Off-Farm Household Labour Allocation and Technical Efficiency among Groundnut Farmers in Eastern Uganda

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Abstract

Integrated Pest Management (IPM) technologies are aimed at improving farmers' incomes and have been adopted by some farmers in Uganda. However, many farmers obtain off-farm income from various activities and have to decide whether or not to further participate in off-farm activities and how much of their labour to allocate to such activities to maximize household utility. Therefore this paper examines factors that influence the likelihood of farm households participating in off-farm work and factors that determine the amount of off-farm labour supply. It also investigates the effect of household labour re-allocation to off-farm activities on technical efficiency. Data were collected from 216 groundnut farmers in Eastern Uganda through a household survey in locations where the IPM project had set up demonstration plots. A bivariate probit model was used to determine factors influencing the likelihood of participation in off-farm work. Weighted least squares model was used to determine factors influencing off-farm labour supply. A stochastic production frontier model was used to determine the level of technical efficiency among groundnut farmers. Age, education, household size, number of children active in farming, location, off-farm income, livestock and poultry farming and farm size significantly influence the likelihood of the household's participation in off-farm work. Education of household head and off-farm wage rates positively influence labor supply to off-farm work. Labor re-allocation to off-farm work among IPM adopters does not necessarily decrease TE at the farm but it does for the non-IPM adopters at 10% level of significance.

***Key words*:** Off-farm work; Labor allocation; Technical efficiency, Eastern Uganda

INTRODUCTION

The government of Uganda is trying to improve the agricultural sector through the Plan for Modernization of Agriculture (PMA) with the aim of increasing productivity and commercialization of farming. Among the priority areas of action of the PMA is research and technology development. Emphasis has been put on development of higher yielding and disease resistant varieties through use of more appropriate technologies. As a result of these efforts, Makerere University Cowpea and Groundnut Improvement Project and the Integrated Pest Management Collaborative Research Support Program (IPM CRSP) developed integrated pest management (IPM) technology to improve the production of groundnuts (*Arachis hypogea*). The crop is one of the leading protein providing foods in Uganda. It is the second most important food crop after the common bean (*Phaseolus vulgaris* L.) and the main legume in the drier parts of the country (Sabiti *et al.*, 1994).

Ekiyar *et al.* (2003) found that groundnut farmers who used the IPM technology package obtained higher profits than those who used the traditional technology. In addition, they found that increasing the use of labor would increase the benefits of using IPM technology. The size of cultivable land and use of hired labor increased the probability of adopting IPM technology by 11.2% and 25.5%, respectively. The IPM technology developed is supposed to improve the welfare of smallholder groundnut farmers in terms of income and food security. However, these farmers, like everywhere else, diversify their household income by allocating some of their labor resources to off-farm activities in order to diversify and increase their revenues. In Uganda farmers are engaged in off-farm income-generating activities, such as market vending, offering casual labor services, civil service, beer brewing and brick making. Therefore, households can be assumed to allocate their time between farm work, off-farm work and leisure activities in a way that maximizes their utility. Delgado (1997) indicates that it is a well-known fact that smallholder farmers in Sub-Saharan Africa do a lot of income-generating activities besides growing crops and tending livestock. They rarely rely on crop or livestock income alone. Local off-farm income can be generated from activities such as sales of handicrafts, processed foods, and offering labor services. Caridad (2003) states that off-farm employment is crucial for the rural poor in that income from off-farm activities represents a significant share of the total income of rural households, but also off-farm jobs absorb an increasing proportion of the rural labor among the land poor. Participating in off-farm activities offers a diversification strategy for the household and off-farm incomes provide a source of liquidity in areas where many are credit constrained.

Profitable groundnut production is labor intensive. However, farm households allocate some of that labor to off-farm activities, whether it is managerial or otherwise. This study therefore had to determine whether or not this labor re-allocation to off-farm work had implications on the production of groundnuts. This was done by examining the labor re-allocation implications on the supply of food and income from groundnuts. Thus the objectives of this study were to (i) determine the factors that influence the likelihood of a farm household's participation in off-farm income-generating activities; (ii) determine the factors that affect the supply of farm household labor to off-farm work; and (iii) determine whether farmers who engaged in off-farm work have a lower level of technical efficiency than those who work full time. This study hypothesized that farmers who engaged in off-farm work have a lower level of technical efficiency than those that work full time.

METHODOLOGY

Study area, sampling and sample size

The study was carried out in eastern Uganda in the districts of Mayuge, Pallisa and Kumi. These are some of the districts where the Makerere University Cowpea Improvement Project and Integrated Pest Management Collaborative Research Support Program (IPM CRSP) set up demonstration sites during the dissemination of the IPM technology. Both purposive and random sampling procedures were used to select study sites as well as respondents. From each of the districts, the 3 sub-counties were purposively selected. IPM users were therefore defined as those farmers who had been growing the improved groundnut varieties and either planted early or used close spacing and sprayed 2 times a season as recommended by the programme. Farmers who grew local groundnut varieties but applied at least two of the recommended IPM practices were also considered IPM technology users. Farmers that did not lie in the above mentioned categories were considered traditional groundnut technology users. With the help of area agricultural extension officers, these two farmer categories were purposively selected (those using IPM technologies and those using traditional methods). From each of the sub-counties 12 IPM users and 12 non-IPM users were randomly selected. This resulted into 24 respondents per sub-county and a sample of 72 respondents per district making a total of 216 respondents for the study

Data types and data collection

Both primary and secondary data were collected. Primary data, which formed the core of this study, were collected from groundnut producers using a structured, pre-tested questionnaire that was directly administered. Data were collected for two production seasons (April-July 2005 and August-December 2005) on sex, age, education level, occupation type, incomes, household size, farm size, access to markets, access to credit and access to extension services among others, of household's head and spouse. The data were entered and cleaned in Statistical Package for Social Scientists (SPSS) computer program. The data were then transferred to STATA version 9.0 where the econometric analysis was carried out.

Model specification

Participation in off-farm work

Following Madalla (1983), Judge *et al.* (1985), Huffman (1991), and Abdulai and Delgado (1999), this study assumes a simple household's utility as a function of goods and services consumed. These include leisure time and consumption goods as shown in equation (1).

(1) $U = U[C, T_L; \mathbf{\Phi}]$

where U is the household's utility function assumed to be monotone increasing in the arguments, strictly concave and is thrice differentiable everywhere; C is the set of consumption goods and services; T_L is total leisure time for the household; and $\mathbf{\Phi}$ is a vector of parameters of household characteristics, such as level of education and age of household head. A random utility model where the farm household has two choices; either to participate in off-farm income generating activities or not is assumed. In general, denoting the utility derived by the household from an participating in off-farm work as U_1, and that of participating in farm work exclusively as U_2, then the i[th] farm household will choose to engage in off-farm income-generating activities if $U_1 > U_2$. Denoting the latent, random variable as $y^*_i = U_1 - U_2 > 0$, then the observable random variable y_i is determined as,

(2) $y_i = 1$ if $y_i^* > 0$
$= 0$ if $y_i^* < 0$

Specifically, the farm household model indicates that an individual in the farm household chooses to participate in off-farm work when the non-farm or market wage (W^M) exceeds his or her reservation wage (W^R). The reservation wage for off-farm work of the individual is the marginal value of his/her time when all of it is allocated to farm labor and leisure. Following Huffman (1991) the reservation and off-farm wage equations can be specified as

(3) $W_i^R = \alpha_1 X_{i1} + e_{ri}$

(4) $W_i^M = \alpha_2 X_{i2} + e_{Mi}$;

i = household head, spouse

where W_i^R and W_i^M are reservation and market wage rates, respectively. X_{ij} are vectors of explanatory variables such as individual, household and location characteristics. An off-farm work participation latent variable (y^*_i) for individual i is given as

(5a) $y^*_i = 1$ if $W_i^M > W_i^R$

(5b) $y^*_i = 0$ if $W_i^M \leq W_i^R$

The probability of participating in off-farm work is specified as

(6) $\Pr(y^*_i = 1) = \Pr(W_i^M > W_i^R)$
$= \Pr(e_{ri} - e_{Mi} < \alpha_2 X_{i2} - \alpha_1 X_{i1})$
$= F(\boldsymbol{\alpha} X_i)$, the cdf for $v = (e_{ri} - e_{Mi})$

It is assumed that the decisions of the household head and spouse to participate are jointly made. Thus the likelihood of an individual participating in off-farm work is affected by the characteristics of their spouse. In this case a bivariate probit model is more appropriate in the estimation of the non-farm work participation function, specified as

(7) $y_i = \beta' \mathbf{X}_i + e_i$; i = head, spouse y_i is the dependent variable which takes a value of 1 if each one of the couple, the household head and the spouse participates in off-farm work and zero if each one of the two does not participate in off-farm work. **X** is a vector of explanatory variables characterizing the household head and spouse, which include age, education level, farm size, location of household, household size, and population density. β' is a vector of parameters to be estimated. Variants of (7) were estimated with robust standard errors.

A Priori Signs of the Coefficients of the Factors Affecting the Participation Decision

Age can influence the ability and will to develop off-farm income-generating activities. A model supporting the hypothesis of a life cycle by Huffman (1980) and Sumner (1982) contends that individuals will increase their work effort at a younger age in order to accumulate assets to draw on later in life. The marginal productivity of a person has a concave profile, first increasing and then decreasing with age. Younger farmers may also want to work more hours to add to their stock of human capital (Mishra and Goodwin, 1998). Therefore both age and age squared were introduced to capture the concave life cycle effect. The coefficient on age is, *a priori* , positive and that of age squared negative.

The level of education (measured as the number of years of formal schooling) was used to indicate productivity potential for both on farm and off-farm activities (Behrman and Wolf, 1984). At constant wages, an improvement in the level of an individual's education can, increase the probability of participation and time allocation to off-farm work, if it increases his or her opportunity cost of staying at home (Abdulai and Delgado, 1999). *A priori*, the education coefficient should have a positive sign.

Also household size was used to reflect the amount of labor that is available to the household for both farm and off-farm work. This means that the household head and their spouse could find it convenient to re-allocate their labor to off-farm work or increase the amount of farm work done or both as a way of increasing household income to meet the big household expenditure. In addition, the larger household size could be a reflection of a large number of very young or elderly dependants who are not active in farming. Therefore the effect of household size is ambiguous.

The number of children active in farming is a very important source of household labor. They are in most cases involved in housework that could influence the participation decisions of the parents. Children take part in most of the post-harvest farming activities and could therefore act as a substitute source of farm labor for the head and their spouse. Abdulai and Delgado (1999) documented that the number of dependents not active in farm work is a factor that is very likely to influence the off-farm participation decision of women in the household.

Similarly distance (in Km) to the nearest trading center/town is expected to have an inverse relationship with off-farm labor supply. It was used to proxy the ease with which employment in the off-farm sector can be obtained since locations close to commercial centers such as towns usually have better employment opportunities. That is, a proxy for transaction costs such as commuting/ transportation costs. These costs increase the reservation wage and reduce the likelihood of participating in off-farm work.

Farm size (measured as the average number of hectares cultivated in that particular season) was hypothesized to affect participation in off-farm work. Households with limited (less than needed) farmland are most likely to resort to off-farm work as a means of survival. It was expected that households with larger pieces of cultivable land were not likely to participate in off-farm work. Thus, farm size should have a negative relationship with the participation decision.

The amount of annual income flows obtained from various off-farm activities is also most likely to influence the participation decision of the household. An individual is more likely to participate in off-farm work if the income flows from the various off-farm sources far exceed those from farming activities. One of the reasons that have been cited as a major cause of rural urban migration is the higher paying employment opportunity in urban centers.

Livestock and poultry enterprises (defined as dummy variables) could be a way of diversification, thus increasing the stability of a household's income flows. This may reduce the amount of labor that a household has to offer for off-farm work thus negatively influencing the participation decision. These were entered as dummies because not all farm households keep or rear livestock and/or poultry.

Off-farm labor supply of the farm household

Following Skoufias (1994) Huffman (1991), and Findeis (2001), this study employed the farm household model (FHM) to analyse off-farm labour supply decisions by farm households. In the FHM household members are assumed to maximize total utility, U, of the household, subject to the household's total (labor and non-labor) income and total time available for work and leisure. It is assumed that household members jointly decide on the level of goods and services consumed by the household and quantities of leisure time so as to maximize the joint utility of the household within a single time period. It is also assumed that U, the household utility function is monotone increasing in the arguments, strictly concave and is thrice differentiable everywhere.

Following Huffman (1991) and Abdulai and Delgado (1999), the model may be written as

(8) $\text{Maximise } U = U[C, T_L; \mathbf{\Phi}]$

s.t.

$PC = P_Y F(T_F, X_F; H_F, \mathbf{Z_F}) - P_X X_F + T_0 W_M + V$

$T = T_0 + T_F + T_L;$

$T_0 \geq 0,\ T_F > 0,\ T_L > 0$

where P is price of consumption

goods and services purchased in the market; C is quantity of those goods and services consumed by the household; P_F is output price for farm commodities sold; **F(.)** is the farm production technology; H_F is the level of the household's human capital that affects farm production; $\mathbf{Z_F}$ is a vector representing other household characteristics that affect farm production, fixed factors and T is total time endowment of household; T_L is total leisure time; T_O is total time allocated to off-farm work; T_F is total time allocated to farming; location related characteristics such as population density; P_X is price of purchased non-labor farm inputs; X_F is amount of inputs used for farm production; T is total time endowment of household; T_L is total leisure time; T_O is total time allocated to off-farm work; T_F is total time allocated to farming; W_M is market wage; and V is exogenous non-labour income (from assets or transfer payments). The Lagrangian is given as

(9) $$L = U[C, T_L; \mathbf{\Phi})] + \lambda_1[P_Y\mathbf{F}(T_F, X_F; H_F, \mathbf{Z_F}) - P_XX_F + T_OW_M + V - PC] + \lambda_2[T_O + T_F + T_L]$$

First order conditions for optimal choice by the farm household with respect to off-farm labour supply give the following

(10) $$T_0^* = T(W_M, P_Y, P_X, P, V, H_F, \mathbf{Z_F}, T)$$

In reduced form we have

(11) $$T_i = \boldsymbol{\beta}'\mathbf{X}_i + \delta\psi_i + e_i$$

Thus for the i^{th} farm household, off-farm labour supply is a function of the explanatory variables represented by the vector $\mathbf{X}_i$, that include off-farm wage rate, non-labor input prices, farm-gate output prices of farm produce, exogenous off-farm income, total time endowment, human capital, and location of the household among others. To cater for sample selectivity bias, the inverse Mills ratio, ψ was incorporated in (11). Variants of (11) were estimated using weighted least squares under the assumption of heteroscedastic error terms. The actual variables used were (i) off-farm wage rate (computed as total off-farm income divided by number of hours worked off-farm), where predicted values were used to cater for endogeneity; (ii) weighted cost of inputs used in groundnut production in that production season; (iii) price of groundnut received by the given farm household in that particular season, predicted values were used to remove endogeneity; (iv) a ratio of non-labor off-farm incomes (rent, pensions and remittances) to farm income in that season to proxy effects of exogenous income; (v) level of education of household head and spouse; (vi) IPM technology adoption dummy variable which takes a value of 1 if the farmer used IPM technology and 0 otherwise; (vii) farm size (measured as the hectares cultivated by the household); (viii) farming experience (measured as the total number of years a farmer had spent in farming); (ix) total household time endowment (measured as the total time available to the household in that given season).

Technical Efficiency

Following Aigner *et al.* (1977) the stochastic production function for the i^{th} farm is specified as

(12) $Y_i = f(\mathbf{X}_i, \boldsymbol{\beta}) + v_i - u_i$

where Y_i is output of the farm, $\mathbf{X}$ is a vector of input quantities, $\boldsymbol{\beta}$ is a vector of parameters, v_i is a random error term that is iid, $N\sim(0, \sigma^2_v)$ and represents statistical noise, u_i is a non-negative one-sided random error term that is iid half-normal, i.e., $|\sim(0, \sigma^2_u)|$ which captures time-invariant technical inefficiency in the production of groundnuts. In both cases v_i and u_i cause actual production to deviate from the frontier. v_i represents the random variability in production that cannot be controlled by the groundnut farmers and u_i represents deviations from the maximum potential output attributed to technical inefficiency.

Following Aigner, Lovell and Schmidt (1977), Bravo-Ureta and Evenson (1994) and Jondrow *et al.* (1982), technical efficiency of a farm is empirically measured as

(13) $Y_i^* = f(\mathbf{X}_i, \boldsymbol{\beta}) - u_i$

where the conditional mean of u_i given $\varepsilon = v_i - u_i$, is calculated as

(14)

$$E(u_i / \varepsilon_i) = \frac{\sigma\lambda}{1+\lambda^2}\left[\frac{f^*(\varepsilon_i\lambda/\sigma)}{1-F^*(\varepsilon_i\lambda/\sigma)} - \frac{\varepsilon_i\lambda}{\sigma}\right]$$

In (14) $f^*(.)$ and $F^*(.)$ are the standard normal density and cumulative distribution functions, respectively; $\lambda = \sigma_u/\sigma_v$, and $\sigma^2 = \sigma^2_u + \sigma^2_v$. Y^* is observed output, adjusted for statistical noise. Technical efficiency (TE) of an individual farm is then defined as the ratio of the observed output Y^*, to corresponding frontier output, Y_i^f, both in original units, and is given as

(15)

$$TE_i = \frac{Y_i}{Y_i^f} = \frac{f(X_i;\beta)\exp(v_i - u_i)}{f(X_i;\beta)\exp(v_i)} = \exp(-u_i)$$

TE takes a value between 0 and 1. The value 1 defines a technically efficient farm at the potential maximum. To generate TE efficiency estimates for the groundnut farm households, A second-order flexible form of the stochastic production frontier was assumed in (13) in the form of the translog model for the i^{th} household. This is given as

$$16.\ \ln Y = \beta_0 + \Sigma_j \beta_j \ln x_j + (1/2) \Sigma_j \Sigma_k \beta_{jk} \ln x_j \ln x_k + v_i - u_i$$

where, Y is the level of output of groundnut measured in kilograms, x_j is the j^{th} input. From (16) inefficiency and efficiency scores were estimated. Following Coelli *et al.* (2005), this study chose a translog functional form due to increased flexibility. Ceteris paribus, a second order flexible functional form is preferred to a first order flexible form (Cobb-Douglas).

RESULTS AND DISCUSSION

Socioeconomic characteristics of the groundnut farmers

Table 1 shows the socio-economic characteristics of the groundnut farmers interviewed. It indicates the descriptive statistics of the variables that were used in the study.

Factors affecting respondent's participation in off-farm work

Table 2 indicates the results of the bi-variate probit estimates. Results indicate that at younger age levels, an increase in age (also associated with increased work experience) tends to increase the likelihood of the household head taking up employment in off-farm work and as age increases further, this probability declines. There is also a tendency among most people to retire to their farms at an old age.

For the spouse the converse is true. A plausible explanation for the negative relationship for the spouse is that at younger age levels the family roles, such as giving birth and caring for the young children imply that women will more often than not work at home than work off-farm. Ahituv and Kimhi (2005) reported similar results in the study of joint dynamics of off-farm employment and the level of farm activity among Israel farmers. The level of education attained by both the household head and spouse has a positive and significant influence on the probability of participating in off-farm employment. Schooling has a positive effect on the tendency to participate in off-farm employment, implying that generally, human capital is more productive in off-farm employment than in farm work (Jolliffe, 2004). This implies that additional schooling raises an individual's off-farm wage earnings potential far more than it raises their reservation wage for farm and home activities (Abdulai and Delgado, 1999).

The findings also show that household size has a negative influence on the likelihood of participating in off-farm work. However, the number of children

Table 1: Variable Definition and Descriptive Statistics

Description of variable	Sample Mean	Standard Deviation
Age of household head (years)	44.22	13.81
Age of spouse (years)	34.20	11.92
Household size (#)	6.93	3.59
Farm size (hectares)	4.83	4.65
Education of household head (years)	7.69	4.80
Education level of spouse (years)	6.22	4.40
Number of children inactive in farming	1.78	1.51
Number of children active in farming	2.06	2.05
Farming experience (years)	21.64	14.06
Groundnut production experience (years)	16.11	14.37
Total household non-labor income (' 000 Shs)	24.28	60.00
Total household off-farm income ('000 Shs)	559.15	1171.03
Dummy for livestock rearing (=1 if rears, 0 otherwise)	0.14	0.35
Distance to the nearest town (Km)	1.51	1.50
Population density	255.53	81.44
Dummy for technology used (= 1 if IPM, 0 otherwise)	0.54	0.50
Land allocated to groundnut (hectares)	0.95	0.84
Family labor (person days)/season	61.58	54.37
Hired labor (person days)/season	31.88	46.91
Capital used ('000 Shs) /season	82.10	90.75
Dummy for household head participating in off-farm work (=1 if yes and 0 if no)	0.36	0.48
Dummy for spouse participating in off-farm work (=1 if yes and 0 if no)	0.18	0.39
Household time allocated to off-farm work (Hours per week)	23.46	47.47
Groundnut output/season (Kilograms)	358.14	588.05

Source: Survey data, 2005. Exchange Rate US$ 1.00 = Shs 1,850

Table 2: Factors Affecting the Likelihood of Participating in Off-farm Work

Variable	Coefficient	S. E.	p-value
Household Head Equation			
Age of hhh	0.207*	0.102	0.04
Age hhh squared	-0.003*	0.001	0.02
Age of spouse	-0.080	0.090	0.37
Age spouse squared	0.001	0.001	0.27
Education hhh	0.141***	0.039	0.00
Education spouse	0.014	0.038	0.71
Household Size	-0.251**	0.088	0.00
Children active in farming	0.243*	0.160	0.02
Farm Size	-0.073	0.038	0.06
Distance, Town	-0.198*	0.084	0.02
Off-farm Income	7.5e-08***	1.81e-07	0.00
Dummy-Rears Livestock	0.368	0.409	0.37
Dummy-Rears Poultry	0.534	0.335	0.11
Population Density	0.004	0.002	0.03
Constant	-1.575	1.911	0.41
Spouse Equation			
Age of hhh	0.262	0.134	0.05
Age of hhh squared	-0.003	0.001	0.04
Age of spouse	-0.330*	0.132	0.01
Age of spouse squared	0.004*	0.002	0.01
Education of hhn	-0.050	0.050	0.32
Education of spouse	0.120*	0.053	0.02
Household Size	-0.219	0.099	0.03
Children active in farming	0.313*	0.134	0.02
Farm Size	-0.041*	0.016	0.01
Distance, Town	-0.423	0.084	0.61
Off-farm Income	6.41e-07***	1.76e-07	0.00
Dummy-Rears Livestock	2.158**	0.691	0.00
Dummy-Rears Poultry	-3.096**	1.065	0.00
Population Density	0.008*	0.003	0.01
Constant	1.556	2.148	0.46
N = 186			
Wald Chi. Sqr = 75.86***			
McFadden's R^2 = 0.535			
Log likelihood ratio = -123.14			

***, **, * denote significance at 1%, 5% and 10% level, respectively.

that are active in farming (children of ages 6-15 years) in a given household increases the probability of both the household and spouse working off-farm. This number is a rough indicator of the amount of family labor that is available for use. With more family labor available for farm work, both the spouse and head may have some time to work outside the farm. Farm size has a negative and significant effect on the likelihood of the spouse participating in off-farm employment. This means that the lesser the land that is available for farming, the higher the likelihood of the spouse seeking off-farm employment.

Income from off-farm employment positively influences the probability of participating in off-farm employment. People will have a lot of motivation to participate in such labor markets when the remunerations are relatively high compared to their reservation farm wages. De Bruaw and Rozelle (2002) found that rural people developed a positive attitude to working off-farm locally or outside their home village provided that there were better income opportunities compared to working on one's own farmland in China. Location or remoteness of the farm was proxied by the distance from the nearest town. The longer the distance from the nearest town, the lower is the probability that the household head will work outside the farm. This suggests that closer proximity to towns increased the likelihood of off-farm labour employment for the household head. Therefore lower transaction costs (e.g. transport) for off-farm labour employment are likely to increase with the degree of remoteness of the household. Area population density positively and significantly influences the chance that a spouse will obtain work outside the farm. Higher population density means less acreage available for agricultural production per capita, at the household level, thus an increase in the desire and need to supplement farm production with off-farm employment. There is a positive and significant relationship between participation in off-farm work decisions of the spouse and the presence of livestock rearing (local breeds) on the farm. Spouses in households that had poultry farming are less likely to work off-farm. A plausible explanation could be that poultry farming requires more family labor than other livestock or that the returns from poultry may be higher than from some non-farm sources.

Determinants of off-farm labour supply

The results from the groundnut farmers are shown in Table 3. A robust standard error regression was estimated under the assumption of heteroskedastic error terms.

There was a positive and statistically significant relationship between IPM technology use and

Table 3: Determinants of Off-farm Labor Supply among Groundnut Farmers

Variable	Coefficient	Robust S.E.	p-value
IPM Technology dummy	1.38**	0.64	0.03
Output Price of groundnuts	-1.16	0.20	0.42
Education of household head	0.30***	0.09	0.00
Education of spouse	0.15	0.10	0.12
Off-farm Wage Rate	0.32***	0.05	0.00
(Off-farm Labour Income /Total Income) ratio	0.05**	0.02	0.02
Input Costs	-0.04	0.03	0.17
Total household time endowment	1.44***	0.56	0.01
Inverse Mills ratio	8.7e-04***	2.5e-04	0.00
Constant	-5.26	3.75	0.16
N = 104			
F-value = 35.34***			
Adjusted R^2 = 0.440			

***, **, * denote significance at 1%, 5% and 10% levels

off-farm labour supply. A plausible explanation could be that IPM technology has relatively higher capital requirements in terms of purchased farm inputs, such as hybrid seed, fertilizers, pesticides and spray pumps. As a result farm households have to seek employment off-farm to raise this capital. The level of education of both the spouse and household head positively affects off-farm labour supply. An individual's level of education is among the major determinants of the off-farm labour supply. This is consistent with findings by Furtan *et al.* (1985), Gould and Saupe (1989), Olfert *et al.* (1993) and Benjamin (1994). Income from off-farm activities positively influences the amount of labour supplied to off-farm work in a given season and so does the off-farm wage rate. As mentioned earlier, people have a lot of motivation to participate in off-farm labour markets when the remuneration therein is relatively high compared to their reservation farm wages. This result is consistent with findings by Bjørnsen (1999) in the study of labour decisions of Norwegian farm households.

Determination of Technical Efficiency: The Stochastic Production Frontier

Stochastic production frontier results are shown in Table 3. Following Coelli *et al.* (2005), this study chose a translog functional form due to increased flexibility. Ceteris paribus, a second order flexible functional form is preferred to a first order flexible form (Cobb-Douglas). The variables used in the estimation were the logarithms of groundnut output, capital, land, family labour and hired labour. The level of output of groundnut was measured in kilograms. Family labor was computed by multiplying adult male and female labor days by 1 and the children days by 0.5. Hired labor measured in person days. The amount of land used for groundnut production in that particular season was measured in hectares. Capital was proxied by the costs of planting seed, costs of pesticides, costs of hired implements and amount of depreciation of the farm implements and tools. In measuring depreciation, the straight line method was used. Efficiency estimates of each farmer were generated and are shown in Table 4.

Table 4: Estimates of the Stochastic Frontier Function

Dependent Variable = Farm Output			
Variable	**Coefficient**	**S. E.**	**p-value**
Family labor in person days	1.561*	0.834	0.06
Hired labor in person days	0.273	0.489	0.58
Land in hectares	2.130	1.582	0.18
Capital	0.126	0.264	0.63
Family labor* Family labor	-0.100	0.105	0.34
Hired labor * Hired labor	0.190**	0.086	0.03
Land * Land	0.243	0.853	0.78
Capital * Capital	0.047	0.030	0.12
Family labor * Hired labor	0.287*	0.161	0.07
Family labor * Land	-0.962**	0.440	0.03
Family labor * Capital	-0.210	0.173	0.23
Hired labor * Land	-0.880***	0.307	0.00
Hired labor * Capital	-0.161	0.119	0.18
Land * Capital	0.383	0.326	0.24
Constant	-0.263	2.504	0.92
Log likelihood = -235.85			
Wald Chi. Sqr = 231.12***			
N = 193			
σ_v = 0.616 (0.097)			
σ_u = 1.218 (0.197)			
σ^2 = 0.916 (0.270)			
λ = 1.487 (0.283)			
Likelihood ratio Test of $\sigma_u = 0$			

***, **, * denote significance at 1%, 5% and 10% level. Standard errors in parentheses for the coefficients of the sigmas and lambda

The technical efficiency (TE) scores generated indicate that farmers in the sample scored between 7% and 86%, with an average of 55%. Results also show that, on average, farmers who use the IPM technology have a TE score of 62% (Table 5).

Table 5: Summary Statistics of Mean Efficiencies

Category of Farmers	N	Mean Efficiency	S.D.
All farmers in the Sample	193	0.548	0.155
IPM Users	105	0.624	0.121
Non-IPM Users (traditional technology)	88	0.458	0.144
IPM Users Who *Participate* in Off-farm Work	56	0.631	0.101
IPM Users Who *Don't Do* Off-farm Work	49	0.616	0.140
Non-IPM Users Who *Participate* in Off-farm Work	51	0.453	0.140
Non-IPM Users That *Don't Do* Off-farm work	37	0.491	0.146

Source: Authors' Computations

In comparison, those who use the traditional technology (Non-IPM users) have an average TE score of 46%. This implies that the training farmers receive for taking up the IPM technology package has a positive bearing on the level at which farm resources are used to produce groundnuts. In turn, this is likely to have a direct impact on the profitability levels of the IPM technologies as compared to the traditional methods of production. Ekiyar *et al.* (2003) found IPM technology farms running more profitably than traditional technology farms among groundnut producers in eastern Uganda. Independent mean t-tests were done to test the significance of mean differences and the results are shown in Table 6.

The results indicate that mean TE score for farmers that use IPM technology is significantly (statistically) greater than that of farmers that use the traditional methods of groundnut production at the 1% level. Similar findings were obtained by Glenville (2000) who found farmers that received training in better agricultural practices had a higher technical efficiency scores than those that had not taken part in any training. On average, IPM technology users that engaged in off-farm employment

Table 6: Technical Efficiency Mean Differences

A. Technical Efficiency Mean Differences: IPM and Non-IPM Users

Category of Farmers	N	Mean Technical Efficiency Score	S.D.
IPM Adopters	105	0.624	0.012
Traditional Technology	88	0.458	0.015
t-value		8.5714***	

T.E. Mean Differences: IPM Farmers: Participating in off-farm work and Not

B. Tests of Mean Differences: IPM Farmers Working On- and Off-farm

Category of Farmers	N	Mean Technical Efficiency Score	S.D.
IPM Farmers Working Off-farm	56	0.631	0.014
IPM Farmers Not Working Off-Farm	49	0.616	0.020
t-value		0.6212	

T.E. Mean Differences: Tradition Technology Farmers: off-farm work and Not

Category of Farmers	N	Mean Technical Efficiency Score	S.D.
Traditional Technology Farmers Who Work Off-farm	51	0.435	0.020
Traditional Technology Farmers Who DO NOT Work Off-Farm	37	0.490	0.024
t-value		**1.780***	

Source: Authors' Computations. ***, **, * denote significance at 1%, 5%, 10% respectively

had a mean technical efficiency score of 63.1% and IPM technology farmers that who do not engage in off-farm work had a technical efficiency score of 61.6%. The difference between the two mean scores was not statistically significant. This may mean that IPM technology farmers that seek income opportunities outside the farm are not necessarily technically more efficient than their colleagues who are full time farmers.

This means that re-allocating some of the labor to off-farm income-generating activities does not necessarily affect groundnut farmers' level of technical efficiency. This could be due to the fact that income obtained from off-farm employment may be used to hire more labor, animal draught power and machinery to meet the production needs of the farm. The results are different for farmers who use *traditional groundnut* technology. Those that participate in off-farm employment had a mean TE score of 43.5% and those who work on-farm full time had a score of 49%.

The difference in the mean TE scores was statistically significant at 10% level. That is, full-time farmers using traditional technology were more technically efficient than traditional technology farmers who took up off-farm employment. This may imply that off-farm labor allocation has an effect on the level of technical efficiency for those farmers using traditional methods of producing groundnuts. A plausible explanation could be that traditional technology farmers are more constrained in the options available to them, in that off-farm employment may not generate enough resources that can be used to hire labour, animal draught power and machinery to meet the farm's production requirements. Another plausible explanation might be the fact that IPM technology increases the productivity of the groundnut farms to levels much higher than those realized by traditional technology farms. Therefore, there is more management labor needed by traditional technology farmers to ensure reasonable yields are maintained per unit of land.

CONCLUSIONS

In this paper, attempt was made to determine the factors that influence the probability of a household head and spouse engaging in off-farm employment and the amount of both partners' off-farm labour supply. The effects of off-farm employment on farm technical efficiency were also examined for both IPM and traditional technology farmers. The findings showed that age, level of education, household size, number of children active in farming, remoteness of the household, level of off-farm income, significantly influenced the likelihood of the household head's participation in off-farm work. Similarly, age, education, farm size, household size, number of children active in farming, off-farm income, population density, livestock and poultry farming were the major factors that affect spouse's participation decision in off-farm employment.

Among the households who work off-farm, it was found that the amount of labor allocated to off-farm work was positively and significantly influenced by type of technology used in production (IPM), off-farm wage rate, off-farm farm income, education level of spouse and household head and total household time endowment. Results showed that IPM users have higher mean TE score than those who use the traditional methods of groundnut production and the difference is significant at 1% level. Labor re-allocation to off-farm work may not affect the level of technical efficiency among IPM adopters. Therefore, for as long as IPM farmers use the technology package properly, they may balance the labor allocated to groundnut production at the farm and that allocated to off-farm work without the risk of reducing potential output. It should be noted that the average TE scores for the IPM adopter farmers are a bit low considering the agronomic practices that go into this type of groundnut production. One would have expected the average TE score for this group to be a bit higher than the figure of 62%. The results, however, show that labor re-allocation to off-farm activities does affect farm TE for farmers using traditional technology at 10% level of significance. IPM production technology is more efficient than the traditional methods of groundnut production and should continue to be promoted.

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