people's homes and are cultivated year after year with the aid of kitchen and compound refuse, while non-compound farms are the much larger farm lands beyond the limits of the family farm environment and which form the main cultivated areas. Thus the size of compound farm lands are smaller relative to the non-compound farms as a result of increased competition among alternative land users. These systems of farming are practiced in the more densely populated areas of the southeastern states of Nigeria and are characterized by fallow systems which have broken down due to population pressure on land that is supported by deliberate dumping of household refuse and animal droppings (Agboola, 1979; Lortha, 1982).

Compound farms are cultivated continuously by alternating yam and cocoyam-based crop mixtures and soil fertility was maintained by the use of compound refuse while fertility of the non-compound farms is maintained by long fallow for a number of years (Nweke and Winch, 1980). However, compound farms could be cultivated in rotation between yam-based systems followed by cassava-based systems, while the upland or non-compound farms are usually fragmented and left fallow for some years (Chidebelu, 1984).

Although these two farm types exist in the area, they are not without their peculiar problems. According to Okigbo (1972), some of these problems include land tenure system which involves scattered fragmented holding and haphazard growing of crops under whose shade annual crops never thrive well; mixed cropping which, while ensuring the farmer stability in crop production, cannot be mechanized; unimproved crops that do not respond to fertilisers; increasing the narrow range of crops produced in relation to nutritional requirements and a fast increase in our food processing potential.

In spite of their shortcomings, both farm types have constituted an insurance scheme since if in a very dry year crops fail on the non-compound farms, crops grown on the compound may come in handy to ensure food security. In addition, International Institute of Tropical Agriculture (IITA, 1985) observed that compound farms provide essential nutrients complementary to staple food crops. The size of compound farms tend to cluster around 20 per cent of the total area. A high degree of soil fertility is maintained because household refuse and animal wastes are used in the compound farms.

Methodology

Imo state of Nigeria lies within latitudes 5°40' and 7°5' North and longitudes 6°35' and 8°30' East. According to the National Population Commission (NPC, 1991), the population of the State was put at 2 485 499. Five distinct soil types have been identified in the area and these include lithosols, alluvial soil, ferralithic soils, medium fine alfisols and clayey hydromorphic soils. The State is divided into three main agricultural zones, namely Oweri, Okigwe and Orlu. It is further divided into 21 local government councils.

Sampling procedure and data collection

Through a pilot survey of the State, Owerri and Okigwe agricultural zones were selected out of the three zones. The selection was based on the existence of compound and non-compound farms in the zones. A total of 240 farmers — 120 from each of the two farm types — were sampled using the multi-stage sampling technique. Usable primary data were collected from the field using structured questionnaires. Major variables on which data were collected include method of land acquisition and rental values of cropped land, labour utilization, expenses on seed and planting materials, fertilisers and agro-chemicals as well as expenses on durable capital inputs. Data were also collected on per hectarage cultivation, farmers' age, market value of crops and distance between farm types and the households.

Model specification

Resource allocation

In determining the pattern of resource allocation among compound and non-compound farms, an econometric model of the type specified implicitly below was used:

$$Y_i = F(X_{i,} X_{2,} X_3, X_4, U) \quad (1)$$

where

Y_1 = Aggregate value of resources used in each farm type (compound and non-compound farm respectively)

i = 1 refers to compound farm, and i = 2 refers to non-compound farms.

X_1 = Farmers' age (Years)

X_2 = Farm size (Ha)

X_3 = Distance between farm type and the household (km)

X_4 = Market value of crops (N)

U = random error term

Analysis of productivity and efficiency of farm types

Similarly, a separate production function of the type (equation 2) was used for the determination and comparison of the productivity and efficiency of resources among the two farm types. The implicit form of this function is;

$$Q_i = F(X_{5,} X6, X_{7,} X8, U) \quad (2)$$

Qi = Naira value of total output in either of the two farm types.

X_5 = Expenses on durable capital (N)

X_6 = Mandays of labour

X_7 = Hectares of farm land cultivated

X_8 = Other inputs (fertilizers, seeds and agro-chemicals)

U = random error term.

Estimation of profit function

In order to determine the relative economic efficiency of the two farm types, a model adapted from Onyenweaku and Fabiyi (1991) and developed by Lau and Yotopolous (1971) was used. The model involved the estimation of a profit function and employing a dummy variable to differentiate between the two farm types in order to test the significance of the value of its coefficient. The unit output price (UOP) profit function model used is specified as:

$$LnII = both\,1D + b_2 LnWr + b_3 LnFs + b_4 LnKv + U, \qquad (3)$$

where

LnII = Profit per farmer in Naira defined as total value of output less total variable cost.
D = dummy variable distinguishing farm type (1 = non-compound farm, 0 = otherwise)
Wr = Wage rate in Naira per Manday of an adult farm worker
Fs = Farm size (Ha)
Kv = Capital input per farmer (N)
U = random error term

The underlying assumptions employed in the formulation of the profit function are that the farmers are maximizing profits, that the farmers are price takers in both output and variable inputs markets, and that the production function is concave in the variable inputs (Lau and Yotopolous, 1972). According to McFadden (1971) there exists a one-to-one correspondence between the set of concave production function and the set of convex cost functions. Hence, without loss of generality, we can consider only profit functions in the empirical analysis of the behaviours of profit-maximizing price-taking firms.

Results

Pattern of resources allocation among farms

In order to determine the pattern of resource allocation among the farm types, the linear, semi-log, double-log and exponential functional farms were fitted to the data. However, the double-log function was chosen as the lead equation following Olayide and Heady (1982). The results of this analysis for compound and non-compound farms are presented below:

$$LnY_1 = Ln_1 0{,}248 + \underset{(0{,}141)}{0{,}161LnX_1} + \underset{(0{,}044)^{***}}{0{,}290LnX_2} + \underset{(0{,}023)}{0{,}011LnX_3} + \underset{(0{,}043)^{***}}{0{,}539LnX_4}$$

$$R^2 = 0{,}84,\ n = 120 \qquad (1.1)$$

$$LnX_2 = Ln0{,}871 + \underset{(0{,}172)^{**}}{0{,}339LnX_1} + \underset{(0{,}049)^{***}}{0{,}113LnX_2} - \underset{(0{,}070)}{0{,}054LnX_3} + \underset{(0{,}040)^{***}}{0{,}533LnX_4}$$

$$R^2 = 0{,}77,\ n = 120 \qquad (1.2)$$

** Significant at 5 per cent

*** Significant at 1 per cent

Variables remain as previously defined in equation 1.

All the variables in compound farms are positively correlated to aggregate value of resources used. This suggests that farm size (X_2), farmer's age (X_1), distance between farms and household (X_3) and market value of crops are associated with larger amounts of resource allocation. Statistically, only farm size, and market value of crops (X_4) were significant at 1 per cent levels with an elasticity of 0,3 and 0,5 respectively. This means that aggregate resources allocation to the farmers will increase by 0,3 and 0,5 per cent respectively. Should farm size and market value of crops be increased by 1 per cent with respect to the non-compound farms, only farmer's age, farm size and market value of crops are positively correlated to aggregate value of resources used. The negative correlation of distance between farms and households to aggregate value of resources may suggest that resource allocation among farmers declines the further away non-compound farms are from households. Statistically, farmer's age, market value of crops and farm size are significant at 1 and 5 per cent levels respectively.

Determination and comparison of productivity and efficiency of resources among farms

Here the linear, semi-log, double-log and exponential functional forms were fitted to the data. Based on Olayide and Heady (1982) the double-log function was chosen. This is specified as:

$$\mathrm{Ln}Q_1 = \mathrm{Ln}0{,}939 + \underset{(0{,}078)^{*}}{0{,}146\mathrm{Ln}X_5} + \underset{(0{,}065)^{***}}{0{,}412\mathrm{Ln}X_6} - \underset{(0{,}0001)}{0\mathrm{Ln}X7} + \underset{(0{,}050)^{***}}{0{,}637\mathrm{Ln}X_8}$$

$$R^2 = 0{,}83;\ n = 129 \qquad (2.1)$$

$$\mathrm{Ln}Q_2 = \mathrm{Ln}1{,}187 - \underset{(0{,}105)}{0{,}038\mathrm{Ln}X_5} + \underset{(0{,}093)^{***}}{0{,}776\mathrm{Ln}X_6} - \underset{(0{,}000)}{0\mathrm{Ln}X7} + \underset{(0{,}018)^{***}}{0{,}403\mathrm{Ln}X_8}$$

$$R^2 = 0{,}76;\ n = 120 \qquad (2.2)$$

** Significant at 10 per cent

*** Significant at 1 per cent

Variables remain as previously defined in equation 2.

For the various resource inputs included in the model, the opportunity costs used were the market prices that prevailed during the production season. The per hectare opportunity costs of compound and non-compound farms were N368,33 and N276,75 respectively (USA $1 = N22). Similarly, the opportunity cost of hired labour is N18,27 while that of expenditure on durable capital and other inputs was taken as N1 plus the relevant interest charge of 30 per cent. The marginal value products of the inputs of capital (X_5), labour (X_6), land (X_7) and other inputs (X_8) for compound farms were calculated to be 29,36; 49,12; 0 and 1,23 respectively while that for the resources in non-compound farms were 35,89; 53,7; 4272,41 and 1,24 respectively. On a comparative basis, the results show that capital, labour and land were more productive in non-compound farms than in compound farms. This implies that the resources of capital and labour should be directed away from compound farms to non-compound farms to increase farmer's income on these farms.

With regard to the allocative efficiency of farmers in the two farm types the ratios of marginal value product (MVP_x) to marginal factor cost (MFC_x) show that capital, labour, land and other inputs have values of 22,59; 2,69; 0 and 0,94 for compound farms respectively while those for non-compound farms are 27,61; 2,91; 15,44 and 0,95 respectively. The farmers were found to be allocatively more efficient in the use of capital in compound farms (22,59) than non-compound farms (27,61). Similarly, they were also relatively more allocatively efficient in compound farms (2,69) than in non-compound farms (2,91) in the use of labour. The implication of these values for capital, labour and land in non-compound farms is that these resources were underutilized. This may suggest that there still exists the possibility of increasing revenue profitably under the existing level of technology through the use of higher levels of labour and capital in compound farms and through an addition to land in non-compound farms.

Technical efficiency of farmers in both farm types

Farmers in any of the two farm types can be regarded as technically more efficient if they consistently produce larger output given the same quantities of resources than their counterparts. Following Onyenweaku and Fabiyi (1991) and Chow (1960), the covariance analysis technique was used to compare the technical efficiency levels in both farms. The estimated production function is specified below:

$$\mathrm{Ln}Q_1 = \mathrm{Ln}155{,}229 + \underset{(7{,}567)^{***}}{29{,}364\mathrm{Ln}X_5} + \underset{(7{,}354)^{***}}{49{,}124\mathrm{Ln}X_6} - \underset{(1049{,}368)}{478{,}542\mathrm{Ln}X_7} + \underset{(0{,}190)^{***}}{1{,}226\mathrm{Ln}X_8}$$

$$R^2 = 0{,}81;\ n = 120;\ e^2 = 1083{,}34 \qquad (2.3)$$

$$\mathrm{Ln}Q_2 = \mathrm{Ln}\text{-}1047{,}598 + \underset{(11{,}588)^{***}}{35{,}886\mathrm{Ln}X_5} + \underset{(9{,}351)^{***}}{53{,}074\mathrm{Ln}X_6} + \underset{(1203{,}733)^{***}}{4272{,}405\mathrm{Ln}X_7} + \underset{(0{,}246)^{***}}{1{,}236\mathrm{Ln}X_8}$$

$$R^2 = 0{,}85;\ n = 120;\ e^2 = 1688{,}95 \qquad (2.4)$$

$$\mathrm{Ln}Q(1+2) = \mathrm{Ln}{-}408{,}377 + \underset{(6{,}408)^{***}}{63{,}248\mathrm{Ln}X5} - \underset{(0{,}382)^{***}}{0{,}794\mathrm{Ln}X_6} + \underset{(813{,}260)^{****}}{5753{,}818\mathrm{Ln}X_7} + \underset{(0{,}173)^{***}}{1{,}560\mathrm{Ln}X_8}$$

$$R^2 = 0,77; n = 240; e^2 = 3312,48 \quad (2.5)$$

***Significant at 1 per cent
Q(1 +2) = Pooled sample
Values in parentheses are standard errors.

In carrying out a structural stability tests, the Chow (1960) F-test was adopted to establish the existence or absence of structural changes in the two functions. This gave an F* value of 8,97 which is statistically significant at 5 per cent level. This implied that the farm production functions are not stable across the two farm types and thus equal technical efficiency does not hold in the two farm types. We then conclude that, at the technical level, the farmers are not equally efficient in both compound and non-compound farms. With respect to the nature of returns to scale in the two farm types, the sum of the elasticities of production show that there is increasing returns to scale in both compound farms (2,12) and non-compound farms (2,31).

Economic efficiency of farmers in both farm types
Here the profit function approach was adopted. The estimated form of this function is presented as:

$$\begin{aligned} LnII = Ln4{,}277 &- 0{,}169D - 0{,}968LnWr \\ &\quad (-0{,}085)^{***}\ (-0{,}486)^{**} \\ &+ 0{,}630LnFs + 0{,}473LnKv \\ &\quad (0{,}105)^{***} \quad (0{,}145)^{***} \\ R^2 = 0{,}29;&\ n = 240 \end{aligned} \quad (3)$$

** Significant at 5 per cent
***Significant at 1 per cent
Values in parentheses are standard errors

The value of the coefficient of multiple determination (R2 = 0,29) shows that 29 per cent of the total variation in the farmer's profit is accounted for by the variations in wage rate, farm size and capital input. However, the coefficient of the dummy variable was negative and statistically non-significant at the 5 per cent level; which implies that the profit function for non-compound farms has a lower intercept term than that of compound farms and there is a higher level of economic efficiency in compound farms than in non-compound farms.

Policy implications and conclusion

The farmers were found to be efficient in the compound farms probably through the maintenance of soil fertility using household refuse. It is therefore recommended that a government waste management policy directed at the effective utilization of bio-wastes in the non-compound farms may increase the fertility status and economic efficiency of non-compound farms. It is also recommended that farmers in non-compound farms should be encouraged to increase their use of fertilizer to such an extent that the fertility in those farms may equate to that of compound farms. Finally, it is recommended that more credit facilities should be made available to the farmers probably through co-operative societies so as to enhance the output of the farmers in both farm types.

It may be concluded that the farmers operated in the stage one of their production function in both compound and non-compound farms.

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