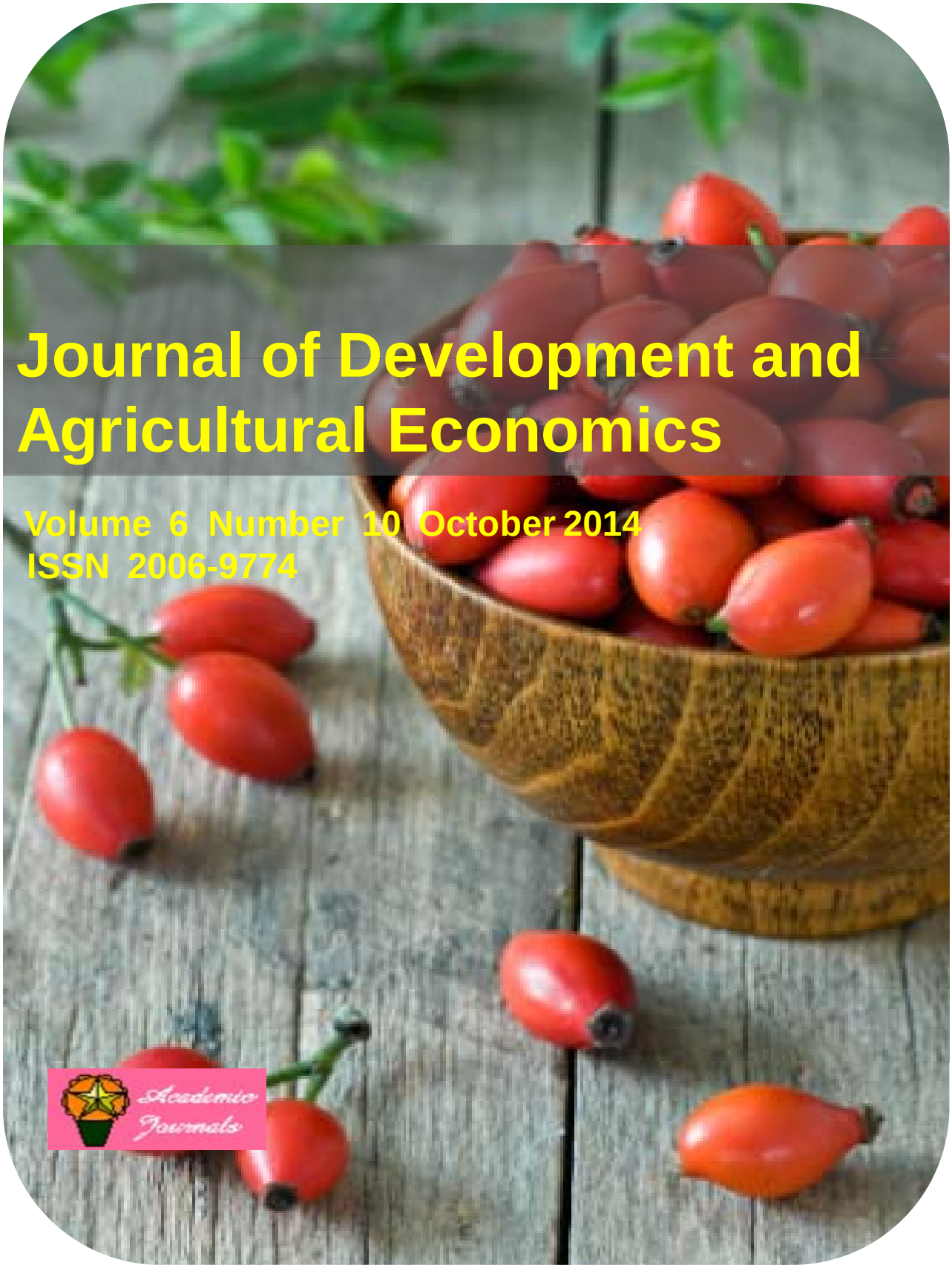

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Full Length Research Paper

Estimating the effects of formal and informal credit on farm household welfare: A hierarchical competitive welfare model approach

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This paper uses the hierarchical competitive welfare model approach to estimate the effects of credit from formal and informal sources on welfare development of farm households in Ghana. Data used for the econometric analyses came from the Ghana Living Standards Survey Round 5 dataset. The results showed that when a farm household is given GHC100 as formal credit, its welfare expenditure would increase by about GHC6. On the other hand, GHC100 given to a farm household as informal credit reduces its welfare expenses by about GHC10. There are two possible explanations for the negativity of informal credit on household welfare expenses. The first is that most informal credit is delivered in material forms instead of cash, which therefore reduces how much borrowing households expend on those materials. The second possible explanation is that informal credit borrowers get trapped in the vicious cycle of poverty such that it reduces their capacity to expend towards the attainment of their welfare outcomes such as food security, healthcare, education and general well-being. A paradigm shift towards the integration of formal and informal financial markets of Ghana is recommended.

Key words: Ghana, welfare, farm household, credit, hierarchical competitive model.

INTRODUCTION

Credit has over the years been used as a development tool, especially in the developing world mostly targeting poor and vulnerable farm households. Evidence from the empirical literature indicates that credit enables poor households against starvation, illiteracy and all other adversities that impinge on their welfare (Afrane, 2002) and improves household power relations (Pitt et al., 2006). It is, however, important to note that the impact of credit on welfare is context specific. According to Mayoux (1999), the level of impact of credit on livelihoods depends on the context within which beneficiaries find themselves. Whereas access to credit is said to narrow the gap between the poor and rich in some cases, it rather widens the existing inequality gaps in other cases (Mayoux, 2001).

It has been reported in Ghana that credit from formal sources helps boost welfare development (Alhassan and Akudugu, 2012; Al-hassan and Sagre, 2006; Dadzie and Ghartey, 2010). As a result, successive governments in the country (Ghana) have never relented in formulating

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and implementing policy reforms and regulations in the financial sector to ensure increased access to credit by all, especially those in the rural areas where agriculture is the main source of livelihood. Notable amongst these policy reforms and regulations are the establishments of the Agricultural Development Bank (ADB) in the 1960s, Rural and Community Banks (RCBs) in the 1970s, the Financial Sector Adjustment Programme (FINSAP) in the 1980s and the establishment of Microfinance Institutions (MFIs) across the country in the 1990s and 2000s. Most of these policy reforms and regulations with assistance from multinational development institutions such as the World Bank and International Monetary Fund (IMF) were largely designed to do away with the informal financial sector.

Unlike the credit from formal sector lenders such as banks and MFIs, credit from informal sector lenders such as input dealers, traders, relatives, friends, and moneylenders in Ghana has always been seen to have negative effects on the welfare development of borrowers. This is because informal lenders are blamed for charging exorbitant interest payments (Schindler, 2010). That notwithstanding, the informal financial market of Ghana continues to exist with many people across the country relying on it to meet their financial needs. The question therefore is, does informal credit really negatively affects the welfare development of farm households in Ghana? This question has largely not been answered in the empirical literature, as there have been very little investigations into how credit from the informal financial market affects the welfare development of their borrowers. Much of the empirical literature on the influence of credit on welfare development quoted above only considers formal credit. This paper estimates the effects of formal and informal credit on the welfare development of farm households in Ghana using the hierarchical competitive welfare model approach.

METHODOLOGY

The hierarchical competitive welfare model was used in the paper as a means to get valid and relevant instrumental variables (IV) for the estimation processes. It follows the work of Khandker and Faruqee (2003) who used similar approach to estimate the impact of farm credit in Pakistan. A detailed discussion of how the model works is provided in the proceeding paragraphs. The econometric framework employed for the analyses was setup through the following reduced form outcome model:

$$y_{ijk} = X_{ijk}\beta_{yf} + C_{ijkf}\delta_f + C_{ijki}\delta_i + \mu_j^y + \mu_k^y + \varepsilon_{ijk}^y \quad (1)$$

Where y_{ijk} represents expenditure on health, education, food, performance of socio-cultural activities, shelter, energy and sanitation, a proxy for welfare of household *i*in community *j* in district *k*. $X_{ijk}$is a set of observed characteristics of household *i*in community *j* in district *k*. C_{ijkf} is the amount of formal credit received by household *i*in community *j* in district *k*. C_{ijki} is the amount of informal credit received by household *i*in community *j* in district *k*. $\beta_{yf}, \beta_{yi}, \delta_f$and δ_i are unknown parameters to be estimated. μ_j^y and μ_k^y represent factors in community *j* and district *k* that affect household welfare, y_{ijk} but are unobservable to the researcher. ε_{ijk}^y is non-systematic errors, partly representing the unmeasured determinants of y_{ijk} that vary across households in community *j* and communities in district *k,* such that:

$$E\left(\varepsilon_{ijk}^y \middle| X_{ijk}, \mu_j^y, \mu_k^y\right) = 0 \quad (2)$$

Assuming all factors were observable to the researcher, the effects of credit from formal and informal sources on household welfare could have been measured by δ_f and δ_i, respectively without bias. Unfortunately, factors contained in μ_j^y and μ_k^y cannot be observed by the researcher and may correlate with $C_{ijkf}$and C_{ijki} which results in selectivity bias that occurs when there is a correlation between the error term and the independent variables (Heckman, 1976, 1979, 1990; Heckman and Li, 2003; Heckman and Sedlacek, 1990; Hausman and Wise, 1976, 1977; Lee, 1982, 1983, 1994; Das and Vella, 2003; Vella, 1998; Winship and Mare, 1992; Khandker and Faruqee, 2003).

Some of the unobserved variables contained in $\mu_{jf}^y, \mu_{kf}^y, \mu_{ji}^y$ and μ_{ki}^y may be used by lenders to determine, which borrower to grant credit to. For instance, it is possible that lenders in formal and informal credit markets may be advancing credit to only households with certain level of endowments. Under such circumstances, lenders might only select households with the required level of endowment for credit delivery. This is because lenders are rational economic agents who allocate credit in the best possible ways that minimise defaults and maximise repayments. This assertion is in line with the arguments that selectivity bias is pervasive and emanates from human behaviour (Roy, 1951; Gronau, 1974; Heckman, 1990). However, researchers are unable to observe all the underlying factors considered by lenders in their lending activities. In simple terms, not all farmers and farm households in the selected communities across the different districts and ecological zones may have equal chances of selection by lenders for credit advancement hence selectivity bias. As such, analysing the outcome of Equation 1 by the ordinary least squares (OLS) estimation method yields biased estimates because selectivity bias violates the assumption of OLS that the error and independent variables are uncorrelated.

To deal with the selectivity bias in credit delivery as described above, the IV approach was employed. This is estimated through the Two-stage least squares (TSLS) estimation which is the commonly used IV estimator (Murray, 2006b; Hahn et al., 2004). The TSLS estimator is good in dealing with selectivity problems caused by simultaneity, measurement errors or omitted variables among others (Cameron and Pravin, 2005; Greene, 2008; Kennedy, 2003; Angrist and Krueger, 1991; Cameron and Pravin, 2009; Murray, 2006a; Wooldridge, 2009). The choice of the IV approach is in conformity with the assertion that the models for

selection bias are only as good as the assumptions of the way it occurs (Arabmazar and Schmidt, 1982; Goldberger, 1981; Lee, 1982). This approach has been used by a number of researchers in related studies (Campa and Kedia, 2002; Villalonga, 2004; Khandker and Faruqee, 2003). This is further supported by the view expressed by Chmelarova and Hill (2010) that if independent variables are endogenous and there are valid IV available, then it is better to use the IV approach since OLS will yield inconsistent estimates.

TSLS estimation procedure consists of two main stages. In the context of this study, the first stage was the estimation through OLS the determinants of borrowing. It included selected individual household characteristics and IV that were assumed to only influence the amounts of credit farm households could borrow from formal and informal sources but not their welfare outcomes. The second stage estimation included the estimated credit amounts derived from the first stage along with other variables deemed to be influencing household welfare. Equations in the first stage estimations are referred to as selection models and that of the second stage are referred to as the outcome models.

To implement the first stage, the following selection models disaggregated by type of credit market were employed:

$$C_{ijkf} = X_{ijk}\beta_{cf} + Z\lambda_f + \mu^c_{jf} + \mu^c_{kf} + \varepsilon^c_{ijkf} \quad (3a)$$

$$C_{ijki} = X_{ijk}\beta_{ci} + Z\lambda_i + \mu^c_{ji} + \mu^c_{ki} + \varepsilon^c_{ijki} \quad (3b)$$

Where C_{ijkf} and C_{ijki} are as defined above. X_{ijk} and Z are household characteristics and IV, respectively that influence the amount of credit farm households could borrow from the formal and informal credit markets respectively. β_{cf}, β_{ci}, λ_f and λ_i are unknown parameters to be estimated. μ^c_{jf} and μ^c_{ji} are community level unobservable factors that influence C_{ijkf} and C_{ijki}, respectively and do not vary across households within community *j*. μ^c_{kf} and μ^c_{ki} are district level unobserved factors that affect C_{ijkf} and C_{ijki}, respectively but do not vary across communities within district *k*. ε^c_{ijf} and ε^c_{iji} are non-systematic errors that represent the unmeasured determinants of C_{ijkf} and C_{ijki}, respectively which vary across households and communities and are such that:

$$E(\varepsilon^c_f | X_{ij}, Z, \mu^c_{ijf}) = 0 \quad (4a)$$

$$E(\varepsilon^c_i | X_{ij}, Z, \mu^c_{iji}) = 0 \quad (4b)$$

Identifying appropriate IV was a key component of this study. According to Demand theory, the price of a commodity is a good instrument for estimating its demand. In this regard, the price of credit from formal and informal credit markets, which are the interest charges, could be good instruments. Unfortunately, these hardly vary within credit markets. Hence, the interest charges could be good predictors of the inter-market demand for credit but not intra-market demand.

To get valid and relevant instruments, three key assumptions were made in this study. The first assumption was that the lendable funds available to formal and informal lenders in Ghana are fixed and limited. The second assumption was that the demand for credit is more than the supply, which triggers competition among borrowers. The third assumption was that there are many borrowers competing for the limited lendable funds available to few lenders at the formal and informal credit markets of Ghana. Based on these assumptions, it is not the price of credit but the availability of funds and level of competition that matters most in determining how much a household could borrow from formal and informal credit markets. This leads to the issue of credit allocation hierarchy as funds are competed for at the national, regional, district and community levels. At the national level, the different regions compete for lendable funds available to lenders in the formal and informal credit markets. At the regional level, different districts compete for lendable funds. At the district level, different communities compete for lendable funds and at the community level, different households compete for the lendable funds available to lenders. So the lendable funds are subject to competition at each level and the final amounts of credit that households are able to get from the credit markets are the cumulative outcome of all the competitions.

Given the available funds, the amount of credit a household is able to borrow from the formal or informal credit market depends not only on its own characteristics but also on the characteristics of other competing households who also seek credit. The competitor's characteristics were therefore considered as appropriate instruments in estimating how much a farm household could borrow from the credit markets. Competitors to a borrowing household are at the national, regional, district and community levels. The characteristics of competitors at all the levels influenced the amount of credit households are able to borrow from the credit markets. For the purposes of simplification, the researcher assumed competition starting from the district level. Thus the amount of credit households are able to get is a culmination of the competition at all the different levels or hierarchies.

Specific household characteristics relative to district and community level competitors' characteristics were used as instruments (Z_{ji}). These included community and district level average years of formal schooling, community and district level average household savings and the average amounts of formal and informal credit borrowed by computing households at the community and district levels. The selection of these factors were partly informed by the empirical literature that years of formal schooling and savings significantly influence the amounts of credit individuals are able to borrow from credit markets (Khandker and Faruqee, 2003; Ayamga et al., 2006). The community level average characteristics were computed as sampled households excluding household *i,* and that of the district level computed as sampled households across *k* districts excluding those in community *j*. The selection models (Equations 3a and b) were re-specified as:

$$C_{ijkf} = X_{ijk}\beta_{cf} + \bar{X}_{j-i}\lambda_{cf} + \bar{X}_{k-j}\lambda_{kf} + \mu^c_{jf} + \mu^c_{kf} + \varepsilon^c_{ijf} \quad (5a)$$

$$C_{ijki} = X_{ijk}\beta_{ci} + \bar{X}_{j-i}\lambda_{ci} + \bar{X}_{k-j}\lambda_{ki} + \mu^c_{ji} + \mu^c_{ki} + \varepsilon^c_{iji} \quad (5b)$$

Where C_{ijkf}, C_{ijki} and X_{ijk} are as defined earlier. The Z variables were replaced by $\bar{X}_{j-i}$ and $\bar{X}_{k-j}$ variables which are the community and district levels average household characteristics respectively that influence the amount of credit farm households could borrow from the formal and informal credit markets. $\beta_{cf}, \beta_{ci}, \lambda_{cf}, \lambda_{df}\lambda_{ci}$ and λ_{di} are unknown parameters to be

estimated. μ_{jf}^{c}, μ_{df}^{c}, μ_{ji}^{c} and μ_{di}^{c} are unmeasured determinants of C_{ijf} and C_{iji}, respectively and do not vary across households within community *j* and communities within district *k*. ε_{f}^{c} and ε_{i}^{c} are non-systematic errors that represent the unmeasured determinants of C_{ijf} and C_{iji}, respectively which vary across different households within community *j* and are such that:

$$E(\varepsilon_{f}^{c}|X_{ij}, Z, \mu_{ijf}^{c}) = 0 \quad (6a)$$

$$E(\varepsilon_{i}^{c}|X_{ij}, Z, \mu_{iji}^{c}) = 0 \quad (6b)$$

The estimated amounts of credit from formal and informal sources were derived as:

$$\hat{C}_{ifj} = X_{ij}\hat{\beta}_{cf} + \bar{X}_{j-i}\hat{\lambda}_{cf} + \bar{X}_{k-i}\hat{\lambda}_{kf} \quad (7a)$$

$$\hat{C}_{iij} = X_{ij}\hat{\beta}_{ci} + +\bar{X}_{j-i}\hat{\lambda}_{ci} + \bar{X}_{k-i}\hat{\lambda}_{ki} \quad (7b)$$

Where:

$\hat{C}_{ifj}$ = Estimated amount of credit from formal credit market;

$\hat{C}_{iij}$ = Estimated amount of credit from informal credit market;

$\hat{\beta}_{cf}, \hat{\beta}_{ci}, \hat{\lambda}_{cf}$ and $\hat{\lambda}_{ci}$ = Estimated parameters;

$X_{ij}, \bar{X}_{j-i}$ and $\bar{X}_{k-i}$ are as defined above

The corresponding outcome model of Equation 1, which constituted the second stage estimation through OLS, was re-specified as:

$$y_{ijk} = X_{ijk}\beta_{yf} + \hat{C}_{ijkf}\delta_{f} + \hat{C}_{ijki}\delta_{i} + \mu_{jf}^{y} + \mu_{kf}^{y} + \varepsilon_{ijkf}^{y} \quad (8)$$

In this regard, the coefficients of credit in the second welfare Equations 8 measured the effect of one more unit of credit from a credit market on the outcome of interest as defined above. In other words, it measures the effect of one more unit of credit denied by lenders in the credit market on household welfare.

To determine whether or not the use of IV was necessary in this study, the Durbin-Wu-Hausman (DWH) test proposed independently by Durbin (1954), Wu (1973) and Hausman (1978) was conducted. This involves using an augmented regression analysis (Davidson and MacKinnon, 1993) by including the residuals from the first stage estimations in the second stage estimations (Baum et al., 2007; Antonakis et al., 2010; Khandker and Faruqee, 2003). Significant residuals imply credits from formal and informal sources, which are the mediators, are indeed endogenous and thus must be instrumented and thus TSLS should be preferred to OLS. This is because the assumption that the independent variables, in this case formal and informal credits are uncorrelated with the residuals (error terms) is violated. The independent variables were tested for multicollinearity using the variance inflation factor (VIF). Theoretically, VIF is derived as [1/(1-R^2)] for each k – 1 independent variable equations (Robinson and Schumacker, 2009). The rules of thumb for VIF include the fact that 1 means no multicollinearity and 10 means severe multicollinearity which must be corrected (O'brien, 2007). Relevance and strengths of the instruments were determined by their associated t-values. White's variance-covariance estimator was used to circumvent the problem of heteroscedasticity (Davidson and MacKinnon, 1993). Thus heteroscedasticity-corrected (HC) variance and robust standard errors were reported.

The empirical models are specified as (Table 1 for definition and measurement of variables):

$$C_{f} = \alpha_{0} + \alpha_{1}X_{1} + \alpha_{2}X_{2} + \alpha_{3}X_{3} + \alpha_{4}X_{4} + \alpha_{5}X_{5} + \alpha_{6}X_{6} + \alpha_{7}X_{7} + \alpha_{8}X_{8} + \alpha_{9}X_{9} + \alpha_{10}X_{10} + \alpha_{11}X_{11} + \alpha_{12}X_{12} + \alpha_{13}X_{13} + \alpha_{14}X_{14} + \alpha_{15}X_{15} + \alpha_{16}X_{16} + \varepsilon_{1} \quad (9a)$$

$$C_{i} = \alpha_{0} + \alpha_{1}X_{1} + \alpha_{2}X_{2} + \alpha_{3}X_{3} + \alpha_{4}X_{4} + \alpha_{5}X_{5} + \alpha_{6}X_{6} + \alpha_{7}X_{7} + \alpha_{8}X_{8} + \alpha_{9}X_{9} + \alpha_{10}X_{10} + \alpha_{11}X_{11} + \alpha_{12}X_{12} + \alpha_{13}X_{13} + \alpha_{14}X_{14} + \alpha_{15}X_{15} + \alpha_{16}X_{16} + \varepsilon_{2} \quad (9b)$$

The effects of credit from formal and informal sources on households' welfare attainments were estimated as (Table 2 for definition and measurement of variables):

$$y = \lambda_{0} + \lambda_{1}\hat{C}_{f} + \lambda_{2}\hat{C}_{i} + \lambda_{3}R + \lambda_{4}DR + \lambda_{5}FI + \lambda_{6}NFI + \lambda_{7}MA + \lambda_{8}\hat{\varepsilon}_{1} + \lambda_{9}\hat{\varepsilon}_{2} + \varepsilon_{3} \quad (10)$$

In all, data from 3,600 households were used in this analysis. The data came from the Ghana Living Standards Survey Round 5, which was conducted in 2005/2006.

This test uses the F-statistic. A significant F-Statistic therefore implies a violation of the assumption in OLS that the independent variable and the residual (error term) are uncorrelated. On the other hand, insignificant F-Statistics means that OLS could have been used for the estimations. The independent variables were tested for multicollinearity using the VIF. Theoretically, VIF is derived as [1/(1-R^2)] for each k - 1 independent variable equations (Robinson and Schumacker, 2009). The rules of thumb for VIF include the fact that 1 means no multicollinearity and 10 means severe multicollinearity which must be corrected (O'brien, 2007). Relevance and strengths of the instruments were determined by their associated t-values. All the estimations were done using STATA Version 11.

RESULTS AND DISCUSSION

Different factors including credit from different sources influence how much households spend on their core welfare outcomes. The study results showed that the amount of credit households received from formal and informal sources significantly influence their expenditures on the welfare outcomes. Thus whereas there is positive relationship between formal credit and how much households spend on payments of healthcare bills, education, housing, sanitation and energy among others, that of informal credit is negative. This means the *a priori* expectations of positive relationships between formal and informal credit on the one hand and household welfare on the other were partially met. Thus a GH¢1.00 increase in the amount of formal credit received by farm households results in their welfare expenditures increasing by about GH¢0.06 and this increase is statistically significant at 1%. On the other hand, a GH¢1.00 increase in the

Table 1. Definition and measurement of variables of selection equations.

Dependent variables	Definition and measurement
C_f	Formal credit (Ghana Cedis)
C_i	Informal credit (Ghana Cedis)
Independent variables	**Definition and measurement**
Gender of household head (X_1)	Dummy (Male = 1; Otherwise = 0)
Purpose for credit accessed (X_2)	Dummy (Agriculture = 1; Otherwise = 0)
Collateral requirements (X_3)	Dummy (Collateral required = 1; Otherwise = 0)
Access to extension services (X_4)	Dummy (Had accessed = 1; Otherwise = 0)
Coastal ecological zone (X_5)	Dummy (Coastal zone = 1; Otherwise = 0)
Forest ecological zone (X_6)	Dummy (Forest zone = 1; Otherwise = 0)
Mean household schooling (X_7)	Total schooling/household size (Years)
Mean community schooling (X_8)	Total schooling/Total sampled in comm. (Years)
Mean district schooling (X_9)	Total schooling/Total sampled in district (Years)
Mean household savings (X_{10})	Total savings/Household size (GHS)
Mean community savings (X_{11})	Total savings/Total sampled in c'ty (GHS)
Mean district savings (X_{12})	Total savings/Total sampled in district (GHS)
Mean c'ty formal credit (X_{13})	Total formal credit/Sample in community (GHS)
Mean district formal credit (X_{14})	Total formal credit/Sample in district (GHS)
Mean c'ty informal credit (X_{15})	Total informal credit/Sample in comm. (GHS)
Mean dist. informal credit (X_{16})	Total informal credit/Sample in district (GHS)

Source: Author's construct, 2013.

Table 2. Definition and measurement of variables for outcome equation.

Dependent variable	Definition and measurement
Welfare (y)	Household living expenses (Ghana Cedis)
Independent variables	**Definition and measurement**
$\hat{C}_f$	Estimated formal credit (Ghana Cedis)
$\hat{C}_i$	Estimated informal credit (Ghana Cedis)
R	Remittance, gifts and grants (Ghana Cedis)
DR	Dependency Ratio (Non-workers/workers)
FI	Farm income (Ghana Cedis)
NFI	Non-farm income (Ghana Cedis)
MA	Market Access (Pre-harvest contract = 1; Otherwise)

Source: Author's construct, 2013.

amount of informal credit received by farm households leads to their welfare expenditures decreasing by about GH¢0.10 and this decrease is statistically significant at 1% (Table 3). In other words, if a household receives GH¢100.00 as credit from formal sources its welfare expenditures will experience a corresponding increase of about GH¢6.00. Similarly, when a household borrows GH¢100.00 from informal lenders, its welfare expenditure will decrease by about GH¢10.00, *ceteris paribus*. One of the possible reasons for this huge difference is the fact

that formal credit is mostly well focused in terms of its usage compared to informal credit. Besides, formal credit comes as a package, which includes other services such as training all of which are critical for the attainment of the core welfare outcomes. Furthermore, informal credit is sometimes delivered in material forms such as food, which means that household expenditures on such items are reduced, *ceteris paribus.* It could also be that informalcredit borrowers get trapped in the vicious cycle of poverty such that it reduces their capacity to expend towards the attainment of their welfare outcomes.

The positive and significant relationship between formal credit and household welfare is consistent with the literature that formal credit enables farm households to expand their farming and related livelihood activities and this helps them improve their living and welfare conditions (Gale and Collender, 2006; Coleman, 1999). It is further corroborated by Khandker and Faruqee (2003), Khandker (2005), Copestake et al. (2005), Dadzie and Ghartey (2010) who concluded in their study that credit helps raise incomes and consumption of poor households in particular and welfare in general. Indeed, similar findings have been reported in related empirical studies in Bangladesh (Khandker, 2005; Pitt and Khandker, 1998; Mahjabeen, 2008; Ahmed et al., 2001; Amin and Sheikh, 2011), China (Li et al., 2011), Indonesia (Okten and Osil, 2004), Bolivia (Maldonado and Gonzalez-Vega, 2008), Vietnam (Duong and Izumida, 2002), Guatemala (Wydick, 1999), India (Imai et al., 2010), Ghana (Al-hassan and Sagre, 2006), Ethiopia (Sebhatu, 2012), Malawi (Swaminathan et al., 2010; Shimamura and Lastarria-Cornhiel, 2010; Hazarika and Alwang, 2003), and Tunisia (Foltz, 2004). These studies generally concluded that formal credit helps improve the welfare of borrowers as it empowers them in their decision-making processes, asset accumulation, political participation and legal awareness among others. It enables poor households stand against starvation, illiteracy and all other adversities that affect their welfare (Afrane, 2002). It also improves household power relations as both women and men are able to earn income, a major determinant of household power dynamics (Pitt et al., 2006) critical in the pursuance of sustainable welfare outcomes. With specific reference to informal credit, the negative relationship found is inconsistent with the views expressed by Schindler (2010) who in a study of informal credit as a coping strategy of market women in northern Ghana concluded that informal credit positively influence the welfare outcomes of women and their households.

It was also found that remittances had positive though insignificant effects on household welfare (Table 3). The *a priori* expectation of a positive relationship was met. This contradicts the finding of an earlier study by Gustafsson and Makonnen (1993) who concluded that remittances do not necessarily lead to poverty reduction and improvement in welfare conditions for that matter. It is however, corroborated by other earlier empirical studies by Diatta and Mbow (1999), Kannan and Hari (2002) and Litchfield and Waddington (2003) among others who concluded that there is positive relationship between remittances and welfare of recipient households. One of the possible explanations for the positive relationship between remittances and welfare expenses is that remittances often come in monetary forms which means that beneficiary households are then in a better position to expend on the core welfare outcomes. It must be noted however, that substantial amount of remittances is also received in material forms.

The level of dependency although negatively related to household welfare expenditures is insignificant. Farm income has negative and significant effects on household welfare expenditures. The *a priori* expectation of positive relationship was thus not met. This means that when farm income of households increases by GH¢1.00, their expenditures on the welfare outcomes decrease by about GH¢0.03 and this decrease is statistically significant at 1% (Table 3). This is inconsistent with the empirical literature that increased income leads to improved livelihoods (Dadzie and Ghartey, 2010; Copestake et al., 2005; Khandker, 2005). One possible explanation to this is that most farm households in rural Ghana are into farming primarily for consumption and are therefore not selling their farm produce for income to finance the attainment of other welfare outcomes. Another possible explanation is that farm income might be mostly used for investments in farm and non-farm production activities as well as savings for 'rainy days' instead of financing welfare expenditures. Besides, wealthier farmers might be spending less on healthcare as they are healthier; education as they are mostly educated; housing as they have their own houses; and so on.

Non-farm income had significant and positive effects on household welfare expenses and therefore the *a priori* expectation of positive relationship was met. The results indicated that a GH¢1.00 increase in non-farm income results in about GH¢0.14 increase in household welfare expenditures. Again, this is consistent with findings of earlier empirical studies noted above. Market access is an insignificant determinant of farm household welfare development. The *a priori* expectation of positive relationship between market access and farm household welfare expenditure was not met (Table 1).

The VIF test indicates that the independent variables are uncorrelated to each other and thus there is no multicollinearity. The significant DWH also indicates that the instrumentation of formal and informal credit was appropriate as they are endogenous and would have yielded biased and inconsistent estimates without instrumentation. The implication of this is that the allocations of credit by formal and informal sector lenders are not done at random. This means that there are some factors which lenders consider in their credit allocations that may not be observable to researchers hence the biasness. The regression specification error test (RESET)

Table 3. Regression results of effects of credit on welfare expenditure (n=3600).

Dependent variable: Welfare Expenses					
Exogenous variables	**Coefficient**	**Robust S.E**	**VIF**	**[95% Conf. Interval]**	
Estimated formal credit	0.0558	0.0122***	2.84	0.0320	0.0796
Estimated informal credit	-0.1029	0.0168***	2.10	-0.1358	-0.0699
Remittances	0.0045	0.0063	1.00	-0.0077	0.0168
Dependency	-0.0158	0.0125	1.03	-0.0403	0.0087
Farm income	-0.0272	0.0085***	1.01	-0.0439	-0.0105
Non-farm income	0.1387	0.0081***	1.09	0.1228	0.1546
Market access	0.0289	0.0644	1.04	-0.0973	0.1552
Constant	29.8979	0.1188***	-	29.6650	30.1308
F(8, 3591)	4330.49	Prob> F	0.000		
R-Squared	0.9021	Root MSE	1.84		
DWH F(1, 3591)	3446.00	Prob> F	0.000		

*** = 1%; VIF stands for Variance Inflation Factor; and RSE is the Robust Standard Errors; Source: Author's computations based on GLSS5 Data, 2013.

test also indicated that the model was correctly specified.

Conclusion

Formal and informal credit has significant effects on the welfare expenses of farm households in Ghana. The effects of formal credit on household welfare expensesare however, positive and that of informal credit are negative. In other words, this paper demonstrates that unlike formal credit, informal credit negatively affects borrowing households' expenditures on the key welfare outcomes - healthcare, education, food, performance of socio-cultural activities, shelter, energy and sanitation. The implication of this finding is that policies to promote welfare conditions of people in rural Ghana should lay more emphasis on the provision of formal credit. Remittances do not significantly influence household welfare expenditures. The effects of farm income on household welfare expenditures are negative and significant. This means that households with appreciable level of income from their farms rather spend less on the attainment of their welfare outcomes.

Furthermore, the effects of non-farm income on household welfare expenditures are positive and significant. The implication of this is that people who have access to non-farm income spend more on welfare expenditures than those without non-farm income sources. The general conclusion is that formal and informal credit significantly affects household welfare development in Ghana. Integration of the formal and informal credit markets with informal lenders acting as community level credit agents is recommended. This might help reduce the negativity of informal credit on household welfare expenditures. Besides, this current paper made used of cross-sectional data and a quasi-experimental design the implication of which is that the estimated effects of formal and informal credit on welfare development is only for the short-term. Thus further research on the subject matter using experimental data and longitudinal research design is recommended.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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Farmers' perception on excreta reuse for peri-urban agriculture in southern Ghana

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Ghana lags behind the Millennium Development Goals' target for sanitation, despite widespread effort by the central government. Most households in peri-urban communities in Ghana lack improved sanitation facilities, and access to faecal sludge disposal sites is also problematic. This study investigates farmers' attitude and perception toward excreta reuse for peri-urban agriculture in Shai-Osudoku district, Ghana. Data were collected on 400 randomly selected respondents using questionnaires and focus group discussions. The study found that a majority of the respondents 'disagree' that excreta are a waste and are willing to use excreta as fertilizer, although a majority 'agrees' that excreta can pose health risks. Perceptions toward excreta reuse for agricultural purpose however differ among households. There is the need for more open discussions on the benefits and risks of excreta reuse in agriculture; this could help enrich farmers' knowledge on the appropriate use of excreta as fertilizer. Further research on the factors that influence farmers' decision to use excreta as fertilizer and their perceptions on the health risks is recommended.

Key words: Sanitation, excreta reuse, farmers' perception, peri-urban agriculture, Ghana.

INTRODUCTION

Most households in peri-urban communities in Ghana lack access to improved sanitation such as improved household latrines. According to the WHO/UNICEF Joint Monitoring Project (JMP), an improved toilet facility is one that hygienically separates human excreta from human contact, and includes: flush/pour-flush to piped sewer system, septic tank and pit latrine; ventilated improved pit latrine (VIP); and composting toilet (WSMP, 2009).

Anecdotal evidence suggests that the few public toilets in peri-urban communities in Ghana are being over-utilised and poorly managed. The sewer excreta systems, such as flush latrines, are rare due to the high costs and scarce water resources. Moreover, the demand for improved sanitation for most households in peri-urban communities may not be high until other needs such as housing, water, farming, and schooling are met (Card and Sparkman, 2010).

Studies have shown that households may benefit more

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in their investments in improved sanitation if such investments offer tangible value to them, such as reuse of excreta as fertilizer for agricultural purpose (Jensen et al., 2005). Interestingly, sanitation service providers, such as pit-emptiers in peri-urban communities, have also indicated that there is lack of dumping sites for faecal sludge. Perceived as a waste and not as a resource by traditional sanitation (Gjefle, 2011), it is not surprising that some households are turned off immediately by the term 'faecal sludge' as it is usually considered as dirty, smelly and harmful substance, albeit the rich resource it provide in agriculture (IWMI, 2013).

Traditionally, human excreta have been used for crop fertilization in many countries including Japan, China and Sweden (Esrey et al., 1998). Farmers in China, South-East Asia and parts of Africa have used human excreta to fertilize fields and replenish the soil organic fraction (Timmer and Visker, 1998; Strauss et al., 2000). Empirically, many ancient Arab, Chinese, Greek, Roman and Spanish authors attest the benefits of human excreta manure (Thurston, 1992). Human excreta, like animal manure, are reported as good soil conditioner and a renewable source of plant nutrients, such as nitrogen, phosphorus and potassium (Drangert, 1998). Vinneras et al. (2006) have provided convincing evidence to support that crop yields resulting from the use of human manure are very high.

In Africa, although the use of human excreta is not widespread, some studies in the continent have attested the economic importance of the organic matter for agricultural purpose. In Uganda, for example, co-compost from faeces is used as fertilizer for various types of crops like bananas, pineapples, maize, cassava, sorghum, jackfruits and passion fruits (Müllegger and Freiberger, 2010). In Ghana, human excreta composts have been tested for its impact on the germination capacity and early growth of vegetables commonly grown in the urban and peri-urban areas (Cofie and Koné, 2009). Farmers in Ghana have also attested to the agronomic benefits of excreta, and users of excreta make three times the net income of non-users (Cofie et al., 2010).

Farmers and other stakeholders in Ghana seem to have inadequate knowledge on human excreta, despite the potential benefits for its reuse in agriculture. While this essential organic manure is considered as waste, the government spends scarce foreign exchange to import chemical fertilizers which are becoming more expensive (Cordell et al., 2009), due to the increasing demand for their use in peri-urban agriculture (Asare et al., 2003). Moreover, chemical/inorganic fertilizers have the potential to pollute both surface and ground water and can cause accumulation of heavy metals in the soil (Mariwah and Drangert, 2011). In addition, the quantum and persistent use of chemical fertilizers for agricultural production can cause serious health problems to producers and consumers. To minimise or alleviate the possible effects of chemical fertilizers use, there is the need for governments and other stakeholders, including farming households to consider ecological sanitation, a new paradigm in sanitation that recognizes human excreta as a resource that can be recovered, treated where necessary, and safely used again (WHO, 2006; Gjefle, 2011).

In considering human excreta reuse for agricultural purpose, it is also important to note that actual use of human excreta depends on people's attitude and perceptions (Mariwah and Drangert, 2011). Douglas (1966) maintains that 'dirt is matter out of place' and the same matter is viewed as dirt in some places and not dirt in the other. Gibson (1979) also appositely puts it that 'perceptions may determine people's behaviour, thus perception determines what we do next'. The aim of this study is to investigate peri-urban (farming) households' attitude and perceptions toward human excreta reuse for agricultural purpose in the Shai-Osudoku district in Ghana. This study is a part of the Sustainable Sanitation Ghana (SUSA-Ghana) project with a broader aim to expand access to improved sanitation facilities among peri-urban residents in Dangme West District, Ghana (http://susaghana.com).

Theory of knowledge, attitudes and perceptions

Information on the knowledge, attitudes and perceptions (KAP) of study participants is important for effective planning, implementation and evaluation of an intervention. The WHO (2008) asserts that a KAP's study can help identify knowledge gaps, cultural beliefs, or behavioural patterns that may facilitate understanding and action, as well as pose problems or create barriers for an intervention or adoption of a technology. Moreover, information that is commonly known and that are commonly held by study participants can also be identified. Furthermore, KAP to some extent, can help identify factors that influence behaviour that are not known to most people, the reasons for people's attitudes, and how and why people practise certain behaviours. Mariwah and Drangert (2011) confirm that the theory of planned behaviour is useful to a perception study because perceptions, like behaviour, are influenced by people's knowledge, beliefs, values, and norms. For instance, the more knowledgeable one is about human excreta, the clearer his/her opinion tends to be, and the stronger the feelings or perception. Similarly, being informed about an issue is even more likely to influence behaviour when knowledge is gained from first-hand experience (Fazio and Zama, 1981). This study, which employs the KAP's approach, is also corroborated by the ideas of Bieberstein (2012) who reports that people's perceptions of risk (for example health-related risks associated with human excreta reuse in agriculture)

related to food products are important determinants of food choices, their attitudes toward technologies used in the food and agricultural sector, as well as behaviour related to safety practices during food production. As observed by Wortman et al. (1992), it is assumed that knowledge about the importance of human excreta can help provide a better understanding and promotion behaviour consistent with beliefs and feelings of study participants like farmers.

METHODOLOGY

Study area

Peri-urban farming communities in Shai-Osudoku district (previously Dangme West district) in the Greater Accra region of Ghana constitute the study area. The study area was chosen as a convenience sample because it is peri-urban and form part of the research area for Dodowa Health Research Centre (DHRC), a partner institution of the SUSA-Ghana Project which provided funding for this study. The district is situated in the south-eastern part of Ghana, lying between latitude 5° 45' south and 6° 05' North and Longitude 0° 05' East and 0° 20' West. The total population of Dangme West is 122,836 persons (47.9% males and 52.1% females), representing about 0.50% of Ghana's total population and 3.06% of the Greater Accra region population (GSS, 2012). The average household size in the District is estimated at 5.2 persons. Agriculture, the dominant occupation, employs about 59% of the people, followed by trade (22.1%) and fishery (6.4%). Financial reports indicate that the highest contribution to internally generated revenue in the District comes from fees and fines, followed closely by business operating permits (http://www.ghanadistricts.com/districts). It is estimated that about 36 and 40% of households defecate in the beach and bush, respectively (SUSA Baseline Report, 2011).

Population, sampling and data collection

Crop farmers in the peri-urban farming communities of the study area constituted the population for this study. Using a household list from the District's Agriculture unit, the study employed a cross-sectional data collected in 2013 on 400 respondents who were randomly selected from purposively considered farming communities in the district: Dodowa (50), Henyum (21), Odumase (39), Adumanya (30), Ayikuma (100), Asebi (100), Abonya (30), Metase (10), Ziakpone (10) and Adumadzan (10). The communities were chosen on the reasons that they are major peri-urban agricultural areas and also form part of the research area of the DHRC, a partner institution of the SUSA-Ghana Project which provided funding for this study. In each selected household, the head or any other adult member who gave consent was interviewed with a survey questionnaire. The questionnaire for the study comprised three main sections: section one elicited household and farm data; section two captured data on respondents' knowledge on human excreta; and section three obtained data on respondents' attitudes and perceptions on excreta reuse for agricultural purpose. In addition, two focus group discussions (FGD) comprising male and female farmer-groups were conducted to complement the responses from the interviews. Consent was sought to tape-record the discussions of the FGDs. With the help of field assistants/interpreters, all the instruments were administered by the researcher in the local language, 'Dangme'.

Analysis of data

Descriptive tools such as frequencies and percentages were used to summarize the socioeconomic characteristics of the respondents. A three-point Likert-type scale ranging from 1 (Agree) to 3 (Disagree) was used to measure the respondents' knowledge and perceptions in their response to pre-set statements on human excreta and their reuse for agricultural purpose. The respondents were asked eight questions about their attitudes and perceptions toward human excreta. Ten statements were also used to assess farmers' knowledge about the use of excreta as fertilizer, as well as their decisions to use excreta as fertilizer. Prior to the interview, the researcher explained the purpose of the study and the possibility of using (sanitized) excreta in agriculture to the respondents. The significant differences between the mean responses of respondents' knowledge, attitudes and perceptions on excreta and their socioeconomic characteristics were assessed using the t-test and a one-way analysis of variance (ANOVA). The data from the FGDs were transcribed to support the quantitative findings from the individual household interviews.

RESULTS AND DISCUSSION

Socioeconomic characteristics of respondents

Table 1 presents the results of the socioeconomic characteristics of respondents. A majority (68%) of the respondents were men and had lived in the study communities for more than 10 years (about 90%). The average age of about 43 years of the respondents was found to be almost similar to the national average of 45 years for farmers in Ghana. A majority had basic education (73%; primary to JHS/MSLC[*]) and about 65% had a household size of at most five persons which is relatively low, implying that household family labour may not be adequate for farm activities. The average farm size of 0.62 ha was found to be relatively lower than the district and national average of 1.5 and 3.0 ha respectively (Shai-Osudoku District Assembly, 2006). The crops cultivated include: plantain, maize, cassava, yam, mango, watermelon, pineapple, and vegetables, mostly on rented plots (71%). A majority of the households earned GH¢400 (US$150) per month. The per capita income was GH¢117.67 (US$59.13) which is below the per capita gross national average monthly income of GH¢224.7 (US$124) (GSS, 2013). This modal monthly income which is positively skewed reflects a characteristic of that of most countries worldwide.

Farmers' attitude and perceptions toward excreta reuse in agriculture

This section presents the results and discussion on the respondents' knowledge, attitudes and perceptions on human excreta reuse for agricultural purpose.

[*] Junior High School/Middle School Leaving Certificate

Table 1. Socioeconomic characteristics of farmers.

Variable		Freq. (%)	Mean (SD)
Gender	Male	272 (68.0)	
	Female	128 (32.0)	
Age (years)	20-29	32 (8.0)	
	30-39	137 (34.2)	
	40-49	134 (33.5)	42.5 (10.9)
	50-59	62 (15.5)	
	60 and above	35 (8.8)	
Length of stay in community	Below 10 years	44 (10.5)	
	10-19 years	107 (26.8)	
	20-29 years	92 (23.0)	24.6 (14.2)
	30-39 years	87 (21.8)	
	40 and above	72 (18.0)	
Education	Tertiary (Univ./Poly/College)	18 (4.5)	
	Secondary (SHS/O'Level/A'Level)	58 (14.5) 161 (40.2)	
	Junior High/MSCL	134 (33.5)	
	Primary school None/no formal education	29 (7.2)	
Household size	5 and below	259 (64.8)	4.9 (1.8)
	6-10	141 (35.2)	
Household monthly income (GHS)	Below 500	219 (54.8)	488.73 (204.1) Mode (400)
	500-1000	177 (44.2)	
	Above 1000	4 (1.0)	
Land tenure system	Own land	61 (15.2)	
	Family land	57 (14.2)	
	Rented land	282 (70.5)	
Crops cultivated	Vegetables (pepper/tomato/onion)	93 (23.2)	
	Maize	184 (46.0)	
	Root/Tubers (cassava/yam)	106 (26.5)	
	Plantain	3 (0.8)	
	Fruits (mango/melon/pineapple)	14 (3.5)	
Farm size	Below 0.5 ha	179 (44.8)	
	0.5-1 ha	183 (45.8)	0.62 (0.28)
	Above 1 ha	38 (9.5)	

US$1.00 = GHS1.99 (May/June, 2013).

Households' attitude and perceptions toward human excreta

More than half of the respondents 'disagreed' that human excreta are waste and not a resource for agricultural production (Table 2). A majority (81%) however 'agreed' that handling human excreta can pose great health risk and for that matter human excreta should not be handled in any way (87%). The comments in the FGDs confirmed the respondents' diverse perceptions toward excreta. A participant in the women's FGD remarked: "Even when you go to toilet you will wash your hands before you do something and now you want to touch it (excreta)." Another participant with a contrary view said that: "It (excreta) came from you so you can touch it." In contrast, another participant said: "When we put cow dung on the floor you can pick it with your two hands but when we put human excreta there it will be a different thing". The facial

Table 2. Respondents' attitudes and perceptions toward human excreta.

Statement	Level of agreement (%)		
	A	DK	D
Human excreta are waste and suitable only for disposal	32.5	14.2	53.2
Human excreta are not resource for agricultural production	31.0	16.0	53.0
Human excreta have no (economic) benefit to humans	30.8	17.0	52.2
Toilet should not be built in/near the household's place of residence	34.8	5.0	60.2
Human excreta should not be handled in any way	87.0	4.8	8.2
Use of human excreta in agriculture is a great health risk	80.8	4.2	15.0
It is a taboo to touch faeces	21.5	7.0	71.5
It is a taboo to touch treated faeces	13.0	9.5	77.5

Note: A, agree (1); DK, don't know (2); D, disagree (3).

Table 3. Respondents' knowledge on utilization of human excreta in agriculture.

Statement	Level of agreement (%)		
	A	DK	D
Human excreta are a resource to the soil	61.5	27.0	11.5
Sanitized human excreta can be used as fertilizer	63.0	27.8	9.2
I will use human excreta on my crops if sanitized	62.5	26.8	10.8
Taste of crops will change when fertilized with human excreta	14.0	30.0	56.0
Smell of crops will change when fertilized with human excreta	12.0	31.0	57.0
Crops can be destroyed when fertilized with human excreta	11.0	32.2	56.8
Crops fertilized with human excreta are good for consumption	57.8	30.2	12.0
I will never consume crops fertilized with human excreta	12.0	31.0	57.0
Animal manure (faeces) can be used as fertilizer	90.5	6.2	3.2
Ever used human excreta as fertilizer on my farm	11.2	0.0	88.8

Note: A, agree (1); DK, don't know (2); D, disagree (3).

expression of a participant in the women's FGD provided evidence of a 'disagreeing' perception towards excreta. Considered as not a taboo (72%), a participant in the men's FGD remarked: "If you cannot touch faeces then you should not shit at all because sometimes you will touch it when you are wiping so it is not a taboo". Moreover, more than half of the respondents (60%) also 'agreed' that a household toilet should not be far from the place of residence; implying the necessity and importance of a household toilet.

Households' knowledge and perceptions on excreta reuse in agriculture

A number of studies have reported on the importance or otherwise of (sanitized) excreta and households' attitudes and perceptions toward the reuse of excreta as fertilizer (Asare et al., 2003; Cofie et al., 2004; Cofie and Koné, 2009; Cofie et al., 2010; Mariwah and Drangert, 2011). From Table 3, it can be observed that more than half of the respondents 'agreed' to the statement that human excreta are a resource to the soil and that sanitized excreta could be used as fertilizer, although only 11% of them had ever used excreta on their crops. A majority of the respondents 'agreed' to use (sanitized) excreta as fertilizer. This was corroborated by a participant in the men's FGD who remarked: "Yes it (excreta) is good for the soil, it is manure, and for example when there are faeces on the ground and crops germinate there, like tomatoes and water melon, they become very fresh and green". In addition, another participant said: "Even human excreta are better for crops than animal manure".

Moreover, more than half of the respondents 'agreed' to the statement that crops fertilized with human excreta are good for consumption. A participant in the women's FGD remarked that: "Yes, we can eat crops fertilized with excreta." This was supported by another woman who said: "The crop will change at maturity and you will not see any excreta, but the crop." Another respondent also said: "It is the food you eat which turns into toilet and when you harvest the crop you don't see the toilet on it so it will make the crop sweeter instead". A participant in the men FGD also remarked that: "Even the taste will be

better; you eat salt so the taste of the salt will go inside the crop and would even taste better". More than half of the respondents 'disagreed' to the statements that 'use of excreta as fertilizer can affect the smell and taste of crops, or can destroy crops'. A statement by a participant in the women's FGD corroborates the general view by the sampled respondents; she remarked: "No, excreta cannot destroy crops; even at the public toilet the cocoyam there are very fresh and we harvest kontomire (spinach) from there". In support of this statement, another participant said: "People defecate behind our house, and a tractor came to plough the land for farming, and the maize there looked nicer than using inorganic fertilizer". These findings show that the respondents were knowledgeable about the potential benefits of human excreta for agricultural purpose.

Perceptions on excreta reuse in agriculture by socioeconomic characteristics

Table 4 presents the mean responses of the respondents' overall attitudes and perceptions on human excreta by their socioeconomic characteristics with regard their value and decision to use excreta as fertilizer. The results of the study show that women were generally more negative to excreta than men. This is consistent with a report by Mariwah and Drangert (2011) who observed that women are more negative towards excreta than men. Perceptions on the value of excreta and decisions on excreta reuse for agricultural purpose by length of stay in the study communities, education, household income, type of crop cultivated and farm size were all significant at the conventional levels. Respondents with less experience in the study area were more likely to 'disagree' that excreta are a waste than those with more experience. In addition, younger people were more likely to 'disagree' that excreta are a waste and were willing to use it as fertilizer on their crops than the aged. This result concurs with the finding by Mariwah and Drangert (2011), although their result was not significant. It can be inferred from this results that younger farmers in the study area are more ambitious and ready to bear risk than elderly farmers.

The results also show that respondents with higher formal education were more likely to 'disagree' that human excreta are a waste and were more likely to 'agree' to use excreta for agricultural purpose than those with no formal education. Moreover, higher income earners were more likely to use excreta as fertilizer than lower income farmers. Land owners were also more likely to 'disagree' that excreta are waste and were more willing to use excreta as fertilizer than tenant farmers. Although inconsistent with the findings of Cofie et al. (2010) who observed that lack of ownership of land does not affect the decision to use excreta, it can be inferred from the results of this study that tenant farmers are more careful in their decision on the use of excreta on rented plots. Moreover, large-scale farmers were more likely to 'disagree' that excreta are a waste than small-scale farmers, and they were more willing to use excreta as fertilizer than small-scale farmers. This result concurs with the findings by Cofie et al. (2010) who reported that the high cost of inorganic fertilizers normally compels farmers to use alternative products (such as like excreta), particularly with increasing farm size. However, vegetable and fruit crop farmers were less likely to 'disagree' that excreta are a waste and were less willing to use excreta as fertilizer than as perceived by arable crop farmers. This result concurs with the findings by Cofie et al. (2010) that due to possible health risks, excreta are used mainly for maize production than for vegetables.

CONCLUSION AND RECOMMENDATIONS

This study investigated (farming) households' attitudes and perceptions toward human excreta reuse for agricultural purpose in the Shai-Osudoku district in Ghana. Data were collected in 2013 on 400 randomly selected respondents using questionnaires and focus group discussions. Using a three-point Likert-type scale and the t-test and ANOVA, respondents' knowledge and perceptions as well as the relationships between their perceptions and socioeconomic characteristics on excreta reuse for agricultural purpose were assessed. The study found that a majority of the respondents in the study communities 'disagree' that excreta are a waste and are willing to use excreta as fertilizer or to consume crops fertilized with excreta, albeit a majority 'agreeing' perception that excreta can pose health risks. The respondents' attitudes and perceptions toward excreta and their decision to use excreta for agricultural purpose however differ with respect to their socioeconomic characteristics. Since farming is the predominant occupation for the people in the study area, it is important that programmes aimed at promoting improved sanitation in those areas should consider alternative ecological sanitation systems such as the use of (sanitized) excreta in farming so as help improve crop yields at minimal cost. There is also the need for more open discussions on the benefits and risks associated with excreta reuse in agriculture; this could help enrich farmers' knowledge on the handling and appropriate use of excreta as fertilizer. Further research on the factors that influence farmers' decision on excreta reuse for agricultural purpose and perceptions on health risks is recommended.

Conflict of Interest

The authors have not declared any conflict of interest.

Table 4. Respondents' attitudes/perceptions on excreta by socioeconomic characteristics.

Variable	N	Human excreta are waste and suitable only for disposal			Will use (sanitized) human excreta in agriculture		
		Mean	SD	F/t-test Stat. (p-value)	Mean	SD	F/t-test Stat. (p-value)
Sex							
Male	272	2.29	0.88	t-test (0.010)**	1.44	0.67	t-test (0.078)*
Female	128	2.04	0.93		1.57	0.71	
Age (years)							
20-29	32	2.62	0.75	ANOVA (0.010)**	1.19	0.47	ANOVA (0.010)**
30-39	137	2.31	0.89		1.39	0.63	
40-49	134	2.13	0.91		1.55	0.71	
50-59	62	2.08	0.91		1.63	0.73	
60 and above	35	1.97	0.89		1.57	0.74	
Length of stay in community							
Below 10 years	42	2.76	0.62	ANOVA (0.000)***	1.07	0.26	ANOVA (0.000)***
10-19 years	107	2.46	0.85		1.34	0.66	
20-29 years	92	2.00	0.94		1.62	0.71	
30-39 years	87	1.93	0.89		1.69	0.70	
40 and above	72	2.11	0.88		1.51	0.69	
Education							
Tert. (Univ./Poly/College)	18	2.94	0.24	ANOVA (0.000)***	1.06	0.24	ANOVA (0.000)***
Sec. (SHS/O'/A' Level)	58	2.76	0.66		1.17	0.53	
Junior High/MSCL	161	1.93	0.91		1.65	0.73	
Primary school	134	2.20	0.88		1.46	0.63	
None/no formal education	29	2.24	0.87		1.59	0.78	
Household size							
5 and below	259	2.20	0.90	ANOVA (0.932)	1.48	0.67	ANOVA (0.996)
6-10	141	2.21	0.91		1.48	0.71	
Household income/mth (GH¢)							
Below 500	219	1.99	0.91	ANOVA (0.000)***	1.64	0.72	ANOVA (0.000)***
500-1000	177	2.47	0.83		1.30	0.59	
Above 1000	4	2.50	1.00		1.00	0.00	
Land tenure system							
Own land	61	2.56	0.79	ANOVA (0.002)***	1.15	0.44	ANOVA (0.000)***
Family land	57	2.28	0.90		1.40	0.62	
Rented land	282	2.12	0.91		1.57	0.71	
Crops cultivated							
Veg. (pepper/tomato/onion)	93	1.80	0.83	ANOVA (0.000)***	1.69	0.71	ANOVA (0.000)***
Maize	184	2.20	0.94		1.51	0.72	
Root/Tubers (cassava/yam)	106	2.60	0.74		1.23	0.52	
Plantain	3	2.67	0.58		1.67	0.58	
Fruits (mango/melon/pineapple)	14	1.93	0.92		1.64	0.63	
Farm size							
Below 0.5 ha	179	2.20	0.88		1.49	0.67	
0.5-1 ha	183	2.13	0.94		1.53	0.72	
Above 1 ha	38	2.66	0.67		1.21	0.47	

*** Significant at 1%; ** Significant at 5%; *Significant at 10%.

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Full Length Research Paper

Economic and technical efficiency of cassava production in Ika North East Local Government Area of Delta State, Nigeria

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Cassava production seems to be economically viable but there seems to exist no empirical documented evidence to this effect in Ika North East L.G.A of Delta State, Nigeria. In view of this, the study analyzed the economic and technical efficiency of cassava production in Ika North East Local Government Area of Delta State. A multistage random sampling was used to select a total of 120 respondents used for the study. Data used for the study was from primary source, which was collected using a well structured questionnaire. Both descriptive and inferential statistics were used to analyze the data based on the objective of the study. The result obtained showed that females (52.5%) are more than males. Majority (50%) of the respondents are married with an average household size of 6. The result further showed that the farmers were in their middle age (42 years) and had acquired reasonable years of farming experience of 10 years. More than half of the farmers had attended formal educational and earn average annual income of ₦180,000.00. The production systems practiced by the farmers was mono cropping. Cassava production was profitable in the area with a profit margin of ₦200,400.00 per a hectare. The Benefit Cost Ratio shows that in every ₦1.00k invested by farmers, ₦1.00k was realized as profit. The multiple regression result showed R^2 value of 0.833 or 83.3%. The coefficients of farm size, labour and cassava stem were positively signed. Farm size, labour, fertilizer and cassava cuttings were underutilized because their efficiency index was greater than one. The cassava farmers identified some of the factors that constrained their farming activities to include: lack of access to credit, high cost of transportation, poor extension services, among others. Based on the findings, it is therefore recommended that farmers should organize themselves into cooperative societies so as to access credit; viable extension service should be provided bridge the extension need of the farmers and effective transportation system to ease evacuation of cassava produce to urban centre where the demands are high.

Key words: Costs and returns, profitability, production system, constraints, input/output.

INTRODUCTION

Cassava (*Manihot* spp.) is important not only as food crop but moreso as a major source of income for rural households. According to Ogunniyi et al. (2012), cassava has some inherent characteristics, which makes it

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attractive especially to the smallholder farmer in Nigeria. Firstly, it is rich in carbohydrates, which make it useful in some industries and consequently has a multiplicity of end uses. Secondly, it is available all year round compared to other crops as it is more tolerant to low soil fertility and resistant to drought, pests and diseases. These attributes combined with other socio-economic considerations are therefore what IFAD has recognized in the crop as lending itself to a commodity-based approach to poverty alleviation (FAO/IC, 1995).

The comparative production advantage of cassava over other staples has made the government to encourage its cultivation even by the resource poor farmers. The crop production is generally thought to require less labour per unit of output than other major staples. It is a good staple whose cultivation if encouraged can provide the nationally required food security minimum of 2400 calories per person per day (FAO, 2000).

In 2002, cassava suddenly gained prominence in Nigeria following the pronouncement of a presidential initiative on the crop. The initiative was aimed at using cassava production as the engine of growth in Nigeria. In recent times, government has encouraged the use of the crop to produce a wide range of industrial products such as ethanol, glue, glucose syrup and bread. The Nigerian government has also promulgated a law, making it compulsory for bakers to use composite flour of 10% cassava and 90% wheat for bread production. The new regulation which came into effect January 2005, stipulated that the large flour mills that supply flour to bakeries and confectioneries must pre-mix cassava flour with wheat flour (Technical for Agricultural and Rural Cooperation (CTA), 2005).

Cassava has been reported as the chief source of dietary food energy for the majority of the people living in the lowland tropics, and much of the sub-humid tropics of West and Central Africa (Tsegia et al., 2002). Therefore, its production and utilization must be given prime attention in food policy. Even though farmers have not yet attained the desired technical efficiency in cassava production as a result of weak access to external inputs such as fertilizers and herbicides (Ezedinma et al, 2006), the wide scale adoption of high yielding varieties and the resulting increase in yield have shifted the problem of the cassava sector from supply (production) to demand issues, such as finding new uses and markets for it.

Nigeria produces more than 45 million metric tons (MT) of cassava, thus emerging as the world's largest producer (USAID, 2010). In spite of this volume, the full yield potential has not been realized since smallholder production rarely exceeds 11 MT per hectare as against 25 to 40 MT per hectare recommended by experts. This yield per hectare is indicative of the yields experienced in the south-south region of Nigeria including Ika North East L.G.A of Delta State. This region is one of the most productive in the country with respect to cassava. The national average is somewhat lower at 10.0 tonnes/ha. In contrast, Thailand national experienced yields of 17.1 tonnes/ha in 2002. Regional yields in countries such as India, Laos, Thailand and Barbados have been estimated as high as 25 to 40 tonnes/ha. Obviously, Nigeria's highest productivity yields fall short of these rates and this situation is due to a number of factors including small scale farming (on plots that are usually less than 1 ha), manual operation, little or no use of fertilizers and limited knowledge in the use of high yielding roots (Olomola, 2007). Farming at this level makes it difficult to achieve efficiency and economies of scale.

At the farm level, production costs for cassava are high relative to those in other countries. Production is not oriented towards commercial use; instead, farmers produce and process cassava as a subsistence crop. The Nigerian cassava system, is characterized by small-scale farmers/holdings cultivating less than 2 ha of cassava (average of 0.5 ha), primarily cultivated for the traditional food market, is subsistence in nature and not oriented to the industrial market. Any surplus cassava is either processed on the farm, or sold to local processors. The average production figures per hectare in Nigeria were 10.5 MT/Ha in the early 1970s, 11.5 MT/Ha in the 1980s, 10.5 MT/Ha by the end of 1980s, and 11.5 MT/Ha in the 1990s and up to 17.3 MT/Ha was achieved in Ondo State in 2004.

It is also important to note that cassava production is mostly done by rural smallholder farmers using low-level production techniques (Omonona, 2009; Oyegbami et al., 2010; Nweke et al., 2002). Though government at various levels has been trying in various ways to encourage rural farmers to adopt the modern cassava production technologies in order to increase the rural farmer's productivity (Frescro, 1993; Otoo, 1994), there are constraints to adoption in rural farming communities (Nweke et al., 2002; Teklewold et al., 2006). In some instances, farmers reject some of modern technology due to their cultural background and inhibitions due to perhaps illiteracy and religious beliefs. Nevertheless, credit constraint has been singled out as a major factor militating against adoption of modern cassava production techniques (Nweke et al., 2002). The technologies are herbicides application, use of hybrid cassava stake, use of insecticides, use of inorganic fertilizer, use of tractor, appropriate spacing, planting date and tillage practices. The adoption of modern cassava production technologies is an important route out of poverty and enhancing productivity for many in the developing world including Nigeria because of the major role cassava play in food security. Many studies have noted poor technology adoption in cassava production as a serious factor constraining outputs (Barham and Boucher, 1994; Ogboso, 2005).

Despite the importance of cassava as a means of livelihood of farmers in Nigeria, the dearth of empirically documented data on the economic and technical efficiency in the Ika North East L.G.A of Delta State

necessitated this study. It is in view of the foregoing that the following specific objectives were addressed:

i) Describe the socio-economic characteristics of the farmers in the area;
ii) Identify the production system employed by the farmers;
iii) Determine the technical efficiency of production in the area;
iv) Analyze the costs and returns of production in the area; and
v) Analyze the constraints to production in the area.

METHODOLOGY

The study was carried out in Ika North East Local Government Area of Delta State, Nigeria. It has an area of 463 km² and a population of 183,657 (NPC, 2006). There are nine communities, namely; Owa, Ute-Ogbeje, Ute-Okpu, Umunede, Idumuesah, Igbodo, Otolokpo and Mbiri spread out into fourteen wards in the area. The Local Government Area has natural vegetation that supports agricultural activities such as crop production, fishing etc. thus; agriculture is the major activities of the people of this area. The principle crops grown in this area are: yam, cassava, melon, maize, tomatoes, plantain, among others.

A multiple-stage random sampling techniques was employed in selecting the respondents. This involves the random selection of four communities from the nine communities in the area. From the four randomly selected communities, three villages were randomly selected to give a total of 12 villages. Finally, ten cassava farmers were randomly selected from the 12 villages to give rise to 120 farmers. Thus, a total of 120 cassava farmers were randomly selected for the study. Primary data was used for the study. The data was collected through the use of structured questionnaire that was administered to the 120 randomly selected respondents. Data used for the study was analyzed using descriptive statistics such as mean, frequency distribution tables, percentages and inferential statistics. Descriptive statistics was used to analyze objective (i) and (ii); objective (iii) was analyzed using multiple regression analysis while objective (iv) was achieved using gross margin analysis and objective (v) was analyzed using mean score derived from 4 point likert scale.

Model specification

Multiple regression model

$Y = f(X_1, X_2, X_3, X_4, X_5)$ - - - - - implicit form

$Y = a_0 + a_1x_1\ a_2X_2, + a_3X_3, + a_4X_4, X_4, + a_5X_5, +$ et ---- Explicit stochastic form

Where
Y=total output of cassava (tonnes)
X_1 = farm size (ha)
X_2 = labour used in man-days
X_3 = fertilizer used (kg)
X_4 = cassava cuttings (kg)
X_5 = herbicide used (litre)
et = Stochastic error term
$a_1 – a_5$ = Parameters estimate
a_0 = constant

Technical efficiency of each parameter was estimated using efficiency index Rxi = biPy/Pxi,

Where
pxi = unit price of input (N),
Py = unit price of output (N),
bi = marginal productivity of the input and
Rxi = Technical efficiency index of the input.

Model for gross margin

The model used for the estimation of the gross margin according to Olukosi and Ernabor (1988) is stated as:

GM = TR – TVC (GI – TVC)

Gross margin = Total revenue – Total variable cost

٢ = GM – TFC

Profit = Gross margin – Total fixed cost

Where
GM = Gross Margin
TR = Total Revenue
GI = Gross income
TVC = Total variable cost
٢ = Profit

Model for Likert scale

$$\overline{Xs} = \frac{\sum fn}{Nr}$$

Where:

$\overline{X}$ s	=	mean
$\sum$	=	Summation
Fn	=	frequency of respondents responses
Nr	=	number of response of respondent

RESULTS AND DISCUSSION

Socio-economic characteristics of the respondents

Table 1 shows the age distribution of the famers. The result indicated that more than half (70%) of the respondents are between 31 to 50 years of age, which is regarded as economically active age according to FAO (1992). At this stage in life, Anyanwu et al. (2001) recognised that people are more likely to be energetic and have the capacity to use innovation. This justified the findings of Ebukiba (2010), who reported that 76% of the cassava farmers in Akwa Ibom State were aged between 31 to 50 years.

The results equally revealed that majority (52.5%) of the farmers are female while 47.5% are male. This implies that women participate more actively in cassava production than their men counterpart. This collaborate the findings of Ebukiba (2010), who reported that 60% of the cassava farmers in Akwa Ibom State were females.

Table 1. Percentage distribution of the farmers according to their socio-economic characteristics.

Characteristics	Description	Frequency (n=120)	Percentage	$\bar{X}$
Age (years)	20 - 30	24	20	42
	31 - 40	12	10	
	41 - 50	72	60	
	51 and above	12	10	
Gender	Male	57	47.5	
	Female	63	52.5	
Marital status	Single	27	22.5	
	Married	60	50	
	Separated	10	8.3	
	Divorced	8	6.7	
	Widowed	15	12.5	
Household size	1 - 4	48	40	5
	5 - 8	48	40	
	9 - 12	18	15	
	13 and above	6	5	
Educational level	Non-formal	15	12.5	
	Primary	26	21.7	
	Secondary	41	34.2	
	OND/NCE	27	22.5	
	HND/B.Sc	9	7.5	
	M.Sc	2	1.7	
Annual income	≤50,000	6	5	180,000
	50,001 - 100,000	36	30	
	100,001 - 150,000	30	25	
	150,001 - 200,000	12	10	
	200,001 - 250,000	6	5	
	250,001 - 300,000	18	15	
	300,001 and above	12	10	
Farming experience	1 - 5	24	20	10
	6 - 10	66	55	
	11 - 15	12	10	
	16 - 20	18	15	
Farm size	3 - 5	54	45	6
	6 and above	66	55	

Source: Field Survey (2012).

It was noted that most (60%) of the cassava farmers were married, 22.5% were single, 8.3% were separated while 6.7% were divorced and 12.5% were widowed. This is justified on the ground that the majority of respondents who engaged in cassava farming are married people. It also implies that cassava production is the means of livelihood for these households.

Household size is a very important factor especially in determining labour for farm work. A farmer with a large household size has the chance of using them as their farm labour. This will affect the size of land cultivated and enhance returns. From the result, it was observed that

Table 2. Percentage distribution of respondents according to production system.

Production system	Frequency (n=120)	Percentage
Mono cropping	93	77.5
Mixed cropping	15	12.5
Inter-cropping	12	10.0

Source: Field Survey (2012).

the farmer had an average household size of 6. This conforms to the findings of Oladeebo and Oluwaranti (2012), who reported average of 8 persons per cassava farmers in South Western, Nigeria.

Again most (34.2%) of the respondents had attended secondary school education, 21.7% of them had attended primary school and 31.7% of them had acquired post secondary school education, while a few (12.5%) of them did not acquire formal education. By implication, a reasonable number of farmers in the area should be able to understand the use of improved technologies and apply it to achieve increased production. Through education, the quality of labour is improved and with it the propensity to adopt new techniques (Tijani et al., 2006; Hyuha, 2006). Thus, cassava farmers in the study area would easily adopt new technologies which could improve their level of profit *ceteris paribus.*

The result reveal an average income of ₦180,000.00 per annual. The breakdown shows that most (45%) of the farmers earned an annual income of between ₦100,000 to ₦150,000, 12% earned between ₦150,001 to ₦200,000, 30% of them earned above ₦200,00 per annual income. Signifying that the respondents are low income earners and this will have a negative effect on the rate of adoption of improve cassava technologies in the area, since capital is needed to procure most of the modern cassava technologies.

The result equally showed that most of the farmers had been in the business of cassava farming for up to 10 years. This is an indication that majority of the farmers has taken into cassava farming for quite a while in the area. This is also in consonance with the findings of Oladeebo and Oluwaranti (2012), who reported average of 13 years farming experience for cassava farmers in South Western, Nigeria.

The result of the farm size as held by the farmers on average was 5 ha, while majority (45%) held a size of between 3 to 4 ha. This followed the study of Oladeebo and Oluwaranti (2012), who reported average of 4 ha farm size for cassava farmers in South Western, Nigeria.

Cassava production system

The result in Table 2 shows that majority (77.5%) of the cassava farmers practiced mono cropping production system, while few (12.5%) of them practiced inter-cropping and 10% practiced inter cropping production system in the area. It is justifiable to say that mono cropping system is the cassava production system practiced by the farmers in the area.

Relationship between inputs and outputs of cassava production

Table 3 shows the result of multiple regression analysis of the relationship between inputs used and outputs from cassava production in the study area. The multiple regression co-efficient (R) was 0.912 or 91.2%. The implication is that the included independent variables (farm size, labour, fertilizer used, cassava stem and herbicide used) were highly correlated with the farmers' outputs. Also the coefficients of multiple determination (R^2) was 0.833 or 83.3%, signifying that 83.3% of total variation in dependent variable (total outputs) was explained by the explanatory variables, that is, inputs (x_1-x_5) included in the model. The fitness of the model was confirmed by the low value of the overall standard error of the estimate (Std. error = 5.27849) and the Durbin-Watson value of 2.356, indicating absence of autocorrelation in the model.

Farm size (x_1): the coefficient of farm size was positively signed and statistically significant at 1%. This implies that increasing the farm size cultivated by the farmers will lead to proportionate increase in total cassava outputs. Again, the statistical significance indicated by farm size of the farmers signifies that farm size contribute to outputs of the farmers. This conforms to the *a priori* expectation.

Labour used (x_2): the coefficient of labour used in cassava production was negatively signed and statistically insignificant. This implies that a unit increase in labour used in cassava production will not contribute to total cassava output. This conforms to the a priori expectation, because increasing labour used in cassava production will add additional cost to total cost of production which will reduce the returns of the farmers.

Fertilizer used (x_3): by the farmers was negatively sign, but was statistically significant at 1%, indicating an

Table 3. Relationship between inputs and total outputs from cassava production in the area.

Variables	Coefficient	Standard error	t-value	Sig
Constant	-18963.514	2191.241	-8.654	*
Farm size (x_1)	0.580	0.200	2.904	*
Labour used (x_2)	-0.231	0.249	0.926	NS
Fertilizer used (x_3)	-5.145	0.378	-13.613	*
Cassava stem (x_4)	0.939	0.262	3.583	*
Herbicide used (x_5)	-5.022	0.883	-5.689	*
R	0.912			
R^2	0.833			
D.W	2.356			
F-statistics	113.432			
Standard error	5.27849			

Source: SPSS Analyzed Data (2012). NS = Non significant; NS = Non significant, *indicate significance at 1% level

Table 4. Technical efficiency of cassava production in the area.

Resource	MVP (N)	MFC (N)	Efficiency Index
Farm size (X_1)	16436.3	1524.5	10.8
Labour (X_2)	17945.4	2846.7	6.3
Fertilizer (X_3)	21050.0	16450.0	1.3
Cassava cuttings (X_4)	4360.0	1405.2	3.1
Herbicide (X_5)	1235.4	1846.1	0.07

Source: Computed Field Survey (2012).

inverse relationship between the fertilizer used and the total cassava output in the area. In other words, increasing fertilizer used for cassava production will lead to decreasing outputs. However, the statistical significance implies that fertilizer used contributes to total cassava outputs. This is in conformity to the *a priori* expectation, because the continued application of fertility to farm will lead to soil acidity and binding of certain important micro and macro nutrients which are needed for optimum crop growth. In addition to the cost it will impute to the overall production cost. Although, fertilizer is required in its optimal level for the improvement of soil fertility, its over-use is damaging to soil.

Cassava stem (x_4): used by the farmers was positively related to total output and statistically significant at 1%. This signifies that increasing use of cassava stem will result to a unit increase in total cassava output. Again, statistical significance indicated that the use of cassava stem is associated with outputs of farmers. Thus, the *a priori* expectation was met.

Herbicide used (x_5): the coefficient of herbicide used was negatively related to the total output but statistically significant at 1%. This implies that increasing the use of herbicides in cassava production will lead to decreasing cassava production output in the area. While the statistical significance signifies that herbicide application contributes to cassava outputs, this agrees with the *a priori* expectation because increasing herbicide used will add additional cost to the overall cost of production and decrease returns accruing to the farmer.

Technical efficiency

From the result in Table 4, it was observed that the farmers were not efficient in the utilization of all the specified resources as far as cassava production is concerned in the study area. Farm size had the highest efficiency index of 10.8, followed by labour (6.3), cassava cuttings (3.1), fertilizer (1.3) and herbicide (0.07). Farm size, labour, fertilizer and cassava cuttings were underutilized since the efficiency index was greater than one. This indicates that additional income can be made from the production of cassava by using more of these inputs efficiently by the farmers. There was over utilization of herbicide since the efficiency index is less than one. Therefore reducing the litres of herbicide used can lead to more income. It should be noted that the MVP's of all the inputs used were not negative, indicating that cassava farmers still use the resources within the

Table 5. Analysis of cost and returns of cassava production per hectare.

Items	Unit	Quantity	Unit Price	Total
A. Revenue				
Cassava tubes	tonnes	14.5	25,000	362,500.00
Cassava stems	tonnes	7	4,500	31,500.00
Total Revenue				**394,000.00**
B. Variable Cost Inputs				
Cassava stems (Cuttings)	tonnes	4	4,500	18,000.00
Fertilizers	Bag	3	5,000	15,000.00
Total Cost				**33,000.00**
C. Cost of Labour	**Mandays**			
Land preparation (Clearing, ploughing and harrowing)		18	750	15,000.00
Planting	mds	10	750	7,500.00
Weeding	mds	30	750	30,000.00
Harvesting	mds	10	750	7,500.00
Transportation				50,000.00
Miscellaneous cost				20,000.00
Total Cost				**130,000.00**
D. Total Variable Cost				**163,000.00**
Fixed Cost				
Depreciation on farm tools (hoes, matches) @ 10				5,600.00
Depreciation on land @ 5%				25,000.00
E. Total Fixed Cost				**30,600.00**
Total variable cost (TVC) = B + C				163,000.00
Gross margin = TR – TVC = A – D				231,000.00
Total cost = TFC + TVC = E + D				196,000.00
Benefit Cost Ration (TR/ TC)				2.0:1.0

Source: Computed From Field Survey (2012).

economically range even though they were not optimally used. This justifies the finding of Ogunniyi et al. (2012),who reported that cassava farmers in Atakunmosa Local Government Area of Osun State underutilized farm size labour, fertilizer and cassava cuttings, while herbicide, was over-utilized.

Cost and returns

From the result in Table 5, total cost of producing cassava per hectare was ₦196,000.00, the total revenue obtained was ₦394,000.00 and the gross margin was ₦231,000.00. The profit of ₦200,400.00 was actualised, this implies that cassava production in the area was profitable. Also the Benefit Cost Ratio was ₦2.00, indicating that for every ₦1.00k expended in cassava production, ₦1.00k was realized as a profit. This follows the findings of Ebukiba (2010) who reported BCR of N1.9:1.0 for cassava farmers in Akwa Ibom State.

Constraints militating against efficient cassava production

The farmers were constrained by the following factors: lack of access to credit facilities (3.8), lack of ready market (2.5), poor storage facilities (2.8), high cost of transportation (3.2), high cost of labour (3.4), inadequate supply of fertilizer (3.5), poor extension services (3.6), problems of pests and diseases (2.9) and poor road network (3.0). This follows the findings of Ebukiba (2010), who reported that cassava farmers in Akwa Ibom State face problems such as inadequate capital, lack technical, lack of government support, lack of improve cuttings and poor market, among others (Table 6).

Conclusion

The finding of this study shows that cassava production in the area is very lucrative, inspite of the inefficient use

Table 6. Mean score distribution of respondents according to constraints militating against cassava production.

Constraints	Mean score (xs)	Decision
Lack of ready market	2.5	Accepted
Lack of access to credit facilities	3.8	Accepted
Poor storage facilities	2.8	Accepted
High cost of transportation	3.2	Accepted
Lack/ inadequate improved varieties	2.0	Rejected
High cost of labour	3.4	Accepted
Inadequate supply of fertilizer	3.5	Accepted
Land fragmentation	2.2	Rejected
Poor extension services	3.6	Accepted
Problems of pests and diseases	2.9	Accepted
Poor road network	3.0	Accepted

Source: Field Survey (2012).

of certain factors of production by the farmers. Hence, the farmers should be encouraged through technical training on production techniques/ practices that will improve their productivity especially in those areas were the study identified inefficiency and underutilization of production resources. These are: farm size, fertilizer and cassava cutting. It is therefore recommended that more farmers should be encouraged to go into cassava farming since it is profitable and can tolerate soil with low fertility.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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Determinants of farmers' adoption decisions for improved pearl millet variety in Sahel savanna zone of northern Nigeria

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Millet is a staple food mainly from local varieties, throughout the Sahel and in parts of the Sudan Savanna. Improved millet varieties are higher yielding and of better quality than the local varieties. This study was carried out after the Yobe State Agricultural Development Program had carried out series of extension services to assess the determinants of adoption of the improved varieties. Multistage systematic and purposive random sampling techniques were used to select 300 farmer respondents. Descriptive statistics was used to describe the socioeconomic characteristics of the farmers while logit regression analysis was used to determine factors that affect the adoption of the technology in the study area. The result showed that household size, farm size, farming experience, maturity period of millet, yield of millet, and access to credit were positively significant in predicting the farmers' probability of adopting improved pearl millet variety. On the other hand, distance to source of technology (improved pearl millet seeds) negatively influenced the probability of adoption. The study recommends improving the funding of the extension organizations and making concerted effort to increase the quantity and quality of human resources available if food security is to be guaranteed in the region.

Key words: Pearl millet, adoption decision, Sahel savanna, agricultural extension.

INTRODUCTION

Nigeria is an important millet producing country with an average annual production of 3.4 million tons (about 7.06 metric tons were produced in Nigeria in 2003 syngenta foundation, 2003). The production increased to 4.8 million tons in 2008/2009 cropping season (NBS, 2013). It ranks second after India in global millet production. While at the National level it ranks third after maize and sorghum among cereal food crops. It is a staple food throughout the Sahel and in parts of the Sudan Savanna. The crop is therefore very important to the nations` agricultural sector because of their high degree of adaptation to stress environments, such as severe drought, poor soils and high temperature is a great relief to life in the Sahel (Rai and Kumar, 1994).

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The crop can grow where even certain weeds cannot survive. Previous research conducted by the Institute for Agricultural Research (IAR) Samaru, Zaria and the current research efforts of the Lake Chad Research Institute (LCRI) Maiduguri, demonstrated a three-fold yield increase through the adoption and use of improved pearl millet varieties and improved management practices. The current agricultural extension service system in Nigeria is prosecuted by the Agricultural Development Project (ADP). The ADPs were established in the Mid 1970s as enclave integrated agricultural development projects with funding assistance from the World Bank. Its objectives were to increase the production of food and industrial crops through systematic extension programme, adaptive research and input delivery system as well as provision of rural infrastructure (rural feeder roads and water supply).

The relative success of the first enclave projects encouraged the Nigerian government to accept the ADP system as the main strategy for promoting agricultural production at the small holder farmer level. The ADPs has thus been established on a state wide basis in all 36 states of the country including FCT Abuja.

However, the success of the ADPs in achieving its objectives in recent times has become questionable especially in facilitating the adoption of new and improved technologies. Singh and Emechebe (1998) had posited that the rate of adoption of a new technology is subject to its profitability and the degree of risk and uncertainty associated with it, the capital requirement, agricultural policies as well as the socio-economic characteristics of the farmers.

In a situation where these attributes are positively available and yet the farmers seem not to have embraced the technology; the Agricultural extension organization may then be held liable for failing in their duty of creating awareness. The case of improved pearl millet varieties and its adoption in sahel savanna of northern Nigeria thus presents itself for study.

The millet grains are used primarily for human consumption because of its high level of fat and protein (the protein vary between 10.9 to 16.9% content (Okoh et al., 1985). The starch and lipids are similar to those of sorghum and maize. However, pearl millet has higher protein content and more desirable levels of essential amino acid than sorghum.

In general, its digestibility is better than that of Sorghum (Rooney and McDonough, 1987). In Nigeria from 1992 to 1994, 3.3 million tons of millet was used directly as food, 1.2 million tones for seed, beer, and only 0.1 million tons were used as livestock feed (ICRISAT/FAO, 1996). The issue is that the adoption of improved pearl millet variety in the study area seems to be at its lowest ebb because of perceived high number of farmers who still grow the local varieties which include, Ex-Borno, Ex-Gashua, Ex-Tukur, Gwagwa, Buduma, Buduma-Damasak and Zango. According to Mijindadi et al. (1998), improved pearl millet varieties are higher yielding. They mature earlier (60 to 70 days as against 70 to 100 days for local varieties). They are resistant to *striga spp*, drought, pests and diseases. They respond optimally to fertilizer and other management practices. More importantly, the grain size is larger while the panicle is more compact.

Despite all these lofty attributes, there seem to be limited extension outreach probably due to wide ratio of extension agent to farm families. Moreover, farmers recycle their local seed varieties with implication for low yield. Kumar and Anand (1993) posited that 40% yield is attributed to use of improved seed quality. Hence farmers` continued use of local and recycled seeds will lead to yield decreases of about 40%. The study therefore aims at determining the socio-economic characteristics of the farmers as well as determining the factors that affect the adoption of improved pearl millet varieties in the study area.

METHODOLOGY

The study area Yobe state was purposively chosen because it is mainly an agricultural state located in Northern Nigeria in the Sahel Savanna Zone. The State borders with Jigawa and Bauchi in the West, Borno State in the East and South while it shares international border with the Niger Republic in the north. According to Wikipedia (2013), the estimated population is 2,532,395 in an area of 45,502 Km^2.

The majority of Yobe State inhabitants are peasant crop farmers but a significant part of the population is actively involved in livestock production as well as trading and fishing. The state is endowed with vast agricultural development potential. Crop, livestock and fishing provide employment to over 80% of the population. The major crops grown are millet, sorghum, cowpea, groundnut, rice and bambara nuts but millet is the most common (Yobe Printing Press, 1998). Currently, the study area is the hotbed of armed insurgency by Boko Haram in Nigeria. The climate of Yobe is hot and dry for most period of the year in the northern parts while the south is cooler and wetter. The hottest months are March, April and May with temperatures ranging from 30 to 40°C. The duration of the rainy season varies from place to place but generally it lasts for about 120 days in the north and more than 140 days in the south. The annual rainfall ranges from 500 to 1000 mm.

Sampling technique

Primary data used for this study was generated from a cross sectional survey conducted in 2010. A multistage random sampling technique was used to select 300 pearl millet farmer respondents in the state. The first stage was random selection of 3 LGAs (Local Government Areas) from Northern zone and 3 LGAs from the southern zone. The second stage was the random selection of 1 district from each of the LGAs. The last stage was the systematic and purposive sampling of 50 pearl millet farmers from each of these districts. A well-structured questionnaire schedule was used to elicit socio-economic attributes of the farmers as well as measuring the factors that determine the adoption of improved pearl millet variety in 2009 farming season. Descriptive statistics was used to describe the socio-economic characteristics of the farmer respondents while logit regression analysis was used to ascertain the determinants of improved pearl millet adoption decision.

Theoretical and analytical framework

In modeling the farmer's decision to adopt the use of improved pearl millet variety, we followed earlier studies that have investigated technology adoption by farmers. According to Feder et al. (1985), technology adoption is affected by such factors as availability of credit, limited access to information, aversion to risk, inadequate incentives, farm tenure systems, insufficient investment in human capital, inadequate farm size, absence of equipment to relieve labour shortages, unreliable and insufficient complementary inputs and inappropriate transportation infrastructure.

Following Ameniya (1981); Jamnick and Klindt (1985) and Kehinde (2011), the decision of farmers to adopt improved pearl millet variety is represented by "1" while the decision not to adopt is represented by "0". We further assume that the farmer is an independent decision maker who makes rational choices and maximizes his utility (Ameniya, 1981; Rahm and Hufman, 1984). In stipulating the logit model, we followed Sheikh et al. (2003) and Kehinde (2011) to assume that the farmers decision not to adopt and to adopt improved pearl millet variety equals 0 and 1 respectively. And that the utility of the technology depends on a vector S_i (farmers' socio-economic characteristics) and a vector R_i (farmers farm characteristics that is production input and output characteristics related to improved pearl millet production). Further, U_{i1} and U_{i2} are indirect utilities derived from not adopting and adopting improved pearl millet varieties, respectively. These utilities can be stated as:

$$U_{i0} = d_i S_0 + g_i R_{i0} \text{ and } U_{i1} = d_i S_1 + g_i R_{i1} \quad (1)$$

Where d_i and g_i are vectors of coefficients corresponding to the variables representing farmer's socioeconomic characteristics and a vector of farmer's farm characteristics which are attributed to adoption of improved pearl millet and e_0 and e_1 are additive error terms. A farmer therefore adopts improved pearl millet if $U_{i1} > U_{i0}$ or does not if $U_{i1} < U_{i0}$. If we now redefine improved pearl millet adoption with a qualitative variable $y_i = 0$, then the probability of adoption of improved pearl millet variety can be written as:

$$P_i = P(y_i = 1) = P(U_{i1} > U_{i0}) = P(e_{i0} - e_{i1}) < [(d_{i0} - d_{i1}) S_i + (g_{i0} - g_{i1}) R_i] = P(u_i) < (B_i X_i) = F(B_i X_i) \quad (2)$$

Where X_i includes both S_i and R_i as stated in Equation (1) and $u_i = (e_{i1} - e_{i2})$ is a random distribution term; P(.) is a probability function; and F is a distribution function for u_i. Thus the probability of a farmer adopting improved pearl millet variety is the probability that the utility of not adopting is less than the utility of adopting or the cumulative distribution function evaluated as $B_i X_i$. The exact distribution of F depends on the distribution of the random term u_i. If it follows a logistic distribution then the F is a cumulative logistic function. If u_i is normal then F is a cumulative normal distribution function. Thus the distribution assumption for u_i determines the type of probability model that reflects the farmers' adoption behavior. We used the logit model from the cumulative logistic probability function to transform the dependent variable to predict the probabilities within the bound of 0 and 1. The dependent variable thus becomes the natural logarithm of the odds when a positive choice is made and the model is specified as:

$$\ln [P_x/(1-P_x)] = \sum B_i X_i \quad (3)$$

Where P_x = the probability that farmers adopt improved pearl millet for an observed set of variables X_i as earlier defined and B_i = the regression coefficient to be estimated.

Model specification

We specified a logit model to identify factors that determine the adoption or non-adoption decision of farmers to use improved pearl millet varieties. Thus, the probability (P_i) that a farmer will adopt improved pearl millet variety is a function of an index Z_i which is also the inverse of the standard logistic cumulative function of P_i that is,

$$P_i (Y=1) = F^{-1}(P_i) \quad (4)$$

Then, $Z_i = F^{-1}(P_i)$

The index is a set (X_i, that is farmers' socioeconomic characteristics, while b_i are regression coefficients which indicate the probability effect of farmers' attributes) and is a linear function of the attributes, that is,

$$Z = b_0 + b_1X_1 + b_2X_2 + b_nX_n\ldots \quad (5)$$

The probability of adopting improved pearl millet variety is given by

$$P_i(Y-1) = \frac{1}{1+e^{zi}} \quad (6)$$

While the probability of not adopting improved pearl millet is given by

$$1 - P_i(Y=1) = \frac{1}{1+e^{zi}} \quad (7)$$

and

$$e^{zi} = \frac{P_i(Y=1)}{1-P(Y=1)} \quad (8)$$

The dependent variable, (Y_i, which is farmer's decision to adopt or not to adopt) takes the value 1 if the farmer adopts and 0 if he does not. We used maximum likelihood estimation since the dependent variable is binary thus making ordinary least squares estimation inappropriate (Pindyck and Rubinfield, 1981; Scolt et al., 1997). The probability that a farmer will adopt improved pearl millet variety (Equation 3) can be estimated the average value of Z_i as:

$$zi = In\frac{P_i}{1-P_i} = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 \quad (9)$$

Where X_1 = Household size (in number), X_2 = Education (in years), X_3 = Age (years), X_4 = Sex (male= 1 and 0 otherwise), X_5 = Farm size (hectares), X_6 = Farming experience (years), X_7 = Member of farmers organization (yes=1 and 0 otherwise), X_8 =Millet maturity period (days),
X_9 = Yield (Kg), X_{10} = Distance of source of improved seeds (Km), X_{11} = Extension contact (yes=1 and 0 otherwise), X_{12} = Access to credit (yes=1 and 0 otherwise).

RESULTS AND DISCUSSION

All the 300-questionnaire schedules distributed were equally retrieved and analyzed. Table 1 shows the socio-economic characteristics of the respondents. About 42% of the respondents were aged 31 to 45 years, indicating that a good number of the respondents belong to the active age group while 90% were males. The low percentage of farm women may be as a result of Islamic religion which tends to restrict women to the households. Sixty percent of the respondents have no formal

Table 1. Socio-economic characteristics of the farmer respondents in the study area.

Variable	Frequency	Percentage
Age		
18 – 30	90	30
31 –45	125	41.7
46 – 55	55	18.3
56 and above	30	10
Total	300	100
Gender		
Males	270	90
Females	30	10
Total	300	100
Education		
No formal education	180	60
Primary	75	25
Secondary	30	10
Tertiary	15	5
Total	300	100
Marital status		
Married	235	78.3
Single	65	21.7
Total	300	100
Household size		
1 – 4	63	20.8
5 – 8	95	31.6
9 and above	142	47.5
Total	300	100
Years of farming exp		
1 – 5	100	33.3
6 – 10	150	50
11 and above	50	16.7
Total	300	100

Source: Survey data, 2009.

education. Illiteracy may positively affect adoption of new technologies. Formal schooling may enhance or at least signify latent managerial ability and greater cognitive capacity in the acquisition of new technology (Barrett et al., 2002). About 80% of the respondents have household sizes of five people and above. This relatively large household size may have implication to adoption of new technologies. This is in consonant with the findings of Kehinde (2011) who posited that large household size increases the farmers' tendency to adopt new technologies. About 67% of the respondents have 6 years and above farming experience indicating that the farmers are not novices.

The result of the logit estimate of the determinants of farmers' decision to adopt improved pearl millet (Table 2) showed that household size, farm size, farming experience, maturity period of millet, yield of millet, and access to credit were positively significant in predicting the farmers' probability of adopting improved pearl millet variety. On the other hand, distance to source of technology (improved pearl millet seeds) negatively influenced the probability of adoption. The Log likelihood statistics of 192.95 confirms the significance of the variables in the model while a chi square statistic of 49.05; which is also significant, justifies the goodness of fit of the regression line.

Table 2. Logit estimates of factors influencing the respondents' likelihood of adoption of improved pearl millet variety.

Likelihood of adoption coefficient		Std. Error	Z	P> |z|
Household size	0.0023	0.0011	2.090**	0.005
Education	0.0299189	0.0700357	0.49	0.669
Age -	0.0108678	0.0091023	-1.19	0.232
Sex	0.4067453	0.2688421	1.51	0.130
Farm size	1.2729231	0.642212	1.98	0.022**
Farming experience	0.2033259	0.1127525	1.80	0.071**
Memfarmersorg'	0.1346071	0.4127561	0.33	0.744
Maturity period	1.504736	0.694134	2.168	0.015**
Yield	1.000661	.00016	4.13	0.000***
Dist of technology	-0.0005517	0.00017	-3.25	0.001**
Extension contact	0.4753018	0.3217224	1.40	0.140
Access to credit	0.7806627	0.3682025	2.12	0.034**
Constant	0.8819395	0.3605838	2.45	0.014**
Log likelihood ratio	192.95			
Chi square	49.05			
Significance	0.0000			

Note: *** **, refer to significance at 1 and 5% significant levels. Source: Computation by the authors from the data.

Specifically, the result revealed a positive and significant relationship between yield of improved pearl millet and the probability of adoption. The result was significant at 1% level of probability. This finding corroborates the findings of Adesina and Zinnah (1993); Shiyani et al. (2002); Kristjanson et al. (2005) and Kehinde (2011). Crop varieties that yield significantly higher stand a better chance of being adopted as well as being used intensively by farmers. The higher the yield from a crop variety, the higher will be the marginal returns to investment in the crop enterprise, and hence higher income. This will be a good incentive for either expanding land area under the improved variety or cropping intensification of the existing land area.

Access to credit was also found to be important in influencing the likelihood of adoption of improved pearl millet variety by farmers in the study area. The variable was found to be statistically significant ($\rho \leq 0.01$) and positively related with the likelihood of adoption. This finding is also in accordance with the findings of De Castro and Teixera (2006); Ouma et al. (2006); Omolehin et al. (2007) and Idrisa et al. (2012). Farmers need credit to acquire new technology. In the case of improved pearl millet, farmers need credit during the planting season to purchase the improved seeds that are usually more expensive than the local seeds. The consequence is that farmers will usually save part of their harvests to be used as planting material in the next planting season.

Results in Table 2 also revealed that distance to source of technology (where the improved seeds are purchased) had a negative and significant influence on the adoption of improved pearl millet variety by farmers ($\rho \leq 0.05$). The negative sign of the coefficient implies that farmers who live closer to the source of technology are more likely to adopt the technology compared to farmers who live farther away from the source of technology. This trend is expected considering the fact that most of these farmers are rural farmers who can hardly travel to distant centres where the technologies are available (Idrisa et al., 2012).

CONCLUSION AND RECOMMENDATION

The study area has the potential to supply the millet need of Nigeria and beyond for human and more importantly for livestock production. This will inevitably reduce the pressure on maize, which is the major source of carbohydrates for man and animals currently. Results showed that household size, farm size, years of farming experience, maturity period of millet, yield of millet and access to credit were positively significant in predicting the farmers' decision to adopt improved pearl millet. On the other hand, distance to source of improved seeds negatively influenced adoption decision of the farmers.

We therefore strongly recommend the establishment of farm service and seed supply centers in strategic places in the study area with a view to making the seeds of improved pearl millet and other farm inputs readily accessible to farmers. We also recommend that pragmatic efforts be made by policy makers to see that the Bank of Agriculture be strengthened to enable them finance farmers since it is only farmers who have access to finance and have the tendency to adopt the technology.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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