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Off-Farm Work and Profit Efficiency among Small-Scale Farmers in North-Central Nigeria

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Abstract
The study evaluated profit efficiency within the context of off-farm work participation among small-scale farmers in North-Central Nigeria. The population of the study comprised participants and non-participants in off-farm work. Multistage sampling technique was used to select 360 respondents for the study. Data for the study were obtained from primary source with the aid of standard questionnaire and analysed using descriptive statistics and profit efficiency model. Findings showed that participants and non-participants had average farm sizes of 3.69ha and 3.59ha, incurred average fertiliser costs of ₦312.77 and ₦246.23 per kg respectively. While farm size significantly ($p < 0.01$) increased profit for participants and non-participants, average fertiliser cost reduced profit for non-participants. In the diagnostic statistics, sigma squared (σ^2) was significant for participants ($p < 0.01$) and non-participants ($p < 0.05$). Gamma (γ) was high (0.9870) and significant ($p < 0.01$) for non-participants indicating high profit inefficiency. Farm family labour significantly ($p < 0.05$) increased profit inefficiency among participants but reduced profit inefficiency among non-participants. Participants had significantly ($p < 0.01$) less average profit than non-participants. It was concluded that participation in off-farm could make farm enterprise unattractive and impair food production. Hence, participants in off-farm work should improve farm production cost management in order to shore up their gross farm profit.
Keywords: efficiency, farmers, non-participants, North-Central Nigeria, off-farm, participants, profit, stochastic frontier

Introduction

Off-farm work refers to activities from which farmers earn income apart from their own farm. In Mexico, De Janvry and Sadoulet (2001) clearly separated farmers into those who participated in off-farm work and those who did not. According to Babatunde, Olagunju, Fakayode and Adejobi (2010), the scenario, however, is different in rural Nigeria, where farmers engaged in several activities at the same time in a way that decisions to participate are not mutually exclusive. Off-farm engagement is generally disaggregated into three components. These are agricultural wage employment (AWE), involving labour supply to other farms, non-agricultural wage employment (NAWE), including both formal and informal non-farm activities, and self-employment (SE) such as own businesses (Babatunde *et al.*, 2010; Ibekwe *et al.*, 2010). Myyra, Pietola and Heikkila (2011) affirmed that besides generating annual income, a farm family might have a goal to accumulate wealth through capital gains from off-farm activities.

Off-farm work is both advantageous and disadvantageous. On one hand, off-farm income stabilises household income. Coupled with inaccessibility to credit facilities, small-scale farmers often resort to off-farm work to obtain fund for farm investment. On the other hand, off-farm work diverts critical resources from the core farm production sector. Where farm input market is imperfect, and there is imperfect substitution of capital for labour, off-farm work could have adverse effect on farm firm profit.

Off-farm income has increased as a proportion of total household income even in developed countries (Woldehanna, Oude-Lansink & Peerlings 2000; Lien, Kumhakar & Hardaker, 2010). According to Bojnec and Ferto (2011), income diversification of rural households is driven by such determinants as higher returns to labour and capital in off-farm economy as well as by risks relating to farm input market imperfections. Dries and Swinnen (2002) and Hertz (2009) have provided evidence on a positive association between off-farm income and farm efficiency. Thus, farm performance could be proxied by technical efficiency, cost efficiency, and allocative efficiency.

The performance of farm enterprise is measured by the level of profit obtainable. Profit is also a measure of sustainability of an enterprise. Thus, until the farm unit is seen as a business outfit, which is the focus of the policy thrust on agribusiness development, there would be continual drain of critical resources from the farm sector. Researchers often use gross margin analysis to determine the ability of the farm firm to meet its current obligation and to remain in operation. Gross margin the difference between total revenue (TR) and total variable cost (TVC).

Bojnec and Ferto (2011) used stochastic frontier model to determine the impact of off-farm income on farm efficiency in Slovenia, using time series data. In their preliminary results, the share of farms with off-farm income varied by type of farming (field crop, horticulture, livestock and mixed farming). Using the translog functional form in preference to Cobb Douglas' as indicated by the log-likelihood ratio, they found that real total intermediate consumption reduced technical efficiency, while total utilised agricultural area and total labour input increased technical efficiency at various levels of probability.

The variance parameter, γ, which lies between 0 and 1, indicated that technical inefficiency was stochastic and that it was relevant to obtaining an adequate representation of the data. The value of γ picked up the part of the distance to the frontier explained for the inefficiency. In their estimation, the value of the variance parameter γ was 0.98. That meant that the variance of the inefficiency effects was a significant component of the total error term variance and that, farms' deviations from the optimal behaviour were not due to random factors only. Thus, the stochastic frontier was a more appropriate representation than the standard ordinary least square estimation of the production function (Hung-Jen, 2002).

Stochastic frontier time-varying decay inefficiency model indicated a positive and significant association of the stochastic frontier time-varying decay inefficiency in terms of real total output, which was used as the dependent variable, with the traditional agricultural inputs, i.e., total utilised agricultural area and total labour input, respectively. Negative association was found with real total fixed assets, whose regression coefficient was insignificant, and real total intermediary consumption, which was statistically significant ($p < 0.10$). Except for total labour input, all regression coefficients for the squared explanatory variables were of a positive sign and significant. The regression coefficients for the interaction effects of the explanatory variables were mixed. A positive and significant association was found for the regression coefficient of the interaction effect of the real total fixed assets and total labour input, while negative sign and statistical significance were found for the regression coefficient of two interaction effects: real total intermediate consumption and real total fixed assets, and total utilised agricultural area and total labour input. These results indicated that the more agricultural area and labour input the farm employed, the more inefficient it was, and vice versa for intermediate consumption and to a lesser extent for total fixed assets. Farm inefficiency was mitigated in a combination of intermediate consumption and fixed assets, and agricultural area and labour input, and vice versa for fixed assets and labour input (Bojnec & Ferto, 2011).

Profit efficiency function

The stochastic profit frontier for this study was patterned after the works of Ali and Flinn (1989), Ali, Parikh, and Shah (1994), Adesina and Djato (1996), Berger and Mester (1997), Maudos, Pastor, Perez and Quesada (2002) and Kolawole (2006). The standard profit function assumes that markets for outputs and inputs are perfectly competitive. Given the input (W) and output price vectors (P), the firm maximises profits by adjusting the amount of inputs and output. Thus, the profit function can be expressed implicitly as:

$\pi = f(P,W;V,U)$ (1)

In logarithms terms, the function is specified as:

$\ln(\pi + \theta)\ln f(P,W) + (V - U)$ (2)

where:

θ = a constant added to the profit of each enterprise in order to attain positive values, so that the factors could be treated logarithmically. The exogenous nature of prices in this concept of profit efficiency assumes that there is no market power on the farmers' side. Instead of taking price as given, the farmers often assume the possibility of imperfect competition, given only the output vector and not that of price. Thus, alternative profit function is:

$\pi = f(Y,W,V,U)$ (3)

in which the quantity of output (Y) produced replaces the price of output (P) in the standard profit function. Profit efficiency in this study is defined as profit gain from operating on the profit frontier, taking into consideration farm-specific prices and factors. The actual normalised profit function, which is assumed to be well behaved, could be derived as:

Farm profit is measured in terms of Gross Margin (GM) which equals the difference between the Total Revenue (TR) and Total Variable Cost (TVC).

$GM(\pi) = \Sigma(TR - TVC) = \Sigma(PQ - Wx_i)$ (4)

To normalise the profit function, gross margin ($\boldsymbol{\pi}$)is divided on both sides of the equation above by *P,* which is the market price of the output of an enterprise. Thus:

$$\frac{\pi(p,z)}{P} = \frac{\Sigma(PQ - WX_i)}{P} = \frac{Q - WX_i}{P} = f(X_i, Z) - \Sigma p_i X_i \quad (5)$$

Where:

TR = total revenue,

TVC = total variable cost,

P = price of output (Q),

X = the quantity of optimized input used,

Z = price of fixed inputs used,

P_i = W/P which represents normalized price of input Xi,

f(Xi,Z) = production function.

As prescribed by Meeusen and van den Broeck (1997), the Cobb-Douglas profit function, in implicit form, which specifies production efficiency of the farmers, is expressed as follows:

$\pi i = f(p_i, z)\exp(V_i - U_i),\ i = 1,2,\ldots n$ (6)

The *Vis* are assumed to be independent and identically distributed random errors, having normal $N(0,\sigma^2v)$ distribution, independent of the *Uis*. The *Uis* are profit inefficiency effects, which are assumed to be non-negative truncation of the half-normal distribution $N(0,\sigma^2v)$. The profit efficiency is expressed as the ratio of predicted actual profit to the predicted maximum profit for a best-practiced operator. This is represented as:

$$\textbf{Profit efficiency}(E_n) = \frac{\pi}{\pi^{max}} = \frac{exp[\pi(p,z)]exp(lnV)exp(-lnU)-\theta}{exp[\pi(p,z)]exp(lnV)-\theta} \quad (7)$$

Firm specific profit efficiency is also the mean of the conditional distribution of *Ui,* which is given by

$$E_n = E\frac{exp(-U_i)}{E_i} \quad (8)$$

E_n takes the value between 0 and 1. If $U_i = 0$ (on the frontier), potential maximum profit is obtainable, given the price it faces and the level of fixed factors and is, thus, efficient. If $U_i > 0$, the farm firm is inefficient, losing profit as a result of inefficiency. In this study, Battese and Coelli (1995) and Coelli and Batesse (1996) models were used to specify the stochastic frontier function with behaviour inefficiency components and to estimate all parameters together in one-step maximum likelihood estimation. Socio-economic variables will be included in the model to indicate their possible effect on the efficiency of the farmers. The variance of the random errors, σ^2v that of the inefficiency effect σ^2u and overall variance of the model σ^2 will measure the total variation from the frontier which would be attributed to inefficiency. The parameter γ represents the share of inefficiency in the overall residual variance with values in interval 0 and 1. A value of 1 suggests the existence of a deterministic frontier, whereas a value of 0 will be seen as evidence in the favour of OLS estimation (Coelli, 1996; Ajibefun & Daramola, 1998; Ajibefun, Battese, & Daramola, 2002; Wang & Wailes, 1996; Wang, 2002).

This study was designed to provide empirical evidence on the role of off-farm work in farm profit efficiency. It was hypothesised that there is no significant difference in farm firm profit between participants and non-participants in off-farm work in North-Central Nigeria.

Empirical formulation of profit efficiency

In line with Effiong and Onyenweaku (2006) and Nganga, Kungu, de Ridder and Herrero (2010), the stochastic profit frontier, using Cobb-Douglas functional form, was specified as follows:

$\ln\pi = \ln\beta_0 + \beta_1\ln X_1 + \beta_2\ln X_2 + \beta_3\ln X_3 + \beta_4\ln X_4 + \beta_5\ln X_5 + \beta_6\ln X_6 + \beta_7\ln X_7 + \beta_8\ln X_8 + (v_i + u_i)$ (9)

where:
π = gross margin (₦),
x_1 = farm size (ha),
x_2 = average cost of hired farm labour (₦),
x_3 = average price per kg of fertilizer (₦),
x_4 = average price per kg of seed (₦),
x_5 = price per litre of agrochemical (₦),
x_6 = average price of farm tools/machineries (₦),
x_7 = average marketing cost (₦),
x_8 = average transportation cost (₦), and
x_9 = capital input (₦).
The inefficiency model (*Ui*) for the stochastic profit frontier was defined by:
$Ui = \delta_0 + \delta_1z_1 + \delta_2z_2 + \delta_3z_3 + \delta_4z_4 + \delta_5z_5 + \delta_6z_6 + \delta_7z_7 + \delta_8z_8 + \delta_9z_9 + (v_i - u_i)$ (10)
where:
z_1 = age (years),
z_2 = sex (1 = male, 0 = female),
z_3 = formal education (years),
z_4 = household size,
z_5 = farming experience (years),
z_6 = farm labour (man days),
z_7 = amount of credit obtained (₦),
z_8 = number of times visited by extension agent, and
z_9 = membership of farm association (1 = member, 0 otherwise).

Paired sample t-test used to test the hypothesis for the study, was specified as follows:

$$t = \frac{X_1 - X_2}{\sqrt{\frac{SX_1^2}{nX_1} + \frac{SX_2^2}{nX_2}}} \quad (11)$$

$t = t - statistic$

$X_1 = mean\ farm\ firm\ profit\ for\ participants,$
$X_2 = mean\ farm\ firm\ profit\ for\ non-participants,$
$SX_1^2 = standard\ deviation\ of\ farm\ firm\ profit\ for\ participants,$
$SX_2^2 = standard\ deviation\ of\ farm\ firm\ profit\ for\ non-participants,$
$nX_1 = number\ of\ participants,$
$nX_2 = number\ of\ non-participants.$

Summary statistics of the variables for cost and profit efficiency

The summary statistics of variables used for profit efficiency in Table 1 showed that there was homogeneity in input cost between participants and non-participants, except for average cost of fertiliser. Average fertiliser cost, a function of the quantity of fertiliser used, was higher among the participants than the non-participants. Fertiliser has been the bane of crop production among small-scale farmers in Nigeria. This is worse among resource-poor farmers. This result showed that fertiliser scarcity and exorbitance were less severe among participants in off-farm work, owing to their relatively relaxed farm budget. This is a confirmation that off-farm income relaxes farm household budget constraint as indicated by (O'Brien & Hennessy, 2005).

Table 1: Summary statistics of the descriptive variables for profit efficiency

Item	Participant (n = 180)		Non-participant (n=180)	
	Mean	Standard Deviation	Mean	Standard Deviation
Total revenue (₦)	479,534.22	329,271.80	453,391.28	264,229.52
Farm size (ha)	3.69	1.49	3.59	1.48
Average cost of hired farm labour (₦)	1,897.33	1,374.90	1,568.44	1,194.65
Average cost per kg of fertilizer (₦)	312.77	971.58	246.23	77.60
Average cost per kg of seed (₦)	1,508.92	1,304.00	1,731.45	1,457.71
Average cost per L of agrochemical (₦)	2,020.92	829.67	2,138.43	847.23
Average price of farm tools (₦)	14,835.97	17,689.90	16,769.39	19,890.07
Average marketing cost per bag (₦)	2,296.37	3,664.55	2,406.04	2,827.32
Average transport cost per bag (₦)	2,181.35	1,175.18	2,161.44	1,116.34

Source: computed from field survey, 2013.

Maximum likelihood estimates of the stochastic frontier profit function

The maximum likelihood estimates of the stochastic frontier profit function were presented in Table 2. In the diagnostic statistics, sigma square was significant for both participants ($p < 0.01$) and non-participants ($p < 0.05$), indicating that the model fitted the data well. Gamma was significant ($p < 0.01$) for non-participants. It was close to one (0.9870), indicating high level of profit inefficiency among the farmers. Rahman (2002) also found high level of profit inefficiency among small-scale farmers in Bangladesh.

The result, also, showed that farm size ($p < 0.01$)) significantly increased profit among participants. Although, farm size is normally associated with large cost outlay, participants sourced additional fund from off-farm work to accommodate the marginal cost. It is also a fact that farm size is often associated with greater output which translates to more revenue. This finding is consistent with Nganga, Kungu, de Ridder & Herrero (2010) that farm size increased farm firm profit.

Average cost of farm tools ($p < 0.05$) significantly increased participants' profit. Two reasons could be advanced for this strange behaviour of this group of farmers. One, their access to additional fund gave them the capacity to acquire more farm tools. Two, due to their off-farm status, reliance on efficient machineries was one major strategy that would enable them succeed as farmers. The behaviour of this variable among participants suggested that they were more inelastic to increasing cost of farm operations. Their goal would just be increased output and, possibly, gross margin.

In the inefficiency function for participants, family labour ($p < 0.05$) statistically increased profit inefficiency. For participants, the allocation of own labour to farm work was inimical to their off-farm business. This finding conformed to Nehring and Fernandez-Cornejo (2005) which emphasised on less own labour by farmers who were in off-farm work. The result also validated the tradeoff theory of labour allocation between farm and off-farm works that off-farm work could be counterproductive with respect to farm enterprises.

For non-participants, age and credit obtained significantly ($p < 0.01$) reduced profit inefficiency. As the farmer aged, albeit not infinitely, accumulated experience and increased level of maturity would enhance profitability of farm firms. Credit significantly reduced profit inefficiency among participants ($p < 0.05$) and non-participants ($p < 0.01$). Availability of credit increased profit because more funds meant increased capacity to acquire critical farm production inputs such as improved seeds, fertiliser and labour as well as facilitated timely operations. This finding, however, invalidated Nganga, Kungu, de Ridder and Herrero (2010) where age in the inefficiency function was positively signed.

Formal education ($p < 0.05$) significantly reduced profit inefficiency for non-participants. Educated farmers had the advantage of selling their farm produce at the lean period, thereby, attracting higher profit. In addition, they had the knowledge that could enhance optimal utilisation of resources, thereby, minimising variable cost and maximising gross margin. This finding is consistent with Nganga, Kungu, de Ridder & Herrero (2010) that higher education reduced profit inefficiency. The result, however, contradicted Wadud and White (2000) and Rahman (2002) who explained that, in Bangladesh, education pulled away households from farming as its opened up opportunities to engage in off-farm work that were often more rewarding than farming on small pieces of land.

Family labour significantly ($p < 0.05$) reduced profit inefficiency for participants and non-participants. In contrast with participants, non-participants in off-farm work relied heavily on family labour for farm productivity because it was their main occupation. Family labour is a critical productive input among small-scale farmers in developing countries (Okoye *et al.*, 2008).

Household size, which was expected to confer labour availability on farm households, was found to have significantly increased profit inefficiency for non-participants ($p < 0.05$). This was possible because larger households had higher levels of consumption, thereby reducing the quantity of produce available for sale, and invariably reducing profit efficiency. This finding contradicted Nganga, Kungu, de Ridder and Herrero (2010) where household size was insignificant.

Table 2: Maximum likelihood estimates of the stochastic frontier profit function

Variable	Parameter	Coefficient	
		Participants	Non-Participants
Constant	β_0	10.7625 (10.2546)*	18.9545 (101.4922)*
Farm size	β_1	0.5387 (5.3932)*	-0.3487 (-7.3121)*
Average cost of hired labour	β_2	0.0392 (0.9178)	0.0244 (6.0640)*
Average price per kg of fertiliser	β_3	-0.0814 (-1.0634)	-0.2879 (-8.1207)*
Average price per kg of seed	β_4	0.0265 (0.7616)	0.0265 (2.5773)**
Average price per litre of agrochemical	β_5	-0.0333 (-1.0957)	0.0292 (8.7689)*
Average price of farm tools/machineries	β_6	0.1205 (2.4244)**	-0.1429 (-11.5394)*
Average marketing cost	β_7	0.0317 (0.9517)	-0.0008 (-0.6513)
Average transportation cost	β_8	0.1110 (1.1998)	-0.4363 (-13.3941)*
Capital input	β_9	-0.0393 (-0.8779)	0.0009 (0.5783)
Inefficiency function			
Intercept	δ_0	-0.3027 (-0.3186)	17.5402 (3.2893)*
Age	δ_1	0.2559 (0.6838)	-3.2897 (-3.0959)*
Sex	δ_2	0.7193 (1.9075)	-0.0066 (-0.4267)
Formal education	δ_3	-0.0267 (-1.2479)	-0.1088 (-2.5144)**
Household size	δ_4	-0.3304 (-1.2600)	0.4056 (2.3508)**
Farming experience	δ_5	0.0843 (0.5327)	-0.6245 (-1.9275)
Farm family labour	δ_6	0.2623 (2.1055)**	-0.5546 (-2.4536)**
Credit obtained	δ_7	-0.0382 (-2.2117)**	-0.3687 (-3.0739)*
Number of extension visit	δ_8	-0.0027 (-0.1009)	-0.0091 (-0.8083)
Membership of farmer association	δ_9	0.4589 (1.3089)	0.3473 (0.3455)
Diagnostic statistics			
Sigma square	σ^2	0.2853 (7.2153)*	0.0106 (2.6832)**
Gamma	γ	0.9974 (0.5379)	0.9870 (146.7041)*
Log likelihood		-133.6595	372.9756
LR test		16.3170	156.2749

*,** significant at 1% and 5% levels.

Source: Computed from field survey data, 2013

Distribution of farmer specific profit efficiency estimates

Majority of participants (38.9%) and non-participants (87.2%) in Table 3 had profit efficiency ranging from 90.00% to 99.99%, while average profit efficiencies for participants (81%) and non-participants (95%) were high. This implied that 9% and 5% of gross margin were lost to profit inefficiencies by participants and non-participants, respectively. The three arable crops selected for this analysis constituted dominant staple foods in many Nigerian households. With increasing urbanisation resulting in greater proportion of non-farmers who are willing to pay for these food items at any price, farmers could obtain high returns to scale. The result further showed that non-participants in off-farm work had greater profit efficiency than the participants. This is another indicator of the tradeoff in labour supply between farm and non-farm sectors of the rural economy. Furthermore, the emerging dual farm structure may not be so beneficial to the small-scale farmers.

Table 3: Frequency distribution farmer specific profit efficiency estimates

	Participants (n=180)		Non-participants (n=180)	
Profit	Frequency	Percentage (%)	Frequency	Percentage (%)
0.00 - 20.99	1	0.60	0	0.00
30.00 - 39.99	0	0.00	0	0.00
40.00 - 49.99	4	2.20	0	0.00
50.00 - 59.99	4	2.20	0	0.00
60.00 - 69.99	26	14.40	2	1.10
70.00 - 79.99	40	22.20	3	1.70
80.00 - 89.99	35	19.40	18	10.00
90.00 - 99.99	70	38.90	157	87.20
Total	180	100.0	180	100.0

Mean profit efficiency: Participants (0.81); Non-participants (0.95)
Source: Computed from field survey data, 2013

As shown in Table 4, the mean profit for non-participants was significantly ($p < 0.01$) greater than that of the participants. Profit is the ultimate goal of any farm enterprise. For the non-participants, the farm firm was largely the sole source of household income as well as livelihood. This underscored the time and management skills they devoted to farming, meaning that they were expected to incure relatively less variable cost of production. Again, the probability of the exit of this group of farmers from farming was not as high as for the participants.

Table 4: Difference in Farm Profit Efficiency Estimates between Participants and Non-participants

Samples	Mean	Standard Deviation	Mean difference	T-ratio	P-value
Participants' profit (₦)	0.8129	0.13956	-0.137	-12.821*	0.000
Non-participants' profit (₦)	0.9499	0.05713			

* significance at 0.01level
Source: Computed from field survey data, 2013

Conclusion and Recommendations

Due to the transfer of labour, invariably time, to the off-farm sector, participants incurred more cost on farm production input. The fund obtained from off-farm work facilitated the procurement of critical productive input. These translated to higher cost production, hence, significantly less farm firm profit than the non-participants, indicating counter-productivity of off-farm work participation. This trend could discourage farm firm production and further precipitate labour migration from the farm sector.

It was recommended that participants in off-farm work in rural Nigeria should improve on input cost management so as to reduce farm production cost and, hence, increase profit. Acquisition of formal education is also recommended to further reduce profit inefficiency especially among the non-participants. Similarly, government's current policy on financial inclusion should be made effective to increase credit availability which would, in turn, reduce farm profit efficiency. These measures would minimise the emerging dual farm structure from adversely affecting food production. The measures would also strengthen the growth and impact of government's new agribusiness policy thrust.

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