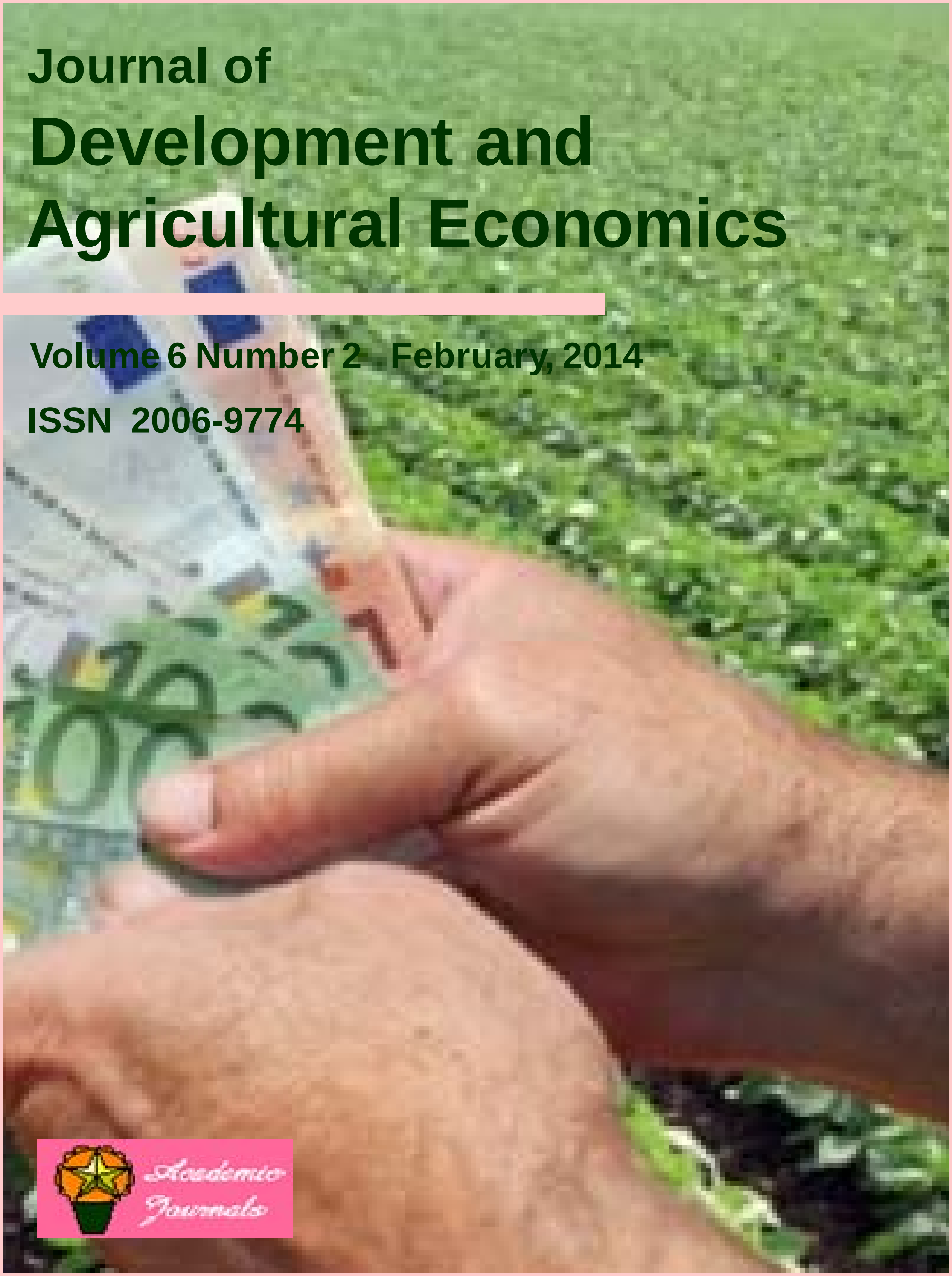
Journal of
Development and Agricultural Economics

Volume 6 Number 2 February, 2014

ISSN 2006-9774



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Pitout JDD, Church DL, Gregson DB, Chow BL, McCracken M, Mulvey M, Laupland KB (2007). Molecular epidemiology of CTXM-producing Escherichia coli in the Calgary Health Region: emergence of CTX-M-15-producing isolates. Antimicrob. Agents Chemother. 51: 1281-1286.

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Journal of Development and Agricultural Economics

Table of Contents: Volume 6 Number 2 February 2014

ARTICLES

Research Articles

academicJournals

Vol. 6(2), pp. 49-58, February, 2014
DOI: 10.5897/JDAE2013.0446
ISSN 2006-9774 © 2014 Academic Journals
http://www.academicjournals.org/JDEA

Journal of Development and Agricultural Economics

Full Length Research Paper

Determinants of soybean market participation by smallholder farmers in Zimbabwe

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Accepted 10 December, 2012

This article examines the determinants of soybean market participation by smallholder farmers in Zimbabwe, with a view to identifying key policy entry points for increasing farmer incomes. Market linkages have been identified as key to the successful integration of grain legumes into the smallholder farming systems of southern Africa. Data for this article is derived from a baseline household survey in Guruve district of Zimbabwe. Using a sample of 187 smallholder farmers, we employed the Heckman's Probit model with sample selection to firstly, identify the factors affecting a farmer's decision to participate in soybean markets and secondly, evaluate the factors that affect the intensity of a farmer's participation. Study findings show that the use of inoculants and improved soybean seed varieties are significantly correlated with participating in soybean markets. Results also show that ownership of radios has a positive effect on the household's decision to participate in the soybean market. Further results show that male-headed households are less likely than female-headed households to participate in soybean markets because legumes are seen as women's crops in Zimbabwe. We conclude that in order to leverage smallholder farmers' market participation in soybean markets, it is important to improve access to inoculants and improved soybean seed varieties and improving access to market information. We recommend that authorities could improve access to market information to improve farmers' decision making on soybeans market participation.

Key words: Soybean, market participation, determinants, smallholder farmers, Zimbabwe.

INTRODUCTION

Market linkages have been identified as key to the successful integration of grain legumes into the smallholder farming systems of southern Africa (Chianu et al., 2009). Soybean (Glycine max) is a commodity with relatively higher prices and that has shown great potential to sustain production in smallholder farming systems due to its multiplicity of use. Soybean can be used as cash crop, as food and also as means of improving soil fertility through Biological Nitrogen Fixation (BNF). The net income benefits derived from soybean production depend on the extent to which farmers participate in output markets. According to IFAD (2003), market participation can be an effective route for rural small-holder farmers to move out of abject poverty and increase income. Studies show that market participation by smallholder farmers in developing countries is very

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low (Barret, 2008). This scenario has slowed down agriculture driven economic growth and exacerbated poverty levels. As such farmers cannot benefit from the welfare gains and income growth associated with market participation. However, for agriculture to meaningfully contribute to economic growth, smallholder farmers have to commercialize their farming activities to produce marketable surpluses (Jagwe et al., 2010). The issue of why most smallholder farmers who happen to make the larger proportion of the poor in developing countries self select themselves out of the remunerative markets remains largely unanswered. It is therefore necessary to identify the key determinants of soybean market participation by smallholder farmers in order to be able to identify key entry points and interventions that can increase household income.

The trade theory posits that if households participate in markets by selling surplus of what they produce on a comparative advantage, they are set to benefit not only from the direct welfare gains but also from opportunities that emerge from economies of large-scale production (Siziba et al., 2011; Barrett, 2008).

Indeed, they will also benefit from technological change effects from the improved flow of ideas from trade-based interactions (Barrett, 2008). Consequently, there will be improved factor productivity. Despite the stream of benefits that are inherent with market participation, evidence from studies in southern Africa shows that smallholder farmers' participation in agricultural output markets is low due to high market transaction costs, information asymmetries, institutional constraints among other constraints. Barret (2008) argues that inducing market participation through trade and price based market interventions does not provide the sufficient conditions to induce improved participation. In addition to these policies, households need to have access to productive assets, adequate private and public investment, institutional and physical infrastructure to access remunerative markets (Siziba et al., 2011; Barret and Swallow, 2006). As noted by Barret (2008) such smallholder farmers with access to production, private and public sector goods, properly functioning institutions and well developed physical infrastructure actively participate in markets contrary to their counterparts.

However, the general trend in most southern African countries is that most agricultural produce is lost soon after production largely because of poor post harvest handling and failure to access the formal markets (Phiri and Otieno, 2008). This trend is attributed to several factors and barriers in agricultural commodity marketing that discourage smallholder farmers from participating in formal markets. These factors range from household characteristics for instance low education levels, labor shortages, inadequate government services, high transaction costs and lack of physical infrastructure (Siziba et al., 2011, Jagwe et al., 2010; Pingali et al., 2005). In response to these challenges, most governments in Sub Saharan Africa implemented marke liberalization policies in the 1980s and 1990s which sought to open new market led economic growth opportunities (Barrett, 2008). It involved the abolition of commodity boards, introduction of free markets and encouragement of private sector participation. According to Jayne and Jones (1997), although the overall aim of the liberalization was to improve the functioning and effectiveness of markets, it produced mixed results. In some cases, there was actual retreat to subsistence agriculture while in others there was increased market participation in more remunerative markets, technological progress and improvements in institutions and physical infrastructure.

This study sets to establish factors affecting soybean market participation and the level of marketed surplus among smallholder farmers. The results of this study are essential in contributing to the existing body of knowledge on soybean market participation which is scant locally as most previous research concentrated on biophysical aspects of soybean production. Therefore, understanding smallholder marketing of soybean is vital for increased participation which may lead to increased farmer incomes, improved soil fertility and ultimately reduced poverty. Information from this study will be useful to agricultural policy makers to create or amend existing policies in an effort to develop the soybeans production and markets as well as motivate producers to access soybean commodity markets.

Smallholder soybean production in Zimbabwe

Historically, soybean production in Zimbabwe was highly mechanised and carried out by commercial farmers in high rainfall areas (Estehuizen, 2011). The commercial farmers had easy access to inputs, financial capital, irrigation services and well developed marketing channels (Madanzi et al., 2012). The output from commercial farmers accounted for 95% while smallholder farmers contributed only 5% of national soybean output (Estehuizen, 2011). Smallholder farmers used unimproved retained seeds and did not have access to Bradyrhizobium inoculant and this contributed to yields as low as 0.6 t ha-1 compared to 3 to 4 t ha^{-1} in the commercial sector (Mabika and Mariga, 1996). The smallholder farmers lacked general knowledge on good agronomic practices. Shumba-Munyulwa (1996) noted that agronomic research on soybean production was confined to the commercial sector and extension in smallholder farming sectors was limited. This implies that the recommendations from such agronomic studies could not be applied to smallholder farming.

In 1996, the government formed the National Soybean Task Force (NSTF) whose mandate was to help increase the participation of smallholder farmers in soybean production and marketing (Madanzi et al., 2012). In

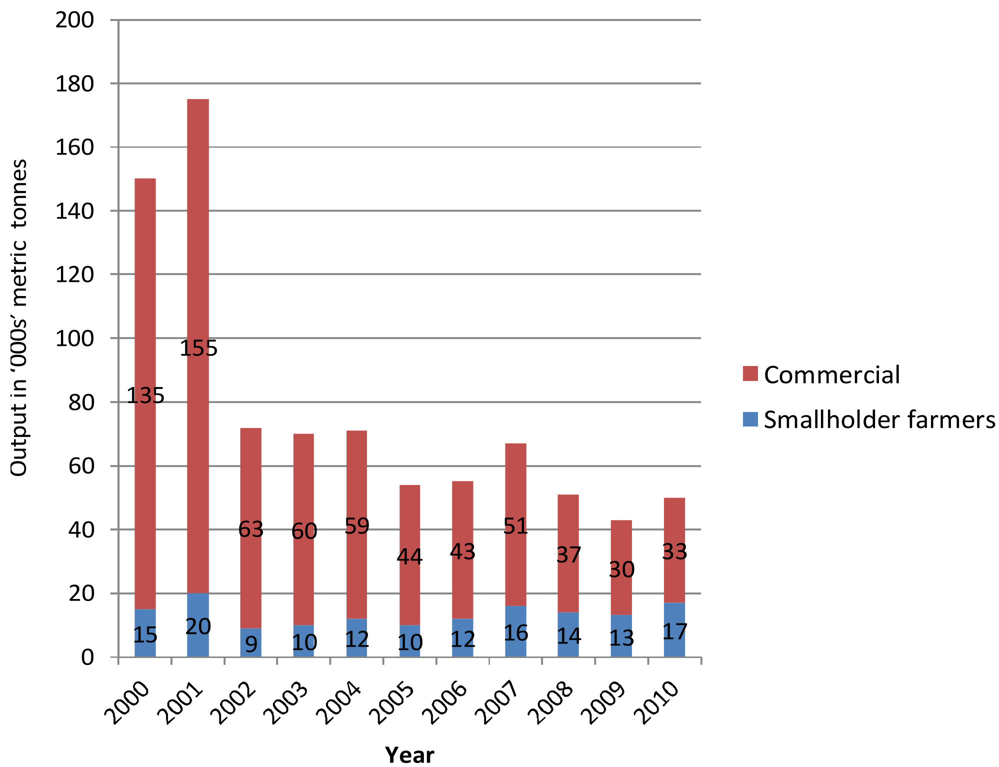

Figure 1. Soybean production in Zimbabwe in "000' metric tonnes. Source: Technoserve, 2011.

particular the programme provided agricultural extension, access to cheap inputs and linkages to markets to smallholder farmers. When the programme started, it enrolled 55 smallholder farmers but by end of 2006 the programme had reached a total of 55,000 smallholder farmers who produced 40,000 t per annum (Chianu et al., 2009). Complimentary efforts have been done by Africare and the N2Africa Project in Zimbabwe who are assisting the smallholder farmers with agronomic knowledge on soybean production in addition to market linkages. Despite these efforts, soybean producing smallholder farmers face challenges such as access to cheap inputs and rhizobium (Madanzi et al., 2012). Although the Rhizobium is produced by Zimbabwe's Soil Productivity and Research Laboratory (SPRL) at a break-even price of $3.20 and distributed through Agricultural Technical and Extension services (AGRITEX) at a retail price of $5.00, some farmers claim that they access the inoculant at more than double the cost (Woomer et al., 2013). The seed houses are not producing sufficient quantities of soybean seed for the market as the smallholder farmers do not purchase the improved seed.

Despite the government's efforts in distributing land from the commercial farmers to landless peasants, Zimbabwe is still facing huge deficits in soybean production with demand far outstripping current production levels. Zimbabwe's annual demand for soybean is 125,000 metric tonnes while production has been fluctuating far below the equilibrium quantity (Varia, 2011). At present, the demand deficits have been filled by imported soybeans from South Africa, Zambia and Malawi. Zimbabwe is only producing 30% of its national demand of 125,000 metric tonnes and capacity utilization at the major soybean processors is only 16% (Technoserve, 2011). The huge demand deficit in soybean production offers an opportunity for smallholder farmers to produce large quantities of soybeans, participate in markets and improve household income. Since soybean is renowned for its high propensity to fix nitrogen, intensive market participation by smallholder farmers would also improve soil fertility and yields for subsequent crops such as maize if farmed on the same land in rotation. However, despite this market opportunity particularly from the booming livestock and poultry industries where soybean is used to produce animal feed, smallholder farmers are producing very low quantities of soybean for sale and market participation is very low as shown in Figure 1.

Figure 1 shows the contribution of smallholder farmers to national output has remained very low between 2002 and 2010. The observed trends in soybean production, presents an opportunity for smallholder farmers to exploit the market by increasing production of soybeans, as well as participating in its supply chain for income generation.

However despite the income generation potential of soybean for smallholder farmers and the huge supply

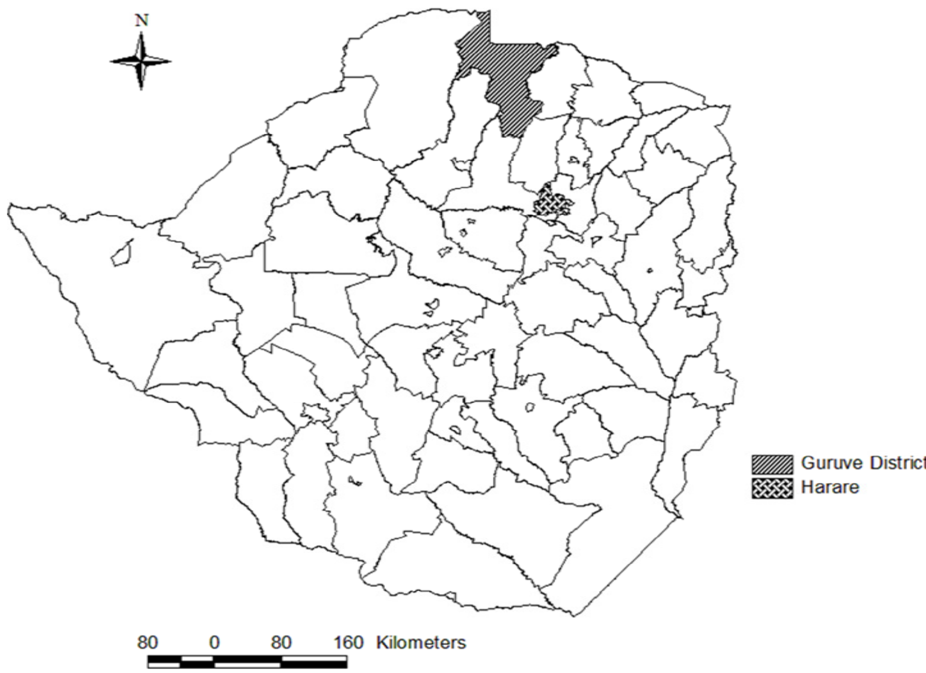

Figure 2. Map of study site: Zimbabwe's Guruve district.

deficit in Zimbabwe, research on soybean has largely focused on biophysical aspects such as yield enhancement, production practices and nutrient use efficiency. There is a lack of information on soybean market participation by smallholder farmers and in particular the factors that influence the level of marketable surplus. Smallholder farmers' market participation is equally important if the full benefits from soybean production are to be realized. The studies on factors affecting smallholder market participation have not been fully exploited especially for soybeans. Most studies (Siziba et al., 2011; Okoyo et al., 2010; Jagwe et al., 2010) conducted on factors influencing smallholder market participation have concentrated on staple crops, that is, maize, cassava and bananas.

Since staple crop markets are very different from soybean markets, recommendations from such studies may not be applicable to soybean markets. Thus this study is an attempt to fill the knowledge gap on soybean market participation by smallholder farmers. To the best of our knowledge, this is the first such study in Zimbabwe, which seeks to identify factors influencing soybean market participation and the intensity of market participation by smallholder farmers.

THE STUDY APPROACH

Study site

This study was conducted in Guruve district, which is in linked to Mashonaland west province of Zimbabwe (Figure 2). The district is linked to the main legume market, Harare, by a 151km tarred road. Although most of Guruve district lies in natural farming region IV, which is a semi-arid and marginal zone, the study sites lie in natural farming region II. The annual average rainfall is 600 mm while the annual average temperature is 26.5°C. This natural farming region is an agro-ecologically high potential zone suitable for growing soybeans, maize and common beans. The altitude range is 800 to1500 m above sea level. The main livelihood activity is farming with maize being the dominant cereal crop while soybeans and common beans constitute the main legume cash crops.

Sampling and data analysis

This study uses cross sectional household data from the baseline survey collected using a questionnaire with semi structured and structured questions. A sample of 187 of actual greater than 128, an apriori power analysis computed using G Power. It therefore means that the sample provides acceptable statistical power (that is 0.80) for moderate correlation r = 0.30, at two tailed 0.05 level of significant (Franzel et al., 2007). Random sampling was used to select the wards and the households for interviewing from the lists that were provided by resident agricultural extension officers. In the first place, 10 households per ward were randomly selected from six wards where the project is being implemented while the 127 all came from a counterfactual site.

A counter factual site is a site similar to the intervention (treatment) in agroecological and market conditions but did not receive a treatment (Binam et al., 2011). The 127 sampled households in the counterfactual site were randomly sampled from 6 wards that did not participate in the project. The sampling approach followed by the project was meant to allow the use of propensity score matching approach in impact assessment. Data collection for this study was done in October 2011 through face- to-face administration of questionnaires. The survey collected information on household composition and characteristics, crop production, household market participation, access to infrastructure, household incomes, ownership of land and non land assets, livestock ownership and access to agricultural inputs on credit.

The analytical approaches

The data was entered, cleaned and then analyzed using STATA Version 11.2. The study uses the Heckman's model with sample selection to identify the factors that affect smallholder farmers' decision to participate in soybean markets and then to evaluate the factors that affect intensity of soybean market participation. This model is adopted on the basis that it models the market participation decision as a two step process that involves (1) the household deciding on whether or not to participate in the soybean market (2) the level of market participation. The factors influencing the farmers' decision to participate are estimated using the Probit model (selection equation) while the level of participation is estimated using the Ordinary Least Squares approach (Outcome equation). Goetz (1992) and Huang et al. (1991) noted that the use of Heckman's model with sample selection allows the interpretation of results by distinguishing between factors that affect the farmer's decision to participate in the market and those that affect the level of market participation.

According to Greene (2003), in instances where observed characteristics only occur in subsets, incidental truncation occurs. As such, this study uses this model as it corrects for sample selection bias and incidental truncation. The selection bias arises due to the observation of sales from a subset of households who participated in the soybean markets. The empirical analysis in this study is premised on three constructs namely household characteristics, information and assets. In this study, the econometric analysis is based on these constructs to reflect the effect of transaction costs on farmer's decision to participate in the market and also the level of market participation. Variables hypothesized to explain smallholder farmers' soybean market participation and level of participation were identified based on theoretical framework and on past empirical work on market participation under transaction costs (Goetz, 1992; Holloway et al., 2000; Key et al., 2000; Alene et al.,2008; Jagwe et al., 2010; Siziba et al., 2011).

This study builds on earlier studies on smallholder market participation under transaction costs by applying this to smallholder market participation in soybean markets. Based on these constructs as in Jagwe et al. (2010), in this study household head's gender, head's age, head's age squared and household size are used as proxies for household characteristics. Livestock wealth or resource endowment is represented by number of cattle owned while information is represented by contact with extension, household head education, distance to nearest market, ownership of radio and ownership of a mobile phone. These constructs are used in the analysis to reflect the influence of transaction costs on the farmer's decision to participate in a soybean market and to estimate the significant factors that influence the level of market participation.

The outcome regression

The outcome model is conditional on market participation and it is estimated using the Ordinary Least Squares (OLS). In the OLS equation, the dependent variable is amount of soybeans sold (continuous variable). In this paper we hypothesized that gender of household head, age of household head, size of the household, farming experience; ownership of cattle and distance to the market affect the intensity of a household's participation in the soybean market—following Jagwe et al. (2010).

Selection equation

In the selection equation, that is the Probit model, the dependent variable is a dichotomous variable 'participation in soybean market (represented as 1 when a household participates in the market and 0 otherwise'). The independent variables that condition the participation of smallholder farmers as adapted from literature are gender of household head, age of household head, size of the household, farming experience; ownership of cattle, ownership of radio, ownership of cellphone, access to extension, use of rhizobial inoculants and use of improved soybean seed varieties (Table 1). Age may influence market participation through various channels such as experience, access to resources and risk preferences. The expected direction of the effect of age is thus ambiguous. The gender of a household head is likely to reveal the differences in market orientation between male and female household heads. Cunningham et al. (2008) argues that male household heads sell their produce when prices are high while female household heads keep their produce for household food self sufficiency. We thus expect the sign to be positive meaning that male-headed households are more likely to participate in soybean markets as compared to their female counterparts.

Alene et al. (2008), posit that the household size is an indicator of the amount of family labor that is available for production activities.

It also explains the consumption levels for a household. We thus expect the sign to be positive when a household's labor resources are efficient that is they produce far more output than what they require for household consumption. In such a case, there is high marketable surplus. However, if the sign is negative it is an indicator of household labor inefficiency that is, a larger household produces far less than what it needs for household consumption and thus less marketable surplus. According to Omiti et al. (2009), the distance to the market negatively influences both the household's decision to participate in the market and the amount sold (intensity of participation). The further the distance to the market, the higher the transport costs and the lower the net benefit to the household. Key et al. (2000) note that farmers who stay in remote areas have low input use that is, they normally substitute high value commercial varieties with locally easily obtainable varieties.

Consequently, this input substitution has adverse effects on productivity, market participation and marketable surplus. We thus expect a negative relationship between distance to market and likelihood to participate in marketing. This implies that the higher the distance to the nearest selling points, the lower the likelihood of a household to participate in markets. However, Fafchamps and Hill (2005) observed that wealthy farmers can sell their produce to distant markets as they can afford the high transport costs compared to the poor farmers. This then implies that we expect the resource constrained farmers to participate in local markets while the resource endowed farmers participate in distant markets.

Most economists argue that relative prices form critical incentives to induce market participation and increase the amount of marketable surplus (Alene et al., 2008; Fafchamps and Hill, 2005). Smallholder farmers in Zimbabwe access market information on prices of inputs and output through contact with extension agents, radios and phoning the buyers using cell phones. Knowledge of input prices enables farmers to make informed decisions on input use intensity and also the area to commit to soybeans. We argue that access to price information positively influences the farmers' decision to participate in soybean markets while the lack of it acts as a disincentive. We therefore expect a positive relationship

Table 1. Description of covariates used in the regression models.

Variable	Description	Measurement	Expected sign
Household characteristics			
Age	Age of household head	Number of years	+
Age squared	Age of household squared		+
Gender	Gender of household head	0=female; 1=male	
Household size	Number of people in a household	Number	+
Farming experience	Number of years household head has been farming as a household	Number of years	+
Information			
Distance to market	Average distance from household's home to nearest point of sale	Km	-
Household head's education	Education level of household head	0=no secondary education 1=has secondary education	+/-
Access to extension	Access to agricultural extension for crop production advice	0=no access	+/-
Own cellphone	Ownership of a cellphone	0=does not own 1=owns a cellphone	+/-
Own radio	ownership of radio	0=does not own 1=owns a radio	+/-
Assets			
Number of Cattle Owned	Number of cattle owned	Ratio	+

between a household's decision to participate in the soybean market and its access to market information, ownership of a radio and or cellphone. By accessing extension agents, farmers get advice on good agronomic practices, improved technologies and market prices. W e therefore expect the sign to be positive when farmers have access to extension agents and negative otherwise. According to Zingore et al. (2007), ownership of cattle is a major determinant of the timeliness of agronomic operations. W e assume that the resource-endowed farmers may use their livestock for traction to till larger pieces of land and for transportation to the market. According to Alene et al. (2008) and Zingore et al. (2007) cattle ownership has a wealth effect, in that those households who own animals are more likely to use fertilizers than those without. The resource endowed households are also more likely to have cash resources to finance basal fertilizer purchases, inoculants and improved soybeans germplasm (Zingore et al., 2007). Varia (2011), notes that resource constrained smallholder farmers lack access to finance, give less priority to their non staple crops and use poor agronomic practices. The combined effect of these factors is very low yields and low market participation compared to the commercial farmers who have higher use of herbicides and fertilizers. We thus expect a positive relationship between wealth (resource endowment) and intensity of market participation as such households are more likely to have higher marketable surplus. According to Alene et al. (2008), access to agricultural extension services enhances market participation and marketable surplus as agents provide technical assistance and information on improved varieties and technologies. Extension agents are the information exchange platform between research and farmers; they decode information from researchers into a format understandable by farmers and also provide feedback to the researchers. These results were also observed by Siziba et al. (2011), who noted that access to extension services reduces farmers risk perceptions and thus improve market participation. W e thus expect a positive relationship between access to extension services and market participation in soybean markets.

RESULTS AND DISCUSSION

Sample characterization

The household survey results in Table 2 show that only 28.88% (54 out of 187 farmers) of the sampled households participated in the soybean market. The average marketable surplus for households that participated in the soybean market is 211.26 kg. These results are consistent with findings by Ojiem et al. (2007) and Giller et al. (2006) who note that soybean output is very low in smallholder farming communities largely because farmers apportion at most 5% of their land to legumes and do not fertilize them leading to low yields. The low levels of marketable surplus could also be a

Table 2. Description of sample household and socioeconomic characteristics.

Parameter	Market participants	Non market participants	p-values
Sample n (prop)	54 (28.88)	133 (71.12)	
Head age (years)	43.76(12.96)	50.43(16.60)	0.0089
Household size	5.33(3.16)	5.18(2.77)	0.7433
Head education (% prop with secondary)	59.26(0.50)	46.62(0.50)	0.1184
Farming experience (no. of years)	15.13(11.94)	20.42(15.51)	0.0257
Gender (%prop of male)	75.93(0.43)	79.7(0.40)	0.5709
Own mobile phone (%prop)	68.52(0.47)	63.91(0.48)	0.5511
Own Radio (% prop)	68.52(0.47)	52.63(0.50)	0.0469
Number of cattle owned	2.35(3.46)	2.35(3.61)	0.0027

result of low input usage and the substitution of commercial high value varieties with low yielding locally available varieties. The results show that the average household head for market participating households (43.76) is significantly lower with a standard deviation of 19.96 than that of non-participating households (50.43) that has a standard deviation of 16.60 and this is significant at 1% level of significance. The probability of younger farmers to participate in soybean market is higher than that of older farmers. The results from the survey show that amongst the market participating households, 75.93% are male headed while 79.70% of the non-market participating households are male headed. Since the p-value is 0.5709, there is thus no statistically significant difference between the two groups of soybean farmers.

Results for the average household sizes show that the mean household size for market participants is 5.33 with a standard deviation of 3.16 while that for non-market participants is 5.18 with a standard deviation of 2.77. Although the household sizes were slightly lower than the national average household size of six, the p-value of 0.7433 indicates that there were no significant differences in household sizes between the market participating and non-market participating farmers. In terms of farming experience, there were statistically significant differences observed between soybean market participating households and the non-market participants at 5% level of significance. Households that participated in the soybean market on average had 15 years of farming experience compared to their counterparts with over 20 years. The 2 sided t test results show that the difference in farming experience is statistically significant at 5% level of significance. This implies that the probability of less experienced to market soybean is very high.

The results also show that 68.51% (standard deviation 0.47) households who participated in the soybean market owned radios while 52.63% (standard deviation 0.50) amongst non-market participants owned radios. Since the p-value is 0.0469, we observed significant differences between the two groups at 5% level of significance. This means that ownership of radios is common among market participating households than non-market participating households. As such, owning a radio increases the probability of marketing soybeans.

Although, we estimated that 68.5% of the soybean market participating households owned cellphones with a standard deviation of 0.47 compared to 65% with a standard deviation of 0.48 for non-participating households; the p-value of 0.5511 shows that there were no statistically significant differences in the proportions. This suggests that cellphone ownership is not a determinant of soybean market participation among the smallholder farmers.

Econometric results

The results from the econometric analysis for the market participation (Probit Model results) and intensity of market participation (OLS regression model) are presented here. Intensity of market participation is estimated conditional on the smallholder farmers' market participation decision.

Factors affecting soybean market participation

Table 3 presents the OLS results for intensity of market participation and the Probit model results for smallholder farmers' decision to participate in the soybean market. The OLS regression model estimates the factors affecting the intensity of participation in a soybean market while the Probit model estimates the determinants of the dichotomous soybean market participation variable.

Selection model results (Probit model results)

The results in Table 3 show that for the Probit model, gender of household head, ownership of a radio, access to agricultural extension services, use of inoculants and use of improved soybean seeds affect the farmers

Table 3. OLS and Probit Estimates for soybean market participation and intensity of participation.

Dependent variable	Probit (selection model) (soybean bean market participation		OLS (outcome) (Amount of soybean sold)	
	β	p-value	β	p-value
Gender	-0.847	0.004***	6.249	0.345
Head age	-0.063	0.172	0.210	0.536
Head age squared	0.000	0.488	0.004	0.490
Household size	0.045	0.511	-0.403	0.256
Farming experience	-0.001	0.939	-0.367	0.183
Ownership of cattle	0.003	0.283	0.023	0.094*
Distance to market	-	-	3.921	0.014**
Own radio	0.672	0.0060***		
Own cellphone	0.003	0.992		
Access to extension	0.4185	0.086*		
Used Inoculants	0.894	0.016**		
Use improved seed varieties	0.684	0.041**		

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

decision to participate in the soybean market as a seller. The gender of the household head negatively influences the likelihood of smallholder farmers' participation in the soybean output market, that is male headed households are less likely to participate in soybean markets than female headed households. The probable explanation is that in Guruve district as in other parts of Zimbabwe, most legumes are culturally viewed as women's crops. These results are consistent with the findings of Alene et al. (2008) for Kenya but contrary to the findings of Cunningham et al. (2008) in a study on gender differences in marketing styles in western Oklahoma. Ownership of a radio, which represents access to a communication asset positively and significantly, influences a smallholder farmer's likelihood of participating in the soybean market. It represents access to formal sources of market information that increases the likelihood of market participation. In Zimbabwe, radio stations frequently air broadcasts on rainfall patterns, crop varieties and input and out prices. Access to this information lowers the transaction costs and road accessibility to the market. According to Siziba et al. (2011) access to such information reduces smallholder farmers risk perceptions and improves the likelihood of participating in the soybean market. These results are consistent with the findings of Siziba et al. (2011) on cereal market participation in southern Africa. Access to agricultural extension agents positively influences the likelihood of participating in soybean markets. The results demonstrate the importance of improved technology and support services in promoting soybean market participation. The likely explanation for this is that agricultural extension workers are the bridge between research programmes and farmers. They provide information on good agronomic practices, production technologies, soybean varieties and market information. This interaction is likely to improve productivity, marketable surplus and enhance a smallholder farmer's likelihood of participating in a market. These results are consistent with the findings of Alene et al. (2008).

The use of rhizobial inoculants in the production of soybeans by smallholder farmers in Guruve district is significantly positive and increases likelihood of participating in the soybean market. The likely explanation for this is that rhizobial inoculants increase average yield and total soybean production with lower costs than using inorganic fertilizers (Chanaseni and Kongngoen, 1992). Thus the results show that smallholder farmers who used rhizobial inoculants for soybeans had a higher likelihood of participating in soybean markets than their counterparts. Similarly, the use of improved soybean seed varieties has a significantly positive influence on soybean market participation by smallholder farmers. The likely explanation is that improved seed varieties (germplasm) have high yield potential and are disease and pest resistant thus improve productivity and marketable surplus (Technoserve, 2011).

OLS regression model results

The results for the OLS regression model are shown in Table 3. Livestock wealth (cattle owned) and average distance to the market explained the intensity (amount of soybean sold) of smallholder farmers' participation in soybean market. Number of cattle owned had a positive and significant influence on the intensity of market participation conditional on market participation. The probable explanation is that resource endowed households have more cattle which they can use for traction and transportation, a development which reduces production and market related transaction costs. The resource endowed households are likely to have finances from which they are able to hire labor, purchase inoculants, buy improved soybean germplasm and thus can grow soybeans on bigger pieces of land compared to the resource constrained smallholder farmers. Furthermore, households who own cattle are more likely to use good agronomic practices to produce their soybean. Resultantly, this will increase yield and marketable surplus. These results are consistent with the results of Alene et al. (2008). Zingore et al. (2007) noted that resource endowed farmers had higher yields in their fields compared to resource constrained farmers.

Distance to the market positively and significantly influences the intensity of soybean market participation by smallholder farmers. This means that as distance to the market increases, the amount of soybean sold by smallholder farmers also increases. These results are in contrast to findings from studies on staple crops in which distance negatively influences smallholder farmers' intensity of market participation (Siziba et al., 2011; Alene et al., 2008, Makhura et al., 2001; Key et al., 2000). A common finding in all these studies is that as distance from the market increases, variable transport costs increase and this discourages resource constrained smallholder farmers from selling high volumes. However, a possible explanation for the Zimbabwean case is that, local buyers offer very low prices compared to well established distant buyers. This is so because established soybean buyers are based in Harare, which lies over 151 km from the study sites. As such most farmers are set to benefit from price differentials between local prices and prices in distant markets.

Conclusion

This article did set out to identify through empirical evidence the determinants of soybean market participation and further evaluate the factors that affect intensity of market participation by smallholder farmers in Guruve district of Zimbabwe. This study used cross sectional household data of 187 randomly selected smallholder farmers in Guruve district in Zimbabwe. Econometric analysis was done using the Heckman model with sample selection, which corrects for selection bias at market participation decision by smallholder farmers. Choice of covariates for the OLS and Probit was guided by economic theory, literature and in some cases intuition. Descriptive results from the survey show that only 28.88% of the survey households participate in soybean market. The market participating households averagely sold 211.26 kg of soybean. Most of the market participating households owned communication equipment such as radios (68.52%) and had bigger land sizes (3.52 ha) compared to the non-participating households. The econometric analysis results from this study show that for the OLS model, livestock wealth or resource endowment and distance to the market have positive influence on marketed surplus. However, for the Probit model, only gender negatively influences the smallholder farmers' decision to participate in soybean market while household ownership of a radio, access to agricultural extension, use of rhizobial inoculants and use of improved soybean varieties have a positive influence on household's likelihood to participate in the soybean market.

Based on these findings from the analysis of the factors affecting soybean market participation by smallholder farmers in Guruve district, we recommend that policy makers can improve farmer to extension worker ratio as this will improve access to technical information and support services on improved technologies such as use of inoculants, biological nitrogen fixation and knowledge on improved soybean seed varieties. Furthermore, policy makers could improve the dissemination of market information as it is currently available through radio broadcasts. Access to market information would improve farmers' knowledge of markets and aid in decision making on market participation as well as the level of marketed surplus. This will lead to increased productivity, high marketable surplus and enhances the likelihood of participating in the soybean market.

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academicJournals

Vol. 6(2), pp. 59-66, February, 2014
DOI: 10.5897/JDAE2013.0506
ISSN 2006-9774 © 2014 Academic Journals
http://www.academicjournals.org/JDEA

Journal of Development and Agricultural Economics

Full Length Research Paper

Synergies between urban agriculture and urban household food security in Gweru City, Zimbabwe

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Accepted 20 November, 2013

It is estimated that 25% of Zimbabwe's population lives in urban areas (CSO, 2002), 70% below the poverty line, and a million in the city of Gweru. The worsening macroeconomic situation in 2008 resulted in urban food insecurity. Households adopted different survival strategies, including the intensification of urban agriculture. In an effort to assess the extent to which urban household food insecurity is mitigated by UA activities, a comparative analysis between households practicing and not practicing UA was done in Gweru in 2009. Household size as well as household head sex, age and employment status were found to affect household UA practice. Results indicated that UA practicing households were food-secure than non-practicing households. Household size, UA participation, household income, household head sex, maize meal price affected household food expenditure. Household head sex, UA participation, household head age and informal activities carried out by household members significantly affected urban household food security. The study concluded that there are synergies that exist between UA and urban household food security.

Key words: Urban agriculture, household food security, Gweru.

INTRODUCTION

Urban food insecurity is a growing challenge emanating from rapid urbanization and rising poverty heightened by the HIV/AIDS epidemic. Rapid urbanization, declining rural productivity and poor marketing systems results in increased urban poverty and food insecurity. Urbanization increases resource competition, costs of supplying, distributing and accessing food, thus negatively impacting on urban household food security. The challenge of feeding cities lies in enhancing consumer access to food by ensuring increased local food production, processing and distribution as well as reversing dependence on distant production sites, thus enabling cities to become more autonomous in food production (Rabinowicz, 2002).

Macro-economic policies since the late 1990s have had a deleterious effect on wage-dependent workers, creating vulnerable urban people. Hovorka et al. (2009) highlighted that economic or political crisis drives UA, which provides safety net for the poor and for households seeking to augment dwindling incomes. It is estimated that one-fourth of Zimbabwe's population lives in urban centers, 70% living below the poverty line (STERP, 2009). The Zimbabwean annual real GDP has been declining an average of -5.9% since 2000 (STERP, 2009). Recession has culminated in non-wage unemployment rate soaring from 80% in 1995 to an

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estimated 94% in 2008. Food shortages in 2007 and 2008 resulted in inflation reaching 231 million percent (CSO, 2008).

UA is defined as mostly crop and livestock rearing on private, leased, or rented land in peri-urban areas, in backyards, on vacant public lands and in semi-public areas. The drivers of UA include: High food prices and rampant inflation; food shortages; growing joblessness; erosion of purchasing power of wages and pensions, and cultural attachment or hobby. UA, is a major coping strategy for poverty and food insecurity alleviation, has been increasing in the SADC region (Harare Declaration, 2003). UA is not a relic of the past, and will not fade away nor brought to the city by rural immigrants who will lose their rural habits over time as the city grows (Hovorka et al., 2009).

Urban agriculturalists are composed mostly of disadvantaged groups such as orphans, women, rural immigrants without jobs, and the elderly. However, there has been an influx of the lower and middle-income earners, as well as richer people seeking a good investment for their capital by undertaking UA for physical and or psychological relaxation (Hovorka et al., 2009). In 2007, it was estimated that 25% of the maize produced in Zimbabwe was produced in and around the cities (AGRITEX, 2008).

UA contributes to local economic development through boosting urban poor asset base, increasing income, alleviating poverty, and including the urban poor and women into mainstream economic activities, thus reducing vulnerability and food insecurity (Mbida, 1995). UA is a direct and indirect occupation provider in cities; it is estimated that 200 million urban residents world over provide food for the market and that 800 million urban dwellers are actively engaged in UA (RUAF, 2009).

In urban areas, virtually everything consumed is purchased; the low purchasing powers are undermined by economic shocks leaving households at the mercy of food insecurity. It is estimated that poor household devotes 60 to 80% of their income on food purchases. Income to purchase food matters less if the food is not available. At the heist of food insecurity in 2007, food was available in Zimbabwe’s rural areas, whilst food shortages were prevalent in urban areas (ZIMVAC, 2008).

Food security

The four pillars of food security are access, availability, safety and stability. FAO (2001) defined food security as a state in which all people at all times have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and health life. Food security includes food supply; physical, social and economic access; adequacy; utilization; safety; nutritious and cultural acceptability.

Problem statement

Since the 1970s, UA has been growing in developing nations, in terms of land usage and number of farmers taking part. In the midst of loss of industrial jobs, decreasing income, and harsh macro-economic conditions, urban households have found it difficult to continue with rural agricultural activities, and these have led to increased UA activities. Despite UA growth in urban areas, households have continued being vulnerable amidst growing urban household food insecurity and outbreaks of food riots.

METHODOLOGY

Primary data was used as a main source of inference, while secondary data was used to validate the primary data collected. There was systemic and purposive Stratified sampling of UA practicing households. First areas practicing UA the most were selected and then the urban agriculturalists were randomly selected in the fields. Data was collected through structured and semi-structured questionnaires. The respondents were randomly selected with a bias towards the UA practicing households. A total of 150 questionnaires were administered of which 69.3% were UA-practicing households. The questionnaire captured data on household characteristics, economic activity, asset endowment, UA production and performance, non-participation in UA, food basket and consumption. The data was entered into the SPSS and STATA for analysis by cross tabulation, mean differencing, gross margin analysis, food security indexation and regression modeling. The study was undertaken in 2009, soon after the country adopted the multi-currency regime.

Descriptive statistics

Were used to describe the differences between UA-practicing and non-participating households. Cross tabulations were used to determine the interaction of socio-economic characteristics with UA participation. Descriptive statistics were also used to explore linkages between urban household food security and UA participation.

Determination of household food security status

According to FAO (2011) the energy requirement is 2100 kcal per person per day. Food security index was calculated by dividing household energy consumed per month by total requirements; households failing below 70% were deemed food-insecure. These Index values were used to explore food security differences between UA-participating and non-UA-participating households.

Regression analysis

Logit model examined the factors affecting UA participation. The study assumed the following model:

$$Y_0 = \alpha+\beta_0X_1+\beta_1X_2+\beta_2X_3+\beta_3X_4+\beta_4 X_5+\beta_5X_6+\beta_6X_7+\beta_7X_8+\beta_8X_9+E$$

Table 1. Household demography characteristics and urban agriculture participation.

Demography characteristic	UA-practicing households	Non-UA-households	Z value
Household size	4.62 (1.66)	3.61 (1.82)	0.62**
Average age	41.41 (14.14)	42.53 (14)	0.65**
	UA participating households (%)	**Non-UA participating households (%)**	**Chi value**
HH Sex			
Female	33.62	54.05	6.65
Male	66.38	45.95	
HH employment status			
Formal employed	62	32	
Informal employed	38	68	

Source: Survey data.

Where: α, β_0,…, β_8 are coefficients, and E=error term; X_1=Household head (HH) sex; X_2=HH age years; X_3=HH educational status; X_4=Household size; X_5=HH employment status; X_6=Total household income; X_7=Rural homestead; X_8=Informal activities, and X_9=Residential status.

Two minimum least squares regression model were used to examine the factors affecting urban household food security:

$$Y_1;\ Y_2 = \alpha+\beta_0X_1+\beta_1X_2+\beta_2X_3+\beta_3X_4+\beta_4 X_5+\beta_5X_6+\beta_6X_7+\beta_7X_8+\beta_8X_9+\beta_9X_{10}+E$$

Where Y_1= household food expenditure; Y_2= household energy adequacy; α, β_0–β_{10} are coefficients; E=error term; X_1=HH sex; X_2=HH age; X_3=HH educational status; X_4= HH size; X_5=HH employment status; X_6=Total HH income; X_7=Rural homestead ownership; X_8=Informal activities; X_9=Residential status; X_{10}=UA participation, and X_{11}=Maize meal price.

RESULTS AND DISCUSSION

Demographic and endowment characteristics

Despite respondents hailing from the same socioeconomic environment, heterogeneous traits between UA farming and non-farming households were noted in household head age, sex, employment status; and household size. UA practicing households were headed by slightly younger heads and also households with more members. It can be postulated that the motive behind the UA participation is to feed the large household. Therefore, comparatively more households with more members are expected to venture into UA activities. Older household members may shun UA because of its laborious nature, and these households may not require UA as a safety net (Table 1).

An association exists between HH sex and UA participation. UA participation is dominated by male-headed households. Households headed by the formally employed stand a better chance of getting UA plots. Low returns accruing from UA resulted in the unemployed households shunning it. Hyperinflation that eroded the formally employed incomes resulted in households participating in UA as a way to augment incomes.

Factors affecting household participation in urban agriculture

In order to better understand household decisions and insights into household factors significantly influencing UA participation, a logistic model was run. The decision to farm and the level of effort spent on UA are affected by household factors such as educational status, household size, and household head sex and age. The R^2 value of 0.618 implies a degree of weak relationship between the independent variables and the dependent variable (Table 2).

Household size is positively related to UA participation. Increase in household size increases vulnerability and leads to households venturing into UA as a coping mechanism.

Household head sex is positively related to UA participation. The haphazard manner of plot allocation, and conflicts inherent in UA plots, favor male participation as compared to females.

Household age is negatively related to UA participation, contrary to expectations. The life cycle hypothesis postulates that older households, after accumulating wealth, will be better cushioned against vulnerability, as they have more assets than younger ones.

Household head educational status is negatively related to UA participation. Well educated households are less likely to venture into UA, as they would be better paid at their workplace and will not require any income augmenting.

Urban agriculture participation

Multi-question interviews with urban farmers revealed

Table 2. Urban agriculture practice logistic regression model.

Urban agric participation	Coefficient	Standard error	P>|z|	Exp(α)
Residential status [+]	-0.48	0.83	0.56	0.62
Household size [+]	1.38	0.52	0.01***	0.92
HH sex [+]	0.10	0.31	0.93**	0.77
HH age [+]	-0.08	0.05	0.09*	3.97
Educational status [-]	-0.70	0.33	0.03**	0.49
Employment status [-]	-0.10	0.37	0.79	0.92
Informal activities [-]	-0.26	0.24	0.29	1.10
Rural home ownership [-]	1.14	1.00	0.26	3.13
Income range [-]	-0.12	0.33	0.73	0.89
Remittance	-0.36	0.38	0.31	0.68
Constant	3.08	3.61	0.39	21.72

[ ], A priori expected signs; ***, **, *significance at 1, 5 and 10% respectively. Source: Survey data.

that push factors into UA include cultural, economic and food security incentives. Ranked in order of importance, survey respondents gave the following reasons for engaging in UA:

1. Production for home consumption (96.2%),
2. Food shortages (74%),
3. Income enhancement (61.5%),
4. Hobby or tradition (37.5%),
5. Supplementary employment (9.6%).

The top three motivating factors for UA engagement are economic. A household's perception of food insecurity risk will affect its farming effort because of the insurance value of own food production (Seeth et al., 1998). Food insecurity, or the perceived risk of it, pushed 96.2% of the respondents into UA for production of food for home consumption so as enhance household food supplies. The food shortages prevalent in 2008 caused 74% of the respondents to venture and or intensify UA activities to alleviate the food shortages. About 61.5% highlighted that UA was a form of income-enhancing activity. Vegetables produced would be sold in the markets as well as surplus grain and other products yielding direct income.

UA yields both direct income through sales and indirect income through reduction of expenditures on food. UA offers direct and indirect employment opportunities in Gweru, highlighted by 9.6% of the respondents. During the summer, UA acts as a form of short-term employment.

Farmers migrating from rural areas would want to continue with their farming practices, and hence would look for UA plots. There has been an influx of the rich, who views UA as a hobby. These accounted for 37.5% of the respondents who highlighted that UA practicing was taken as a hobby.

The major crop produced was maize, cultivated by 99.3% of the respondents; this validates the notion that engagement of UA is mostly for food security reasons. This was followed by sweet potatoes, beans, groundnuts, round nuts, vegetables and cowpeas, at 72.1, 62.5, 14.4, 1.9, 0.9 and 4.8%, respectively. The crops produced are mostly for food and nutrition security, though a surplus could be sold to generate income.

Urban household food security

Urban household food security is a contentious issue in the endeavor to reduce food insecurity. Of importance is the question: how significantly does UA produce contribute to the household food basket?

Time family food runs dry and coping or adaptive strategies adopted

During the heist of food shortages in 2008, households were affected by food run-outs. Table 5 shows that non-UA participating households were mostly affected by food run-outs during the hyperinflationary era.

More non-UA practising households had food running out at the start of the month, middle of the month and month end as compared to UA-participating households, whilst more UA participating households never ran out of food during the hyper-inflationary era (Table 3). When households were affected by food shortages, they adopted strategies to see them through the month.

In the aftermath of rampant food shortages that bedevilled the country in 2008, 50% of the households borrowed food, 43.3% opted for less preferred foodstuffs, 45.3% reduced their number of meals, and 46% reduced meal quantity and frequency during times when food ran out. Approximately 22.7% of households reported that they would sometimes spend the night without eating,

Table 3. Household food shortage and urban agriculture participation.

Time food ran out	UA participating households (%)	Non-UA participating households (%)	Critical value	Chi value
Start of the month	26	30	7.81	9.42
Middle of the month	28	28		
Month-end	24	26		
Never	22	15		

Source: Survey data.

Table 4. Coping strategies when food runs dry.

Strategy	Urban agriculture participating households (%)	Non-urban agriculture participating households (%)
Opting for less preferred food	38.5	54.4
Reducing quantity consumed	36.5	65.2
Reducing number of meals	38.5	41.3
Borrowing food	45.2	60.9
Selling assets	33.7	21.7
Spending night without eating	21.2	26.1

Source: Survey data.

Table 5. Expenditure by income category.

Parameter	Income category		
	Lower 20%	Middle 60%	Upper 20%
Food proportion	0.5	0.48	0.46
Per-capita food consumption	29.1	26.59	23.4
Total non-food consumption	70.64	108.76	147.46

Source: Survey data.

whilst 30% liquidated assets to purchase food. Table 4 summarizes the coping strategies that were adopted by respondents when they were faced with food shortages.

Expenditure approach

Expenditure responses showed the proportion of income devoted to food; this is affected by household wealth, employment status, residential status and sex. A priori the proportion of food expenditure and per-capita food consumption would decrease as income increases, whilst non-food expenditure would increase with rise in income. Table 5 shows expenditure profiles according to income category.

This is consistent with the Engelian relationship between income and the proportion of income allocated to food. As income increases, the percentage of the budget allocation to food falls whilst the converse is true. The respondents in the study area purchased a variety of food commodities: staples, luxuries and inferior commodities. Foodstuffs that were classified as essential included maize grain, maize meal, flour, rice, potatoes, beans and beef. The proportion of households purchasing beef and rice increased with income levels. For the inferior foods chunks and kapenta, purchase decreased with increase in income. As income increases, the consumption of less desirable commodities decreases, as shown by chunks and kapenta. Table 6 shows the consumption of foodstuffs according to wealth category.

Table 7 shows expenditures of foods and non-foods according to UA participation. The mean food expenditure for UA participating households was significantly lower than for non-UA participating households as well as proportion of food purchased. Households engaged in UA do not purchase grain and other products such as vegetables and pulses. The mean percentage food expenditure for non-UA-practicing households is greater that of UA-practicing households,

Table 6. Food purchases according to wealth category.

Food items	Lower 20% (%)	Middle 60% (%)	Upper 20% (%)	Chi value	Critical value
Beef	73	76	87	45.06	18.3
Rice	53	58	100	35.80	23.7
Chunks (soyacake)	63.3	63.3	30.0	27.79	26.3
Kapenta	76.7	67.8	53.3	33.00	32.7

Source: Survey data.

Table 7. Expenditure profiles.

Households	Total food expenditure	Percentage expenditure on food	Non-food expenditure
UA participating households	$93.52	47.11	111.43
Non-UA participating households	$95.91	50.13	109.84

Values with** are significant at 5%; Source: survey data.

Table 8. Factors affecting household food expenditure.

Parameter	Coefficient	R^2	F	P
		0.5959	5.20	0
		Std. Error	t	P>|t|
UA participation [-]	-0.04*	6.33	-1.2	0.08
Residential status [+]	-6.76	6.27	-1.08	0.28
Educational level [+]	4.04	1.99	2.03	0. 44
Employment status [+]	0.51	2.84	0.18	0.86
Household size [+]	5.62***	2.03	2.77	0.01
HH age [+]	0.31	0.27	1.14	0.26
Rural home ownership [-]	-0.65	6.25	-0.1	0.92
Income [+]	4.52**	2.14	2.12	0.04
HH sex [+]	-9.94*	5.96	-1.67	0.09
Informal activity [+]	5.67	8.28	0.68	0.49
Maize meal price [+]	1.99***	0.68	2.95	0.01
Constant	43.43	22.50	1.93	0.06

***, ** and * indicate statistical significance at the 1, 5 and 10% levels respectively, [ ] indicate *a priori* expectations.

mainly because UA-practicing households purchase less grain, maize meal and vegetables, resulting in low food basket costs.

The mean non-food expenditures for UA-participating household are significantly greater than those of the non-UA-participating households. UA-practicing households purchased more non-food items as compared to non-UA practicing households; mainly because money saved from not purchasing grain and maize meal was spent on non-foodstuffs.

Factors affecting household food expenditure

Household food expenditure is affected by both social and economic factors. UA participation, household size, total household income, household head sex and maize meal price are shown to significantly affect household food expenditure (Table 8). The R^2 value shows that 60% of the variation in household food expenditure is explained by the model.

UA participation is significant at the 1% level, and an increase in UA participation lowers food expenditure. UA produce-mainly maize grain-results in reduced maize meal purchase and inevitably household food expenditure.

Male-headed households are likely to be food-secure than their female counterparts. This is because female-headed households are normally unemployed, and as such they are deprived of the much-needed finances to purchase adequate food as compared to male-headed households.

Table 9. Household own food security assessment.

Food status	UA-practising households (%)	Non-UA-practising Households (%)	Critical value	Chi-value
Food insecure	2	7		
Sometimes food insecure	44	54	5.99	7.017
Food secure	54	39		

Source: Survey data.

As the household size increases, the household food requirement also increases, as well as household food expenditure. Smaller households have less food expenditure than large households.

Household educational status increases employment opportunities as well as the adoption of new technologies, which includes consumption of new foodstuffs and as such changes in preferences. Usually these new foodstuffs cost more, and as such this increases the food expenditure of the household.

Income increase by the household will also result in increased food expenditure. As income increases, household food expenditure also increases. This stems from the fact that maize meal is one of the major components of the food basket, and, with an increment in its price, the household food expenditure will increase.

Caloric and energy requirement

Before calculating the caloric food intake, households were asked to judge their own food security status. This assessment reviews what households egoistically[1] felt their food security status to be. At the time of the survey, 56.7% of the households felt that they were food-secure, whilst 40% and 3.3% felt that they were sometimes food insecure and food insecure, respectively.

Participation in UA gives sovereignty to households, hence the likelihood of been food security increases with participating in UA activities (Table 9).

The foods consumed by the households were converted into calories using the UNHCR 1996 caloric requirements per day to obtain the monthly household energy requirements. UA participating households consumed more energy than non-UA participating households. The caloric and energy requirements showed that 47% of the households were food-secure whilst 53% of the households were food-insecure, with 52.9% of the UA-participating households being food-secure, compared to 47% from the non-UA-participating households. This is consistent with earlier assertions about household own assessment. Household food security was enhanced by UA participation.

Factors affecting urban household food security

To determine the factors that affect household food security, a regression model of caloric index[2] was run. The R^2 value was 0.6019, whilst the P value shows that the equation is significant at the 1% level (Table 10). The estimated model shows that, household head sex and age, UA participation, household size, and informal activity significantly affected urban household food security.

There is a positive relationship between UA participation and food security, significant at 5%. This is expected as UA produce fosters food base resulting in increased availability of grain to the household and as such improves the food security of the households. UA produce also lowers food costs. By not purchasing maize meal, money can be channeled to other foodstuffs, improving the food base and food security status of the household.

Household head sex is significant at 5% and is positively related to the food security. Male headed households during the heist of food shortages fared better as they could use their muscular power in queues to get foodstuffs.

Household size is significant at 1%, and is negatively related to the food security. Higher household size results in reduction in per-capita food consumption increased household food dependency greatly compromising food consumption. This is as expected, since the larger the household the more vulnerable it is to food insecurity.

Household head age is positively related to the food security status of the households, and is significant at the 10% level, consistent with the life cycle hypothesis. The life cycle hypothesis assumes that assets are accrued as one advances in age, and that these assets can be liquidated during times of income constraint. During the time of the survey, the country was experiencing hyperinflationary conditions, and, as such, the workers' income was greatly eroded and households failed to

[1] Ego of the respondent, which can be ego positive or ego negative. Ego positive respondents tend to overestimate their food security status, whilst ego negative respondents would underestimate their food security status.

[2] The caloric index was calculated by the calories consumed divided by the calories required and this was converted into a percentage

Table 10. Factors affecting household food security.

Variable	R^2	F	P	P>|t|
	0.6019	**3.7071**	**0.0005**	
	Coefficient	**Std. error**	**t**	
Rural homestead ownership [+]	0.14	10.84	0.01	0.99
HH sex [+] (0 female, 1 male)	0.18**	9.71	1.8	0.08
HH education[+]	1.62	3.53	0.46	0.65
Income range	1.12	3.40	0.33	0.74
UA [+]	0. 30**	0.14	2.13	0.04
Household size [-]	-1.24***	3.58	-3.47	0.00
HH age [+]	1.10*	0.56	1.95	0.06
Informal activity [+]	0.32**	3.21	-0.99	0.33
Maize meal price [-]	2.06	0.70	2.95	0.01
HH employment[+]	-0.52	4.20	-0.12	0.90
Residential status [±]	11.16	10.91	1.02	0.3
Constant	6.69	39.59	-0.21	0.83

***, ** and * indicate statistical significance at the 1, 5 and 10% levels respectively; [ ], *a priori* expectations. Source: Survey Data.

secure adequate food. Households endowed with assets could liquidate these so as to purchase or even import foodstuffs.

There is a positive relationship between food security and informal activity participation. This is consistent with expectations as participation of informal activities increases income, which can be used to purchase foodstuffs. During hyperinflation, foodstuffs were very expensive, and, by participating in many informal activities.

Conclusions

Household size as well as household head sex, age, and employment status were found to affect household participation in (UA) in Gweru city, Zimbabwe. UA participation is dominated by bigger families, male-headed, formally employed and relatively young-headed households. The risk of food insecurity drove people into UA activities, as shown by pull factors into UA participation, such as meeting household food consumption, food shortage, income enhancement, hobby and supplementary employment. Major UA products were predominantly food crops, showing the importance of UA in food provision. Household size, UA participation, income, household head sex, and maize meal price affected household food expenditure. Households participating in UA were found to have lower food costs whilst the non food costs were higher. Household food security was affected by household head sex and age, UA participation, and informal activities carried out by the household members. UA has a positive impact on urban household food security as it provides food as well as income through money saved from buying food, hence raising the standard of living.

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academicJournals

Vol. 6(2), pp. 67-75, February, 2014
DOI: 10.5897/JDAE2013.006
ISSN 2006-9774 © 2014 Academic Journals
http://www.academicjournals.org/JDEA

Journal of Development and Agricultural Economics

Full Length Research Paper

Awareness and adoption of improved cassava varieties and processing technologies in Nigeria

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Accepted 11 November, 2013

Development of high yielding and disease resistant cassava varieties, coupled with the promotion of efficient processing technologies, was the principal intervention aimed at changing the cassava sub-sector in Nigeria. National research and extension programs in Nigeria and IITA have been spearheading efforts to disseminate these varieties alongside improving farmer's access to processing machineries. Several Research-for-Development (R4D) projects were implemented to this effect between early 1980 to date. This paper investigated the effects of improved cassava varieties and processing technologies on adopting households. It also attempts to test and establish the link between adoption of improved cassava varieties and access to processing technologies. The data used in this paper come from a sample household survey of 952 households conducted in four regions of Nigeria. The results showed that in all the study sites farmers grow mixture of improved and local cassava varieties. They process cassava at home using small processing machines and also using services of commercial processors. The most common processed cassava products were found to be garri and fufu. Adopters of improved cassava varieties have higher cassava yield of 16 tons/ha compared to 11 ton/ha for non-adopters. There was also significant yield variation between villages that participated (15 tons/ha) in research for development (R4D) training and those which did not (13 tons/ha). The bivariate probit model estimates showed a strong relationship between adoption of improved cassava varieties and farmers' access to grating machines. Moreover, farmers that were members of either community organizations or cooperative organizations had a higher tendency of using improved varieties than others, suggesting that the introduction of new cassava varieties would be enhanced by farmers' access to processing facilities and services. Moreover, training of farmers and processors through R4D programs has led to increased use of improved technologies.

Key words: Cassava, improved varieties, processing, bivariate probit.

INTRODUCTION

Cassava is an important regional food source for 200 million people – nearly one-third of the population of sub-Saharan Africa. In Nigeria, it is one of the most important food crop. It is the most widely cultivated crop that provides food and income to over 30 million farmers and large numbers of processors and traders. However, in Nigeria, Cassava Mosaic Disease (CMD) poses a serious threat (Alabi et al., 2011). The most vulnerable areas are the South-South and South-East States including the Niger Delta Region (Ogbe et al., 2006; Nweke et al.,

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2002). Several initiatives were enacted to address the critical threat of a CMD outbreak in Nigeria and West Africa and to revitalize Nigeria's agricultural economy[1]. Among those efforts was that of IITA and national partners which developed and disseminated high yielding and CMD resistant cassava varieties. Between 2002 and 2010, IITA implemented a research for development (R4D) project called Integrated Cassava Project (ICP) to support the presidential initiative (PI) for cassava launched in 2002 to boost cassava production and processing. Through this project, IITA successfully introduced and promoted cassava varieties via the National Agricultural Research Services (NARs) and Agricultural Development Programs (ADPs). These efforts were complemented with promotion of cassava processing machineries especially for graters. Participants in the project from all major cassava producing regions of Nigeria, were also trained on crop management (density, weed management, fertilizer application etc). In addition, cassava processing centers were established along with introduction of small grating machines. Through these efforts, more than 40 cassava varieties were successfully introduced and promoted to farmers in Nigeria and the establishment of many processing centers and fabricating enterprises was facilitated between 2002 and 2010. It is important to note that local fabricators were trained in producing and maintaining the processing machines.

There is need to understand whether farmers are aware of the improved cassava varieties and processing machines? Also, what is the adoption status of these technologies? Are there any relationship between adoption of improved varieties and processing machines? Similarly, the introduced improved varieties were expected to give higher yields through better varieties with enhanced resistance to biotic stresses. What is the extent of the realization of such yield potentials in farmers' fields?

A number of studies have been carried out on the adoption of improved technologies singly and independently (Shiferaw and Holden, 1998; Zeller et al., 1998; Alene et al., 2000; Oluoch-Kosura et al., 2001; Abdoulaye and Sanders, 2002; Bamire et al., 2002; Akinola et al., 2010). According to von Braun (1988), agricultural growth via technological transformation leads to an expanded food supply which presupposes relationship between production and processing operations in agriculture. Greene (2000) and Maddala (1983) posited that most studies on adoption have reflected farmers-, farm-, institutional and technology-specific factors based on analysis that identified and estimated separately in a single equation model. However, a single equation estimation model could be threatened by bias, inconsistency and inefficiency in estimates. The problem might become worse in decision where simultaneity is detected or observed heterogeneities are correlated. In such situations, possible relationship and synergies in adoption decision are overlooked. Simultaneous estimation makes it possible to establish relationship that can be useful in adoption decisions. Improved cassava varieties and grating machines were often jointly deployed in most areas, but in some cases improved varieties were first demonstrated. Increase in cassava production through better and higher yielding varieties could stimulate more cassava processing and consumption (Braun, 1988). On the other hand, enhanced cassava processing could also lead to increased demand for raw cassava products thereby necessitating greater production. Therefore, a joint estimation method is expected to provide better estimates of the contribution of key variables to either adoption of improved cassava varieties or use of grating machines.

This study was carried out to provide empirical evidence of the state of awareness and adoption of improved cassava varieties and grating machines in Nigeria. Moreover, it attempted to establish likely relationship between the production and processing activities among the Nigeria's farming households.

[1] For details see Nigerian cassava presidential initiative, Integrated Cassava Project of IITA, RTEP program of the federal government.

METHODOLOGY

Study area, sampling method and data collection

The survey was carried out in 4 geopolitical zones in Nigeria known for cassava production. These zones were the South-West (SW), South-South (SS), South-East (SE) and North Central (NC). A total of 952 respondents were selected comprising of 38% who participated in project R4D interventions (participants) and 62% who did not (non-participants). The participants were selected based on their initial participation in the project. These included 160 respondents from the SW, 96 respondents from the SS, 70 respondents from the SE and 35 respondents from the NC. The non-participants were selected randomly from non-participating communities in the regions. They included 262 from SW, 157 from SS, 114 from SE and 58 from NC (Figure 1).

Data analysis

Descriptive statistics and econometric modelling were used in this study. As stated earlier, the joint estimation of adoption of varieties and processing technologies is preferred. The use of joint estimation is expected to reduce the most serious problem in modeling this type of decisions, of variables being endogenous at least for the 2 main variables in the model (use of improved varieties and use of processing machine). Therefore, a Bivariate Probit is used. The model is expressed as follows:

$$Y_{1i}* = X_{1i}\beta_1 + \mu_{1i}$$

$$Y_{1i} = 1 \text{ if } Y_{1i}* > 0$$

$$Y_{1i} = 0 \text{ Otherwise} \qquad (1)$$

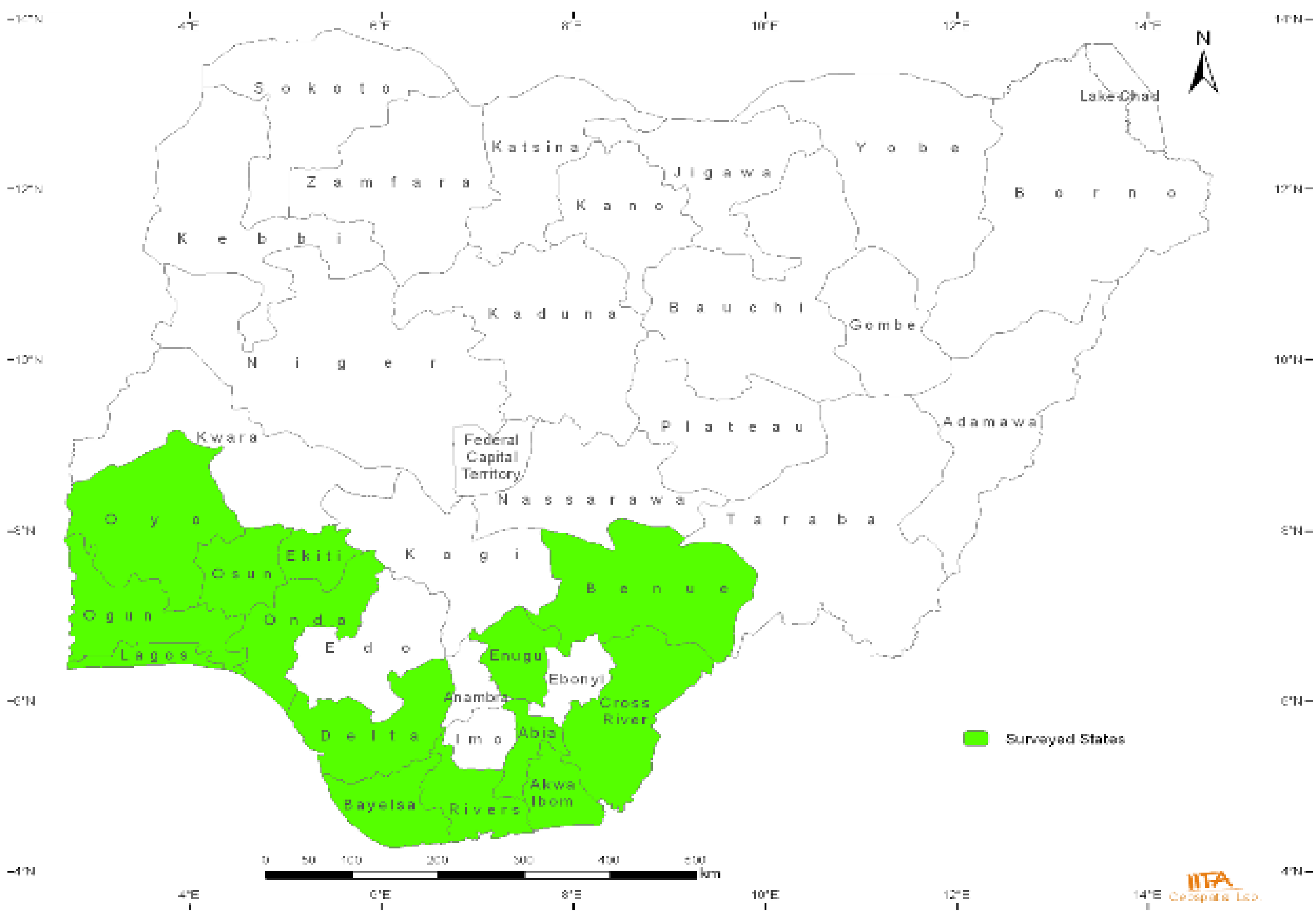

Figure 1. Map of the study area.

$$Y_{2i}* = X_{2i}\beta_2 + \mu_{2i}$$
$$Y_{2i} = 1\ Y_{2i}* > 0$$
$$Y_{2i} = 0 \text{ otherwise} \qquad (2)$$

Where Y_i is the decision to use any of the technology; the two latent variables are decision to use improved cassava varieties and decision to use cassava grating machines. The coefficients β_1 and β_2 are vectors of explanatory variables influencing decision to use improved cassava varieties and grater machines, respectively; and μ_{1i} and μ_{2i} are error terms which are normally distributed but related.

The empirical model of the bi-variate model and each for the single estimation is explicitly stated as follows:

$$Y_1 = \beta_0 + \beta_2 GENDER + \beta_2 AGE + \beta_3 EDUCATION + \beta_4 HHSIZE + \beta_5 CASH + CMSOKAL + COSOKAL + VARAWARE + TRAINING + GRATER + \mu_1$$

And

$$Y_2 = \beta_0 + \beta_2 AGE + \beta_3 CASH + \beta_4 CMSOKAL + \beta_5 COSOKAL + \beta_6 ARLAND + EXTENSION + TRAINING + VARIETY + \mu_2$$

The independent variables included farmer, farm and institutional factors postulated to influence technology adoption. These variables were sex (gender) of the household head, age (age) of the household head in years, the household size (HHsize), measure of social interaction resulting from membership in farmers' organization and cooperative societies (CMSOCKAP and COSOCKAP), cash available at hand measured in dummy, education of household head (education) measured by farmers' ability to read and write, effective extension contacts (extension) measured in dummies by the regularity of visits by extension agents, size of arable land (ARland). Other variables included were the percentage of land planted improved cassava varieties (variety) and proportion of cassava grated by grating machine (grater) as well as farmers' awareness of existence and benefits of improved cassava varieties.

The rationale for inclusion of these factors was based on a priori expectation of agricultural technology adoption literature. The effect of age on technological adoption decisions may be negative or positive. Younger farmers have been found to be more knowledgeable about new practices and may be more willing to bear risk and adopt new technology because of their longer planning horizons. The older the farmers, the less likely they are to adopt new practices as they place confidence in their old ways and methods. On the other hand, older farmers may have more experience, resources, or authority that may give them more possibilities for trying a new technology. Thus, for this study, there

Table 1. Description of variables.

Variable	Description	Unit
Gender	Gender of the respondent (Male = 1, Female = 0)	
Age	Age of respondent in years	Years
Education	A measure of ability to read and write. Ability to read and write = 1, 0 otherwise	
HHsize	Number of people living under the same roof and taking joint decision about their welfare	Number
Cash	Cash saving: 1 = if having saving in cash form, 0 = Otherwise	
CMSOCKAP	Membership of community association, 1 = member, 0 = non-member	
COSOCKAP	Membership of cooperative society, (1 = member, 0 = non-member)	
Varaware	Respondent's awareness of improved cassava varieties, 1 if aware, 0 = non aware.	
Training	Respondent's participation in either training on improved cassava varieties or use of grating machines	
Grater	% of tuber grated by grater machine	%
Arland	Household arable land	ha
Extension	Contact with extension services on the use of improved varieties and grading machines, 1 = access, 0 = non access	
Variety	% of land cultivated to improved cassava	%

is no agreement on the sign of this variable as the direction of the effect is location-or technology-specific (Feder et al., 1985; Nkonya et al., 1997; Oluoch-Kosura et al., 2001; Bekele and Drake, 2003). Education was hypothesized to influence the adoption of decisions positively since, as farmers acquire more, their ability to obtain, process, and use new information improves and they are likely to adopt. Education increases the ability of farmers to use their resources efficiently and that will enhance their ability to obtain, analyse and interpret information. Several studies reviewed by Feder et al. (1985) indicate positive relationship between education and technology adoption (Alene et al., 2000; Nkonya et al., 1997; Oluoch-Kosura et al., 2001).

Institutional factors of social capitals and farmers' awareness of the benefits derivable from improved cassava varieties, participation in R4D programs (training*)* and extension contact were hypothesized to influence the adoption positively as these support services facilitate the uptake of new technologies. Membership in associations (CMSOCKAP), such as cooperative societies (COSOCKAP), has been found to enhance the interaction and cross-fertilization of ideas among farmers (Bamire et al., 2002). Farmers who are not members of associations are expected to have lower probabilities of adoption and a lower level of use of either improved cassava varieties or grating machine. The extension contact variable incorporates the information that the farmers obtain on their production activities on the importance and application of innovations through counselling and demonstrations by extension agents on a regular basis. It is hypothesized that the respondents who are not frequently visited by extension agents have lower possibilities of adoption than those frequently visited (Adesina and Zinnah, 1993; Shiferaw and Holden, 1998; Oluoch-Kosura et al., 2001; Bamire et al., 2002). The variable was measured as dichotomous with respondents 'contact during the period scoring one, and zero for no extension contact on the use of the technologies (Table 1).

Measures of wealth such as off-farm income and income from other sources apart from processing were also hypothesized to influence adoption positively. They are generally considered to be capital that could be used either in the production process or be exchanged for cash or other productive assets. They are expected to influence the adoption of the technologies positively (Shiferaw and Holden, 1998; Zeller et al., 1998; Negatu and Parikh, 1999). To the extent that liquidity is a constraint to adoption, off-farm income and income from other sources will have a positive effect on adoption. The level of off-farm income, however, may not be exogenous but be affected by the profitability of the farming operation that in turn depends on technology adoption decisions. Thus, the adoption of the technologies and the level of off-farm income may be determined simultaneously. This arises due to the labor allocation decisions of the households about farm and non-farm activities. However, the off-farm income of the household surveyed is mostly derived from the remittances of family members in non-farm business activities and from employment in non-farm sector. As the skill requirements for these jobs are likely to be different from those of farming, the farm and non-farm employment may be considered as non-competitive activities. In this situation, the level of non-farm income would be largely exogenous to the adoption decision (Lapar and Pandey, 1999).

Household size, which includes all people living under the same roof and who eats from the same pot as the household head, has been identified to have either a positive or a negative influence on adoption (Manyong and Houndekon, 1997; Zeller et al., 1998; Oluoch-Kosura et al., 2001; Bamire et al., 2002; Bekele and Drake, 2003). Larger family size is generally associated with greater labor force availability for the timely operation of farm activities. The negative relationship of the variable with adoption has been linked to the increased consumption pressure associable with a large family. It is therefore difficult to predict 'a priori' the sign for this variable in this study. In addition, percentage of improved cassava varieties was expected to be positively related to the percentage of cassava grated and vice versa. The size of arable land is also expected to be positively related to technology adoption.

RESULTS AND DISCUSSION

Socioeconomic characteristics of the sample households

Demographic and socioeconomic characteristics of our sampled households are summarized in Table 2. These characteristics play important role in understanding the

Table 2. Socioeconomic characteristics of the sample households.

Variables	Values
N	**952**
Region (%)	
South-South(SS)	27
South-East (SE)	19
South-West (SW)	44
North-Central (NC)	10
Gender (%)	
Male	89
Female	11
Marital status (%)	
Single	3
Married	89
Divorced	1
Separated	1
Widowed	7
Age of household heads	
<20	1
21-40	26
41-60	61
61-80	12
>80	1
Age of household heads (average)	49
Years of farming experience (%)	
1 – 10	18
11- 20	32
21-30	24
31-40	17
>40	9
Farming experience (average)	24
Farming experience in cassava production (average)	22
Cassava processing experience (average)	19
Years of processing experience (%)	
1-20	66
21-40	29
41-60	4
>60	1
Household size (average)	8
Dependency ratio (average)	1.5
Main decision maker (%)	
HH head	69
Spouse	2
Children	0.1
HH head and spouse	24
HH head and kids	3
Spouse and kids	1
All members	2
Level of education (%)	
Educated	77
Year of education	
1-5	6
6-10	35
11-15	51
16-20	8
>20	0.1
Average number of years of education	10
Association	
Cooperative association (%)	27.4
Processing association (%)	9.9
Growers associations (%)	20.4
Marketers association (%)	4.9
Transporter association (%)	1.1
Total association group (%)	63.7
Cooperative (average years)	22
Processing association (average years)	8
growers associations (average years)	6
marketers association (average years)	6
Transporter association (average years)	7
Intervention village	38
Counterfactual village	62

Source: Data analysis (2012).

differences among households and hence explaining their behaviour regarding technological change. The major characteristics of households covered in the survey included are those related to the relative frequency distribution of heads of the households by gender, age, years of formal education, marital status. Also included were household asset ownership structures, distribution of household farms, land tenure types, sources of farm credit, and household consumption patterns. The sampled household heads were 81% men and 89% of them were married having family responsibility. Family responsibility presupposes their willingness to get involved in productive activities to meet family demands. The average family size of 8 suggested availability of family labour on the farm. In addition, the dependency ratio of 1.5 which showed that there were more number of dependants (children below 15 years old and adult above 64 years old) compared to working population (> = 15 years and < = 64 years old) in all the zones. Education level of the respondents was high with an average of 10 years of formal education and with 77% of respondents responding to be having formal education.

Average farming experience was 22 years indicating that study sample was composed of experienced farmers (Table 2). Most of the respondents belong to grower and cooperative groups among others. These groups normally encourage their members sometimes with moral

Table 3. Percentage of household making different products from cassava.

Products	Pooled	Percentage of total	Intervention	Non-intervention	Participation	Non-participation
N	**952**		**358**	**594**	**145**	**807**
Garri	82	52	75	85	90	80
Fufu making	48	30	39	53	55	45
Flour making	10	6	10	10	15	9
Starch	2	1	3	2	10	1
Abacha	10	6	16	6	0	0
Lafun	6	4	15	1	0	0

Source: Data analysis (2012).

and sometimes financial support (credit) for adopting technologies.

Agricultural production in the study area

The main land tenure system was by inheritance (53%) followed by one being rented (29%) among others. Majority of the respondents cultivated farm size of 2 ha or less (80%). This is an indication that they were mainly small scale farmers. The respondents were engaging in cultivation of many crops including roots and tuber, cereals, legumes among others. When arable crops were ranked according to most important crop grown, 70% of the respondents indicated that cassava was their most preferred crop, followed by yam, maize and plantain among others. Percentages of area of land cultivated for different crops also indicated that cassava had the biggest area and occupied the largest percentage of land used for cropping by the farmers irrespective of village types considered.

Household cassava processing

Cassava tubers are processed by households into different cassava products. Almost all the products were previously known to farmers, the work done by change agents was just to improve their processing activities, thus adding value to it and increasing market value. Looking at Table 5, the products increased over the years. However, by disaggregating by village groups, it can be seen that the control villages is better than intervention ones. There were higher percentages of participants processing all these products than non-participants. This same trend is observed when considering alternative ways of utilizing cassava at home. Garri and fufu (foufou) were the most common products made by households constituting 52 and 30%, respectively, while the remaining percentage was shared by other products like cassava flour and starch (Table 3).

Technological awareness and use of technologies

Awareness and use of cassava production technology

Awareness and knowledge of a technology is a prerequisite for its use. Information on level of awareness and use of production technologies is presented in Table 4. The level of use for improved cassava was relatively high (68%) than other production technologies like fertilizer. The results suggest that awareness and use of improved variety of cassava was skewed towards intervention villages which have higher percentages for both variables compared to non-intervention villages.

Increased in awareness and use of improved technologies as shown in the table increased with how closer the respondents were to the change agents with participating farmers having highest awareness and use levels, followed by non-participating farmers from intervention villages and then farmers from non-intervention villages.

Awareness and use of cassava processing technology

The study found that among the promoted innovation, awareness of grating and pressing was the highest. Farmers with first-hand information from research and extension agent (participating respondents) have higher awareness and use in all introduced technologies. Table 5 shows that the spread of information about the technologies was a collective effort by many stakeholders. Results indicate that farmers to farmers' technological diffusion played the greatest role in dissemination of the technologies. Also, it is expected that with better use of production and processing technologies by farming households from intervention villages and participating respondents, these farmers would have positive impact on their farm output and productivity.

Table 4. Awareness and use of inputs used in cassava production.

Variable input	Pooled		Intervention		Non-intervention		Participation		Non-articipation	
	Aware (%)	Use (%)	Aware (%)	Use (%)	Aware (%)	Use (%)	Aware (%)	Use (%)	Aware (%)	Use (%)
Improved planting materials	75	68	88	74	67	65	100	94	70	64
Basal (NPK)	45	25	45	30	44	23	61	50	42	21
Topdress_Urea	27	7	25	8	29	6	39	17	25	5
Herbicides	37	17	33	14	40	19	46	26	35	16
Insecticides	30	8	29	10	31	7	36	16	29	7
Manure	33	13	30	14	35	12	36	15	33	12

Source: Survey data (2012).

Table 5. Sources of information about different technologies (% of respondents).

Technology/source	N	IITA (%)	NGO (%)	Farmer (%)	Media (%)	Ext. agent (NARS) (%)	Agro-dealer (%)	Others (%)
Improved planting materials	629	16	1	28	3	46	3	4
Peeling	153	8	3	44	7	28	9	1
Washing	121	7	3	46	3	33	9	1
Grating	360	10	1	59	2	22	5	2
Chipping	42	12	2	17	12	43	12	2
Extracting	289	8	1	61	5	19	4	2.3
Pressing	71	13	3	56	3	20	4	1
Sifting	70	6	1	43	9	23	13	6
Drying	36	8	-	31	11	33	14	3
Boiling	8	25	-	25	-	38	-	13
Distilling	45	7	-	31	9	42	9	2
Fermenting	164	15	1	51	2	23	7	2
Frying	10	20	-	10	-	50	10	10
Pelletizing	123	7	2	53	3	24	6	5
Grinding	78	10	3	37	15	23	5	6
Milling	39	5	3	44	13	28	3	6

Source: Data analysis (2012).

Table 6. Average reported cassava yields among farmers.

Variable	Adopter	Non-adopter	Difference	Participating villages	Non-participating villages	Difference
Yield (ton/ha)	16.1±4	11±5	4.9** (114)	15.0±4	13.0±8	2** (5.2)

Figures in the bracket are t-values; ***, ** means significant at 1 and 5%, respectively. Source: Survey data (2012).

Cassava productivity

It is expected that investment in inputs such as improved cassava cuttings along with complementary agronomic practices would lead to higher yields for adopting farmers. Survey results indicate that the cassava tuber was higher for adopting households compared to non-adopting ones. The difference between the two groups was also found to be statistically significant (Table 6). Also, as expected, yields were higher in villages that participated in R4D programs compared to on-participating ones. This might be related to the higher use of improved cassava varieties and the trainings received by farmers in those villages.

Determinants of adoption of improved cassava varieties and grating machines

Both single equation and joint estimation results are presented in Table 7. Results from single probit

Table 7. Probit and Bivariate Probit model estimates of the determinants of adoption of improved cassava varieties and grating machines.

Determinants	Single equation estimation				Joint estimation			
	Probit model: Adoption of improved cassava varieties		Probit model: Use of cassava grating machines		Y1 = Decision to use improved cassava variety		Y2 = Decision to use cassava grating machine	
	Estimates	P>|z|	Estimates	P>|z|	Estimates	P>|z|	Estimates	P>|z|
Gender	0.236	0.351			0.139	0.179		
Age	0.011	0.500	0.004	0.575	0.002	0.738	-0.003	0.479
Education	0.151***	0.000			-0.076	0.431		
HHsize	0.071	0.015			0.017	0.100		
Cash	0.408	0.046	0.322*	0.040	0.127	0.220	0.091	0.328
CMSOCKAP	0.286	0.193	-1.311***	0.000	0.275*	0.015	-0.521***	0.000
CPSOCKAP	0.834***	0.000	0.811***	0.000	0.206*	0.059	0.067	0.513
Varaware	6.330***	0.000			1.462***	0.000		
Training	0.115	0.672	0.761***	0.001	0.050	0.716	0.096	0.475
Grater	0.452**	0.048			1.411***	0.000		
Arland			0.014	0.199			-0.002*	0.057
Extension			0.410***	0.001			0.009*	0.059
Variety			0.205	0.195			1.196***	0.000
Constant	-8.614	0.001	0.511	0.121	-2.787	0.000	-0.019	0.925
Athrho					12.694			
Rho					1.000			
Chi^2	368.00		105		206.338			
$Prob>chi^2$	0.000		0.000		0.000			
Pseudo R^2	0.384		0.091					
Log likelihood	295.27		-532.44					

***, **, * Significant at 1, 5 and 10%, respectively. Source: Data analysis (2012).

estimations for both varieties and machines are shown to help understand the joint relationship between adoption of improved varieties and access to cassava grating machines. The joint estimation results are emphasized and preferred for interpretation because both use of improved cassava varieties and use of grating machines have shown positive effects on each other in the single equation estimation. Results from joint estimation using bivariate probit regression showed that different variables affected the probability of adoption of improved cassava varieties and probability of use of grating machines. For the first equation on use of improved cassava varieties, significant variables that affected probability of such use included membership in community organizations, membership in cooperatives organizations, awareness of the benefits associated with the adoption of the improved varieties, and the proportion of cassava grated. Farmers that were members of either community organizations or cooperative organizations had a higher tendency of using improved varieties than others. Membership in community organization showed a positive effect in increasing the probability of adopting improved cassava varieties by 0.28. Also, membership in cooperative societies increased the probability of adoption of improved cassava varieties by about 0.21. In addition, greater increase in the probability of adoption of improved cassava varieties is indicated by model results for awareness of the importance and benefits associated with the use as well as the proportion of cassava grated using grating machines in the household. As expected, those farmers who were made aware of the potential of improved cassava varieties were more likely to adopt them. Awareness about the benefits of improved cassava varieties had a positive coefficient of 1.46, while the coefficient on the proportion of cassava grated using machines was slightly lower at 1.41 (Table 7). This underscores again the importance of giving farmers opportunity to experience and learn about new technologies in the adoption process. Also, since the majority of households (about 82%) use mainly small grating machines at home, these results indicate that promotion of such small scale processing would have great impact in increasing adoption of improved cassava varieties.

For the second equation, model estimation results indicate that the most significant variable influencing the use of grating machine was the proportion of land planted to improved cassava varieties. A 10% increase in the proportion of land planted to cassava varieties increased the probability of using grating machine by 12%. Frequency of access to extension services showed a positive effect on the probability of adopting grating machine by about 1 percentage point. Farmers with smaller farm showed higher tendency of using grating machines. This was expected as farmers with smaller farms would likely have more time for processing activities than others. Membership in community organization was negative but significant in influencing the use of grating machine. This result might be related to the availability of small individual grating machines that most farmers are using instead of relying on big community level processing centres.

Conclusion

Awareness and adoption of improved cassava varieties was relatively high. Adopting farmers have high cassava yield of 16 tons/ha compared to non-adopters (11 ton/ha). However, yields are still low when compared to potential yield of 30 to 40 tons/ha from research trial plots. Introduction of smaller grating machines has helped increase awareness and use of cassava grating and pressing machines by households. However, there is a need to mechanize peeling of cassava roots in order to address the increasing labor constraints in rural areas. Mechanizing peeling is the next big leap that is needed for cassava industry to continue to grow in Nigeria. The results of bivariate probit regression showed that adoption of improved cassava varieties had an effect on farmers' access to grating machine and vice versa. That is, the most significant variable influencing the use of grating machine was the adoption of improved cassava varieties.

The results confirm the strong complementarity between improved cassava varieties and processing machines. Since the use of grating machines is having greater effect on adoption of improved cassava varieties, introduction of processing machine should precede that of improved cassava varieties. Also, the introduction of new technologies should be backed up by training and provision of complementary services. Finally, promotion of processing should also include small processing machines as their availability in the study areas has been an important factor explaining the observed differences in adoption.

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academicJournals

Vol. 6(2), pp. 76-86, February, 2014
DOI: 10.5897/JDAE2013.0483
ISSN 2006-9774 © 2014 Academic Journals
http://www.academicjournals.org/JDEA

Journal of Development and Agricultural Economics

Full Length Research Paper

Export horticulture and household welfare: Evidence from Zambia

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Accepted 11 November, 2013

Evidence is very scanty in Africa on the welfare effects of the recent shift of the horticulture industry from involving poor households through outgrower arrangements towards employing them in consolidated production entities. This study determines the impact of large-scale export vegetable production on the welfare of the employees in Zambia. It uses data from a survey of a random sample of farm worker households and comparison households in nine villages around one of the four largest estate vegetable farms in Zambia. Evidence from control function, propensity score matching, and odds-weighted regression models suggest huge and significant welfare effects as measured by per capita consumption expenditure. Estimated at 44 and 45% for non-food and food expenditure, respectively, the impact is not affected by the households' initial wealth in any statistically significant manner. This means that the recent industry changes might need to be supported and better understood, as opposed to being admonished.

Key words: Zambia, labor, welfare, consumption, propensity score.

INTRODUCTION

With a per capita income of USD 423 and 64% of the Zambia's population (which is estimated at 12.5 million), living below the poverty line (World Bank, 2011), Zambia ranks among the poorest countries in the world. About 56% live in rural areas (World Bank, 2002) of which 97.4% are engaged in agriculture (CSO, 2000). Within a labor force of 3.4 million, 85% are employed in agriculture, 6% in industry and 9% in services. With unemployment at 7.9% (CSO, 2008), agriculture is often the only potential source of livelihood or income within the informal sector. The Zambian agricultural sector contributes about 20% to real GDP and 39% of earnings from non-traditional exports (IMF, 2011). The sector mainly consists of smallholder farmers who make up about 52% of the country's farmers (Chipokolo, 2006) and contribute 80% of the nation's food. However, despite their substantial aggregate contribution to national food supply and GDP, smallholder farmers constitute a third of the nation's hungry and poor (CSO, 2004). Several factors have been cited for the low welfare levels among smallholder farmers, including low productivity, frequent droughts, and unsatisfactory access to markets, market information and credit facilities (Chiwele, 2004; USAID, 2005). Export horticulture (flowers and vegetables) in Zambia developed in the early 1980s and growth in the sector in the last decade is seen as one of the opportunities for raising welfare levels among the rural poor, while also generating foreign exchange

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(Hichaambwa, 2010). In the 1990s and early 2000s, the industry expanded rapidly as numbers of companies increased, raising export volumes of vegetables and cut flowers from US $6 million in 1994 to over $33 million in 2001 when the sector employed about 10,000 people (ZEGA, 2002). However, most of these gains in both export volume and earnings were lost in 2005 (Hichaambwa, 2010).

The decline was due mainly to the demise in 2004 of the largest horticultural export company, Agriflora.[1] For smallholder farmers who participate in the industry under contract with larger firms, the bankruptcy of Agriflora deprived them of reliable income, transport logistics and technical support. Although, donors tried to cushion part of the shock, their support could not be sustained indefinitely. The industry also faces a number of other challenges, including exchange rate fluctuations (Sergeant and Sewadeh, 2006), inelastic prices in traditional markets (Mataa and Hichaambwa, 2010) and high air freight costs (ZEGA, 2002) that exceed levels observed in most other countries in the region.[2] Tightening standards in the UK and other EU export destinations in recent years have also served a major blow to the Zambian horticultural sector, especially among smallholder producers. It is argued that the cost of compliance to the European retailers' private standards for Good Agricultural Practices (EurepGAP) cut farmers' incomes in half between 2002 and 2006 (AgriFood Standards Project, 2007).

As a result, less than 3% of the smallholder farmers involved in supplying European markets in 2000 were still doing so in 2006. Most large-scale exporters have employed three major coping strategies. The first is to significantly reduce output and concentrate on the higher-value and higher-margin lines. The second strategy is to increase output and try to reduce costs, that is, improve efficiency to increase margins. The third strategy has been to reduce or eliminate all outgrower arrangements with smallholder farmers, increasingly placing greater emphasis on consolidation and "own" production.[3] However, the shift from smallholder contract-based farming to large-scale estate production may imply more employment for rural households (Dolan and Humphrey, 2000). A number of studies have considered the impact of export horticulture on household income and poverty in Africa. In Kenya, McCulloch and Ota (2002) found that households involved in export horticulture were better off, particularly in rural areas. They further contend that enabling more households to participate in the sector could reduce poverty substantially in both rural and urban areas.

Maertens and Swinnen (2009) used company and household survey data from the vegetable export chain in Senegal to quantify income and poverty effects of high standards trade through labor markets. They found that horticultural exports from Senegal to the EU had grown sharply despite strongly increasing food standards, and that these exports had strong positive effects on poor households' incomes, reducing regional poverty by about 12% and extreme poverty by half. Third, tightening food standards induced structural changes in the supply chain including a shift from smallholder contract-based farming to large-scale integrated estate production. These studies offer valuable lessons on the poverty-reducing effects of export horticulture. However, low-income countries are characterized by varying cost structures, levels of development and institutional sophistication, and experiences, all of which leave part of the debate for much of Africa still open.

The Zambian industry has faced relatively greater challenges adjusting to tightening standards due to a number of other unique structural constraints, including, as already outlined, the collapse of the largest market player, higher transport costs[4], and macroeconomic factors (high agricultural taxes and unstable exchange rates). This study uses data from 41 farm worker households and 64 comparison households to determine the impact of large-scale export vegetable production on the welfare of employees. It also seeks to determine whether the household's initial wealth has significant effects on the level of impact. Most of the prior studies cited earlier use income as a proxy of welfare. We use consumption expenditure as the outcome variable. As a proxy of welfare, consumption expenditure is often argued to be more reliable and less prone to under-reporting errors than income. We find huge and significant effects on consumption. At least, 49% of the farm workers' consumption can be attributed to participation in large scale estate horticultural farm activities. This is consistent with recent similar studies (Maertens and Swinnen, 2009; McCulloch and Ota, 2002) and challenges conventional arguments that consolidation of large-scale farms is bad to poor households.

METHODOLOGY

Impact identification strategy

Program impact can be defined as the expected value of the difference between the level of the outcome variable attained by participating households and that which they would have attained

[1] Agriflora got into financial difficulties in 2004, leading eventually to it going into administration. Some of its assets were sold to other exporters, but a significant amount of its production was lost and has not been recovered.

[2] The main cost of running a cargo aircraft is the cost of aviation fuel which is about 50% of the direct costs associated with cargo aircraft thus making the cost in Zambia much more expensive than other competing countries in the region, by 40 to 50% (ZEGA, 2002).

[3] Outgrower arrangements normally cover a range of services provided by the large companies, including pricing of inputs, input advances (charged with interest) and the price paid for produce supplied to the company.

[4] Because it is landlocked and located a long way from the lucrative EU markets, Zambia lacks easy access to ports. This renders Zambia incapable of competing effectively in the EU wholesale and other low-value markets (AgriFood Standards Project 2007).

had they not participated in the program (Wooldridge, 2002; Ravallion, 2001). That is:

$$ATT = E(Y_{1i} - Y_{0i} \mid w_i = 1) \cdot \quad (1)$$

Where *ATT* is the average treatment effect on the treated, Y_{1i} is per capita consumption expenditure (the outcome of interest) for the treatment group (that is, households supplying labor to the large horticultural farm), Y_{0i} is the outcome of interest for the comparison group, w_i is a dichotomous variable equal to one if the household has at least one of its members supplying labour to the large-scale horticultural farm and zero otherwise, and *E*(.) is the expectations operator.

Consumption expenditure was computed by adding together the values of all goods and services consumed by the household (purchased or own-produced) during the 12-month period prior to the survey. This was divided by household size to obtain per capita consumption expenditure. When the i^{th} individual participates in wage estate employment, their level of consumption expenditure is Y_{1i} and if they do not their income is Y_{0i}. This is the conditional mean impact, conditional on participation, also known as the treatment effect or the average effect on the treated (Wooldridge, 2002). However, if there is a difference in the mean of the outcome variable between participants and non-participants in the absence of the program, a bias will arise and this bias is given by:

$$b = E(Y_{0i} \mid w_i = 1) - E(Y_{0i} \mid w_i = 0). \quad (2)$$

This bias could be corrected if $E(Y_{0i} \mid w_i = 1)$ were known. Unfortunately, the level of participants' consumption expenditure had they not participated cannot be observed. However, had the program been assigned randomly, the participants and non-participants could have the same expected income in the absence of the program. In this case, the expected income of non-participants will correctly reveal the counterfactual. For most programs, randomization is not possible due to ethical, cost and other pragmatic reasons. In the case of vegetable estate employment, treatment households either self-select themselves and/or are deliberately chosen on the basis of their individual characteristics. Under such a quasi-experimental design, statistical controls must be used to address the differences between the treatment and control groups (Barker, 2000). Under some form of exogeneity (Imbens, 2004), most quasi-experimental impact studies estimate the conditional average treatment effect on the treated as:

$$ATT = E(Y_{1i} - Y_{0i} \mid \mathbf{x}, w_i = 1) \quad (3)$$

Where x is a vector of covariates.

The assumption implied by (Equation 3) is that conditioning on carefully selected covariates renders the household's treatment status independent of potential outcomes, such that the unobserved $E(Y_{0i} \mid w_i = 1)$ can be represented by the observed $E(Y_{0i} \mid w_i = 0)$. This makes it possible to attribute any systematic differences in the outcome variables between treated and control units with the same values of the covariates to the program in question. A more dimensionally appealing but equivalent version of 'selection on observables' involves replacing x in (Equation 3) with the estimated conditional probability of participation, or propensity score, defined as $\hat{p}(\mathbf{x}) = E(w = 1 \mid \mathbf{x})$ (Rosenbaum and Rubin, 1983).

Data and data sources

This study uses data from a cross-sectional survey conducted in 2009 in nine villages around Borassus Estate, one of the three largest export horticulture producers, located about 25 km west of Lusaka, the capital of Zambia. A total sample of 41 treatment (that is, farm worker households) and 64 comparison households (that is, poor households located in the same neighbourhood as farm worker households but with no members working on the large vegetable farm) was drawn using stratified random sampling. Selection of farm worker households was based on a sampling frame developed out of a farm register, whereas the sampling frame for the comparison households was developed through comprehensive listing of non-worker households within the same neighbourhood. The simple random sampling applied to each stratum/frame ensured that, within the stratum, every listed household had an equal chance of being selected into the sample. Although, the households in the two strata looked similar on the basis of visible characteristics (save for participation status), we also used matching techniques to ensure comparability. The 41:64 (or roughly 2:3) sample allocation ratio between the treatment and comparison strata was deliberately done to provide more matching options for each treatment households. Among other things, the household questionnaire elicited information about participation in the horticultural industry, other livelihood activities, as well as standard demographic and human capital status. It also collected detailed information regarding food, nonfood and durable goods consumption expenditures, which was used in the computation of consumption-based measures of welfare.

The study benefited from secondary data and publications obtained from various organizations, including the Ministry of Agriculture and Cooperatives (MACO), the Central Statistical Office (CSO), the World Bank (WB), NZTT, and other relevant publications. Discussions with personnel from the Zambia Export Growers Association (ZEGA), the Natural Resources Development College (NRDC)/ZEGA Training Trust (NZTT), and management of the three major horticultural farms provided valuable information on the sub-sector.[5] The resultant expanded understanding of the sub-sector also helped in the interpretation of the quantitative results.

Empirical models

Estimation of the propensity scores

Program impacts are measured by assessing whether a program changes the mean value of an outcome variable among participants compared with what the outcome would have been had they not participated. The central evaluation problem then is that participants cannot be simultaneously observed in the alternative state of no participation (referred to as the counterfactual) (Shahidur et al., 2010). Evaluators typically simulate the counterfactual by comparing program participants with a control with similar characteristics. Construction of the counterfactual determines the evaluation design, which is broadly classified as experimental or quasi-experimental. A key feature of the experimental design is complete randomization, which ensures that households in treatment and control groups are, on average, similar and that any observed systematic differences in the outcome variables after the intervention are attributable to the intervention (Table 2). However, randomization is not always possible in observational studies such as ours. Ravallion (2001, 2003) characterizes the various methods used to estimate impact under quasi-experimental conditions. As a second-best alternative for these conditions, for example, comparison can be facilitated by statistically constructing comparable treatment and comparison strata. Propensity score matching (PSM) presents a unique set of techniques for

[5] In general, the discussions provided a picture of a once-prosperous sub-sector that was unfortunately on a decline at the time of the study.

reconstructing an experimental environment out of non-random, quasi-experimental conditions. We use variants of propensity-score-based methods to estimate the impact of employment in estate horticultural firms on household consumption, where the propensity scores (PS), or conditional probabilities of participation (given the observed characteristics), were estimated using a probit specification:

$$\text{Prob}\left(w=1\,|\,\mathbf{x}\right)=\Phi\left(\theta+\boldsymbol{\delta}'\mathbf{x}+\varepsilon\right) \quad (4)$$

Where Φ is a standard normal cumulative distribution function (CDF), ε is an error term, θ is the intercept to be estimated, $\boldsymbol{\delta}$ is a vector of slope parameters also to be estimated, and x is a vector of covariates. Equation 4 was estimated using maximum likelihood (ML) procedures in Stata (StataCorp, 2008).

In general, participation can be explained by the household's observable characteristics associated with access to resources (land, capital, and labor) and information, skills and ability (age, education), preferences (age, ethnicity, demographic structure), and geographic location (Maertens and Swinnen, 2009). To avoid endogeneity, we use initial (2005) values of variables such as asset endowment and livestock ownership. To ensure consistency of the PSM, only covariates that exhibited significant correlation with the participation variable and/or the outcome variable were included in x. Propensity-score-based models are only as good as the quality of the matching and are valid only under certain identifying assumptions. The balancing effects of the propensity scores were tested using a number of procedures including stratification, *t* tests for the differences in covariate means between the two groups (participants and non-participants) before and after the matching (Rosenbaum and Rubin 1985), effectiveness in reducing standardized bias, and ability to drive the overall probit relationship to insignificance as measured by a joint likelihood ratio (LR) test and pseudo R^2 (Caliendo and Kopeinig, 2008).[6]

Estimation of impact

We use three broad categories of models to estimate the impact of participation on the outcome variable – the control function approach, propensity score matching, and propensity score weighting. Heckman and Robb (1985) showed that selection bias can be controlled by including a vector of covariates as control functions:

$$\ln\left(y_i\right)=\gamma+\lambda w_i+\boldsymbol{\beta}'\mathbf{x}_i+\mu_i \quad (5)$$

Where y_i is the outcome variable (in our case per capita consumption expenditure) for household *i*, γ and λ are parameters to be estimated, β is a vector of parameters to be estimated, x is as defined above, and μ is a random error term.

Wooldridge (2002) contends that (equation 5) could be consistently estimated by OLS as long as the outcome variable is not correlated with the unobservable characteristics, also known as selection on observables. However, robust standard errors were used due to failure to reject heteroskedasticity. In the second specification of the control function approach, we replace x with the propensity score, a method pioneered by Rosenbaum and Rubin (1983):

$$\ln\left(y_i\right)=\gamma+\lambda w_i+\phi PS_i+\mu_i \quad (6)$$

Where the propensity score (*PS*) is as defined in (equation 1), that is, $PS_i=\hat{p}\left(w_i=1\,|\,\mathbf{x}\right)$, and ϕ is a parameter to be estimated.

In a more general version of correction on propensity score, we also include an interaction term between participation and the demeaned propensity score (Rosenbaum and Rubin, 1983; Wooldridge, 2002):

$$\ln\left(y_i\right)=\gamma+\lambda w_i+\phi PS_i+\varphi w_i\left(PS_i-\mu_{ps}\right)+\mu_i \quad (7)$$

Where μ_{PS} is the mean of the propensity score, and φ is a parameter to be estimated.

The results from the control function models (equation 5) through (equation 7) were corroborated with ones obtained through propensity score matching (PSM), which involves for each treatment unit finding matches in the control group based on observable characteristics (Abadie and Imbens, 2002; Dehejia and Wahba, 2002). Thus, the ATT was computed as the weighted average of the difference in the outcome variable between treatment households and matched control ones, where matching was done by kernel functions and ATT computation was restricted to the region of common support. The kernel matching estimator is given as (Heckman et al., 1997; Smith and Todd, 2005; Gilligan and Hoddinott, 2007):

$$ATT=\frac{1}{n}\sum_{i\in T}\left\{Y_{1i}-\frac{\sum_{j\in C}Y_{0j}K\left(\frac{P_j(\mathbf{x})-P_i(\mathbf{x})}{a_n}\right)}{\sum_{k\in C}K\left(\frac{P_k(\mathbf{x})-P_i(\mathbf{x})}{a_n}\right)}\right\} \quad (8)$$

Where *T* is the treatment group participants; *C* refers to the comparison group, *K* is the kernel function, and a_n is the kernel bandwidth. Inferences were made possible by bootstrapping standard errors.[7]

While matching produces consistent estimates, Hirano et al. (2003) show that the odds-weighted regression approach to PSM, or propensity score weighting (PSW), results in fully efficient estimates. Under this framework, impact is the estimated slope coefficient $\hat{\lambda}_1$ in the simple regression model:

$$y_i=\gamma+\lambda w_i+\mu_i \quad (9)$$

But with the observations weighted by 1 for treatment households and by the estimated odds ratio, $\hat{P}(\mathbf{x})/\left(1-\hat{P}(\mathbf{x})\right)$, for comparison households, where $\hat{P}(\mathbf{x})=E\left(w=1\,|\,\mathbf{x}\right)$ is the estimated conditional probability of participation.

Heterogeneous impact

The Hirano et al. (2003) framework can be extended to the case where the impact of the treatment is differentiated by some defined

[6] A well-balanced propensity score is necessary for artificially constructing an experimental environment from a quasi-experimental situation. The idea is that there should be no association between treatment status and each covariate once the observations have been restricted to the region of common support.

[7] Kernel matching, unlike nearest-neighbor matching, arguably leads to more valid bootstrapped standard errors (Abadie and Imbens, 2005; Gilligan and Hodinott, 2007).

household categorization. We use this framework to estimate disaggregated impact:

$$\ln(y_i) = \gamma + \lambda w_i + \pi w_i * D_i + \mu \quad (10)$$

Where D is a dummy variable based on the household's initial wealth status.

A household was categorized as poor (D = 1) if the initial wealth index was negative, where the wealth index was computed from assets data using principal components analysis (Filmer and Pritchett, 2001). Thus, the impact of participation is equal to $\hat{\lambda}$ for the relatively less poor households (D = 0) and $\hat{\lambda} + \hat{\pi}$ for the poor ones. Thus, $\hat{\pi}$ is the additional impact that a poor household would experience relative to its relatively richer counterparts.

RESULTS AND DISCUSSION

Table 1 presents selected sample characteristics, comparing control and treatment households. The results indicate that the two sub-samples were generally well-balanced with respect to most characteristics. Significant differences between control and treatment households were evident only with respect to the age of the household head, location and initial wealth of the households. Although, the age of the household head was generally low (averaging 40 years), households with at least one estate farm worker had generally younger heads compared to their non-worker counterparts. Treatment households were also more likely to be male-headed, to have more educated members, and to be further away from the main road and schools; although, these differences were not statistically significant. Not only did treatment households have greater initial wealth but they also were well-off as indicated by a positive mean wealth index. On the other hand, households in the control group were generally poor (windex < 0). At the time of the survey, treatment households also had almost twice as much consumptions as their counterparts in the control group, and this was true even if consumption was disaggregated into its components (Figure A2). These general descriptive results were further confirmed by probit analysis of participation (Table 2). The marginal effects (column 2) show that an additional year to the age of the household head was associated with a 1.3% drop in the household's probability to participate in estate wage employment. Surprisingly, the probability to participate was inversely and significantly correlated with the number of members in the active age group (15 to 55 years). Location and initial wealth were the largest determinants of participation.

The PS balancing test results confirm the existence of strong bias for most covariates and that balancing successfully eliminated this bias (Table A1).[8] In general, matching produces consistent estimates as long as the unobserved factors are equally distributed between the two groups.[9] The estimated PS was also inspected for the common support requirement. This was found to be satisfied, as indicated by the fact that 0 < PS < 1 and by a large PS overlap (0.07, 0.86) between the control and treatment groups (Figure A1).

Impact estimates

The descriptive statistics discussed earlier indicate that those who participate in estate horticulture firms as workers are better off as indicated by wealth and consumption. However, descriptive statistics are limited and may not imply causality as they fail to account for other sources of the observed differences. Table 3 presents impact estimates as determined by the various models discussed earlier. All the five models indicate huge positive and significant effects of participation. More specifically, employment in estate horticulture farms raises per capita household consumption by 49 to 53%. Although, the specific impact estimates vary from model to model, they are generally very close to each other. The control function models (columns 1 through 3) further confirm the importance of conditioning on the observables, either directly (column 1), or through the propensity score (columns 2 and 3). The interaction between the treatment indicator and the demeaned propensity score had a dampening but insignificant effect. Model 1 also shows that per capita consumption expenditure is directly correlated with education level attained by the members, and inversely related to household size. Village 2 households had 21% less consumption, just as they were less likely to participate compared to households in all other villages. Table 4 presents impact estimates disaggregated by initial wealth and category of consumed items based on the odds-weighted regression analysis (Hirano et al., 2003).

The results re-confirm the significance of consumption effects, ranging from 46% for relatively non-poor households, to 56% for poorer ones. The greatest difference between poor and non-poor households was with respect to food items; although, impact heterogeneity across wealth strata was generally not statistically significant.

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[8] In addition to covariate *t* tests, the estimated propensity score also satisfied the balancing property within an optimally determined number of strata or blocks (Becker and Ichino, 2002). Estimation of the propensity score and generation of balancing tests were achieved through a combination of psmatch2 (Leuven and Sianesi, 2003), pscore and pstest (Leuven and Sianesi, 2003) procedures in Stata.

[9] A key identifying assumption for the PSM is that there should be no unobserved factors that influence both participation and the outcome variable. This is variantly called in the literature as the conditional independence assumption (CIA), matching on observables, unconfoundedness, etc. 'Hidden bias' would be of concern if this assumption is violated (Rosenbaum and Rubin, 1983; Caliendo and Kopeinig, 2008; Jalan and Ravallion, 2003; Cameron and Trivedi, 2005).

Table 1. Descriptive characteristics.

Variable	Variable description	Overall	Control units	Treated units
		(1)	(2)	(3)
n	Number of observations	105	64	41
Demographics			**Means**	
hage	Age of hh head (years)	40.48	42.05	38.03**
hsex	Male-headed households (%)	75.00	73.00	78.00
hedu	Education level of the head (years)	7.66	7.33	8.17
mxedu	Education of most educated member (years)	8.89	8.63	9.29
dmar	Households with married heads (%)	66.00	63.00	71.00
c 0 to14	Children 0 to 14 years old	2.06	2.02	2.12
m 15 to 55	Male members 15 to 55 years old	1.84	1.94	1.68
f1 5 to 55	Female members 15 to 55 years old	1.87	1.97	1.71
m 56plus	Elderly members 56 years or older	0.15	0.14	0.17
deprat	Dependency ratio (%)	38.27	37.06	40.16
nlab	Number of members providing labor	1.90	1.97	1.78
hhsize 05	Household size in 2005	5.27	5.39	5.07
Accessibility				
kmroad	Distance to nearest main road (km)	0.54	0.49	0.61
kmpsch	Distance to nearest primary school (km)	0.52	0.49	0.56
kmssch	Distance to nearest secondary school (km)	18.32	18.30	18.35
Location				
dvil2	Households in village 2 (%)	30.00	36.00	20.0*
dvil7	Households in village 7 (%)	27.00	28.00	24.00
dvil8	Households in village 8 (%)	31.00	33.00	29.00
dvilr	Households in other villages (%)	10.00	3.00	20.0**
Initial wealth				
windex	Asset wealth index in 2005	-1.62E-09	-0.23	0.36***
tlu 05	Tropical livestock units in 2005	0.25	0.20	0.31
area	Landholding size (ha)	0.52	0.49	0.58
Welfare				
texp	Consumption expenditure (million ZMK)	3.06	2.44	4.03***

Test of statistical significance of mean differences between treatment and control/comparison households: *** p<0.01, ** p<0.05, * p<0.1 . Dependency ration was computed as the ratio of inactive members to household size. Asset wealth index was computed with principal components analysis as in Filmer et al. (2001). Villages 1, 3 to 6, and 9 had very low frequencies. Thus, they were grouped together into dvilr. Source: Data from estate horticulture worker survey (2009).

Conclusions

Poverty is widespread in low-income countries like Zambia. Encouragement of land and labor intensive industries such as export horticulture is seen by many as one way to reduce poverty. This study determined the impact of large-scale export horticulture on the welfare of the employees. Data were from a survey of rural households around one of the four major large-scale export horticultural farms about 25 km west of Lusaka. The results, based on eight alternative econometric specifications, consistently point to the existence of huge and positive consumption effects. On average, as much as 44 to 56% of the workers' per capita consumption expenditure could be attributed to their participation in the export horticultural industry. The impact was found to be greater for households that were poor to start with and especially with respect to food consumption; although, statistically, such differences were not significant. As the industry is undergoing structural transformation from contract farming towards consolidation, these results suggest that export horticulture could still play an

Table 2. Propensity score estimation with the probit model.

Variable	Variable description	Parameter estimate	Marginal effects
		(1)	**(2)**
_cons	Intercept	1.959* (1.080)	
hage	Age of the household head (years)	-0.033* (0.020)	-0.013
hedu	Education of the household head (years)	-0.017 (0.072)	-0.006
mxedu	Education of most educated member (years)	-0.008 (0.078)	-0.003
m 15 to 55	Male members 15 to 55 years old	-0.321* (0.180)	-0.121
f1 5 to 55	Female members 15 to 55 years old	-0.322* (0.180)	-0.121
m 56plus	Elderly members 56 years or older	0.246 (0.390)	0.093
hhsize 05	Household size in 2005	0.062 (0.120)	0.023
Windex	Initial asset wealth index in 2005	0.495*** (0.180)	0.186
tlu 05	Initial tropical livestock units in 2005	0.084 (0.270)	0.031
Area	Landholding size	-0.057 (0.250)	-0.022
Kmroad	Distance to nearest main road (km)	0.406 (0.360)	0.153
dvil2	Village dummy, 1 = village 2	-0.677* (0.380)	-0.237
Dvilr	Village dummy, 1 = villages 1, 3 to 6, 9	0.823 (0.550)	0.319
Number of observations		105	
Likelihood ratio Chi-sq		30.63***	
Pseudo R2		0.218	
Predicted probability		0.367	
Actual probability		0.391	

Dependent variable: Whether the household supplied labor to the large-scale horticultural farms (= 1) or not (= 0). Robust standard errors in parentheses. Significance: *** p<0.01, ** p<0.05, * p<0.1. Source: Data from estate horticulture worker survey (2009).

Table 3. Impact estimates based on the control function, propensity score matching and odds-weighted models.

Variable	Variable description	Model 1	Model 2	Model 3	Model 4	Model 5
		X as control functions	***PS* as control functions**	***PS* and demeaned PS as control**	**Propensity score matching**	**Odds- weighted regression**
		(1)	**(2)**	**(3)**	**(4)**	**(5)**
Constant		13.12*** (0.26)	12.81*** (0.080)	12.80*** (0.10)	-	13.02*** (0.052)
w	Treatment, 1 = Estate worker	0.491*** (0.068)	0.492*** (0.087)	0.494*** (0.089)	0.535*** (0.096)	0.512*** (0.084)
PS	Propensity score	-	0.416** (0.17)	0.455* (0.25)	-	-

Table 3. Contd.

*w** (*PS- u ps*)	*w* interacted with demeaned *PS*	-	-	-0.0663 (0.34)	-	-
hage	Age of hh head (years)	0.0010 (-0.004)	-	-	-	-
hedu	Education of hh head (years)	0.002 (0.016)	-	-	-	-
mxedu	Education, most educated (years)	0.068*** (0.014)	-	-	-	-
m 15 to 55	Male members 15 to 55 years old	-0.04 (0.040)	-	-	-	-
f1 5 to 55	Female members 15 to 55 years	-0.0226 (0.042)	-	-	-	-
m 56plus	Elderly members 56 years or older	0.0392 (0.086)	-	-	-	-
hhsize 05	Household size	-0.125*** (0.029)	-	-	-	-
windex	Asset wealth index	0.0378 (0.036)	-	-	-	-
tlu 05	Tropical livestock units	-0.019 (0.037)	-	-	-	-
Area	Landholding size (ha)	-0.013 (0.044)	-	-	-	-
mmroad	Distance to main road (km)	0.013 (0.058)	-	-	-	-
dvil2	Village 2 dummy	-0.207** (0.091)	-	-	-	-
dvilr	Villages 1, 3 to 6, 9 dummy	0.018 (0.11)	-	-	-	-
Goodness of fit F statistic		13.56***	26.25***	17.35***	-	36.88***
Observations		105	97	97	97	97
R-squared		0.69	0.37	0.37	-	0.31

Robust standard errors in parentheses. Significance: *** p<0.01, ** p<0.05, * p<0.1.Dependent variable: Natural log of per capita consumption expenditure.Source: Data from estate horticulture worker survey (2008).

Table 4. Heterogeneous impact estimates based on odds-weighted regression analysis.

Variable	Variable description	Category of expenditure		
		Total	**Food**	**Non-food**
		(1)	**(2)**	**(3)**
Constant		13.02*** (0.052)	12.10*** (0.045)	12.49*** (0.068)
w	Treatment, 1 = estate worker	0.456*** (0.084)	0.452*** (0.11)	0.440*** (0.10)
*w*D*	*w* interacted with wealth dummy	0.104 (0.13)	0.240 (0.15)	0.0127 (0.15)
Goodness of fit F statistic		20.21***	23.22***	10.89***
Observations		97	97	97
R-squared		0.32	0.37	0.19

Robust standard errors in parentheses. Significance: *** p<0.01, ** p<0.05, * p<0.1. Dependent variable: Natural log of per capita consumption expenditure.Source: Data from estate horticulture worker survey (2009).

important role towards poverty reduction. This is somewhat contrary to conventional, and largely anecdotal, arguments, that large-scale commercial farms are exploitative. It also calls for a re-orientation of public sector support and emphasis from enhancement of contract farming alone to a mix of strategies that also include ways to enhance large-scale export production. For example, domestic and export tax regimes that promote large-scale export horticulture could eventually translate into welfare gains for the poor households that live around those farms.

ACKNOWLEDGEMENTS

Special thanks go to management and staff of Borassus Estates for the permission to undertake the survey in and around their farm. The study also benefited from discussions with personnel from the Zambia Export Growers Association (ZEGA), the Natural Resources Development College (NRDC)/ZEGA Training Trust (NZTT), and management of the three major horticultural farms in Lusaka. Comments obtained from staff of the Department of Agricultural Economics, University of Zambia, during a presentation are greatly appreciated.

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Table A1. Balancing properties of covariates in treated and control groups.

Variable	Sample	Mean treated units	Mean control units	% Bias between treated and controls	% Reduction in |bias|	H_0: Mean (treated) = mean (control)	
						t	Probability > |*t*|
		(1)	(2)	(3)	(4)	(5)	(6)
hage	Unmatched	38.030	42.053	-43.3		-2.17	0.032
	Matched	38.971	37.688	13.8	68.1	0.58	0.561
hedu	Unmatched	8.171	7.328	29.8		1.53	0.128
	Matched	7.743	7.796	-1.9	93.7	-0.08	0.935
mxedu	Unmatched	9.293	8.625	26.0		1.34	0.182
	Matched	8.914	8.750	6.4	75.4	0.28	0.779
m 15 to 55	Unmatched	1.683	1.938	-21.3		-1.07	0.285
	Matched	1.571	1.654	-6.9	67.4	-0.36	0.723
f1 5 to 55	Unmatched	1.707	1.969	-23.5		-1.17	0.245
	Matched	1.714	1.652	5.6	76.0	0.24	0.809
m 56plus	Unmatched	0.171	0.141	6.3		0.33	0.743
	Matched	0.143	0.145	-0.5	92.8	-0.02	0.984
hhsize 05	Unmatched	5.073	5.391	-14.9		-0.78	0.437
	Matched	5.086	5.115	-1.4	90.7	-0.06	0.950
windex	Unmatched	0.364	-0.233	58.6		3.11	0.002
	Matched	0.100	-0.012	11.0	81.1	0.51	0.610
tlu05	Unmatched	0.312	0.204	13.5		0.74	0.463
	Matched	0.138	0.126	1.5	89.0	0.15	0.878
Area	Unmatched	0.578	0.490	12.4		0.61	0.540
	Matched	0.437	0.408	4.2	66.0	0.24	0.811
kmroad	Unmatched	0.607	0.494	24.4		1.26	0.210
	Matched	0.591	0.550	8.9	63.4	0.35	0.724
dvil2	Unmatched	0.195	0.359	-37.0		-1.81	0.073
	Matched	0.229	0.165	14.2	61.5	0.66	0.513
dvilr	Unmatched	0.195	0.031	52.9		2.87	0.005
	Matched	0.114	0.059	17.9	66.2	0.82	0.417

Note: Matching reduced pseudo R^2 from 0.218 to 0.032 and the overall likelihood ratio Chi-square for the probit relationship from 30.63 (p-value = 0.004) to 3.09 (p-value=0.998).

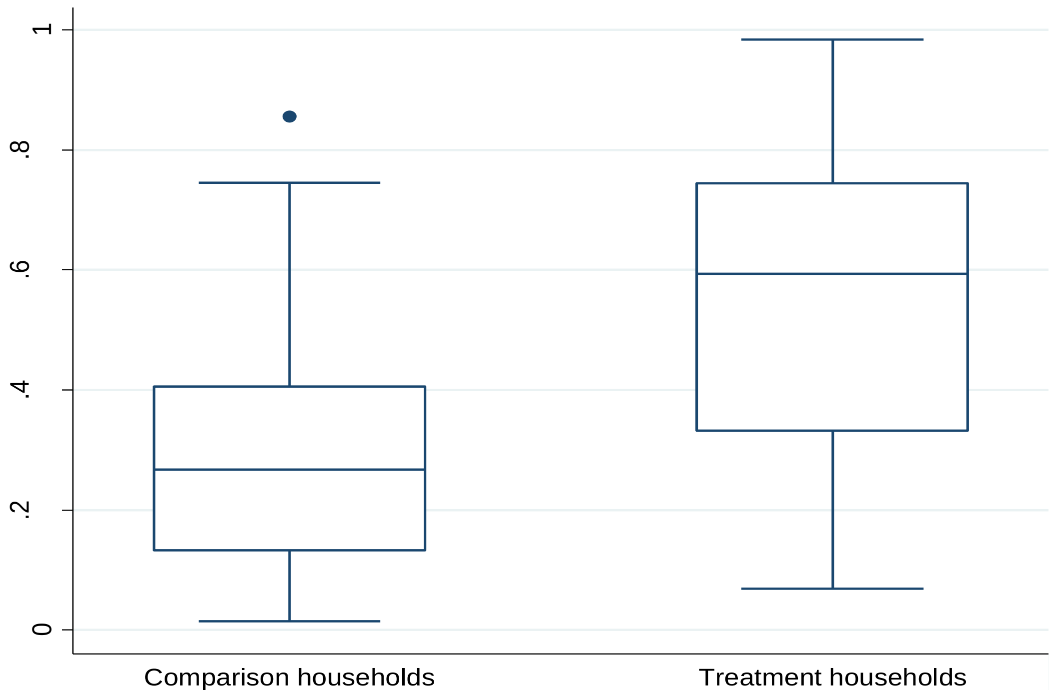

Figure A1. Distribution of propensity scores over comparison and treatment households. Notes: Common support requirement was satisfied within (0.070, 0.855).

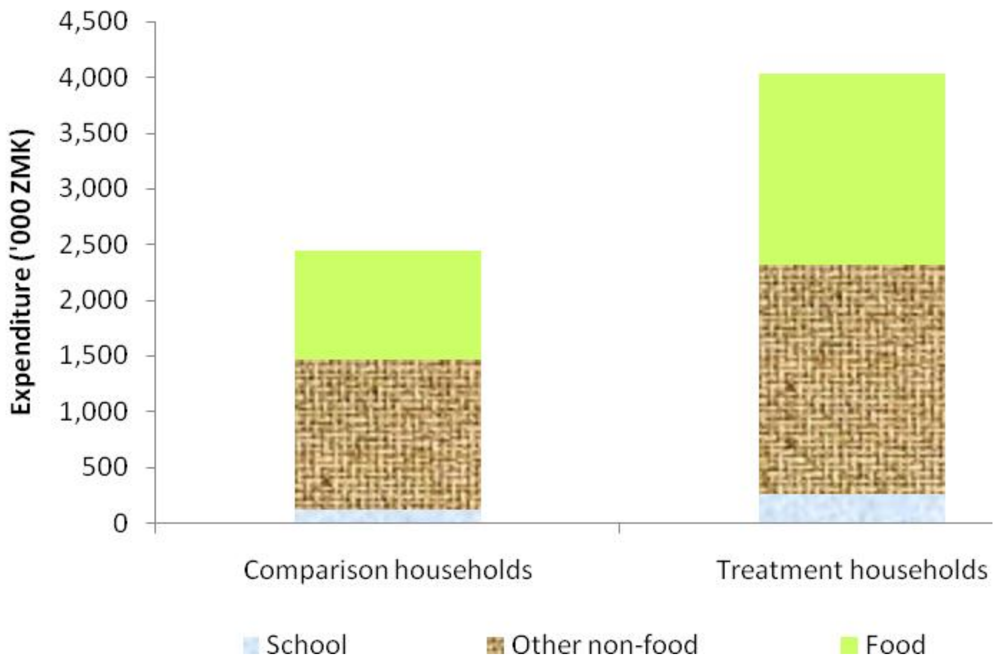

Figure A2. Expenditure patterns for comparison and treatment households.

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Vol. 6(2), pp. 87-93, February, 2014
DOI: 10.5897/JDAE2013.0527
ISSN 2006-9774 © 2014 Academic Journals
http://www.academicjournals.org/JDEA

Journal of Development and Agricultural Economics

Full Length Research Paper

Econometric analysis of factors affecting competitive advantage of broiler agribusinesses in Ghana

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Accepted 19 December, 2013

This paper econometrically analyzed the factors affecting competitive advantage of broiler agribusinesses in Ghana, using multiple regression analysis. Through a multi-stage random sampling technique, structured questionnaire was used to collect farm level data from 441 small-scale commercial broiler agribusinesses in the Greater Accra, Ashanti and Brong Ahafo Regions of Ghana. The average variable cost of producing a broiler at an average market age of 57 days was GH¢8.48 (US$5.93). Of this cost, feed and one day-old chick costs together constitute about 72%. Results of the econometric regression analysis show that feed and day-old chick costs, broiler market age and capacity utilization are the main factors that significantly affect competitive advantage of broiler agribusinesses in the study area. Feed cost, one day-old chick cost and market age of broilers positively and significantly affect cost of broiler agribusinesses while production capacity utilization negatively and significantly affect cost. This suggests that reducing feed and day-old chick costs, market age of broilers and increasing capacity utilization will reduce production cost to promote competitive advantage of broiler agribusinesses. Broiler agribusinesses should be encouraged to adopt better feed management practices and also feed broilers with nutritious feed for the right market weight to be gained by week eight to reduce expenditure on feed. Policies that will encourage broiler producers to increase production capacity should also be encouraged.

Key words: Competitive advantage, broiler, agribusiness, econometric, Ghana

INTRODUCTION

Competitiveness of the global food market has raised concerns among economist and policy makers about the need for competitive advantage in the agribusiness sector of developing countries (Mugera, 2012; Grznár and Szabo, 2006). This is particularly so because competitive advantage ensures continuous survival and profitability of agribusinesses, and so has heightened the need for more competitive strategies to be developed for growth (Sánchez and Pérez, 2005). According to Porter (1985), the goal of all firms is to achieve a competitive advantage in relation to their rivals. This is created when a firm uses its resources and capabilities to achieve either a lower cost structure or differentiated product to position itself competitively in the industry. Competitive advantage enables a firm to earn profits that are higher than the average profit earned by its competitors. Ghana's broiler agribusiness sector is a major component of the livestock and poultry sub-sector of the Agricultural sector that contributes about 5% to agricultural Gross National Product (GNP). The sector also provides high quality protein meat and inclusively employs 75% of the Ghanaian population in the areas of processing, nutrition, health, product and by-products as well as vending at food joints and chop bars (Anku, 2005). The sector also serves as an important source of ready cash for emergency needs. According to available statistics from

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the Ministry of Food and Agriculture (MOFA, 2010), between 2003 and 2008, poultry meat contributed 26% of the 32% growth recorded in total domestic meat production in Ghana.

Up until the 1990s, the broiler sector of Ghana supplied about 95% of the total domestic poultry meat requirement. However, by 2008 the broiler sector could only meet about 11% of the total domestic requirement, with the rest coming from imports (Randan and Ashitey, 2011). The decline in the market share of the domestic broiler sector in total market demand (import and production) has been attributed to increased competition from cheap poultry imports as well as changes in government policies such as the removal of government support for drug costs, discontinuation of government importation and support for feed mill ingredients and the reduction of preference in interest rates for agricultural credit (Nkansala, 2004). These factors raised the cost of broiler production by over 60%, resulting in many broiler enterprises folding up. Recognizing the need to revive the broiler sector to reduce poverty and malnutrition, governments provided some interventions to support the sector. These interventions included the implementation of the National Agricultural Research Project (NARP) in 2002 and the importation of 20,000 Mt of yellow maize in 2005 that were sold to poultry farmers to boost local production. Other interventions were facilitating the capitalization and marketing of broiler birds through a joint Government and Agricultural Development Bank broiler out grower scheme in 2003. In spite of all these supports, increasing production cost continues to raise concerns among stakeholders about competitive advantage of the broiler sector in Ghana. There is therefore the need to achieve competitive advantage in the Ghanaian broiler agribusiness sector. This is to ensure that the broiler sector position itself strategically to survive, grow and compete favourably in the increasingly competitive global agribusiness market to become more profitable in the future.

The ability of an entrepreneur to control production cost is key at promoting competitive advantage of a firm's product. Indeed, the increasing cost of broiler production which has implication for competitive advantage has been a major concern among broiler producers. This situation threatens the future survival of Ghana's broiler sector and therefore requires urgent and concerted efforts to save the sector from total collapse. Since broiler producers have little or no control over the demand for their products as well as inputs prices due to the competitive nature of the market, a more plausible way to achieve competitive advantage in the sector is to reduce production cost to keep broiler producers in business. However, this will require that broiler producers know the main factors affecting production cost and the extent to which they affect competitive advantage in order to take appropriate steps to reduce cost. This is to ensure that local broiler producers compete favourably in the global market. The main research question is: What are the factors affecting competitive advantage of broiler agribusinesses? The decline of the broiler agribusiness sector in Ghana has been attributed to high inputs costs such as feed, drugs and energy. True as these views expressed on the decline of the broiler industry may be, they are not based on scientifically conducted studies. In actual fact, systematic and rigorous econometric studies examining these issues in Ghana are limited (Kudzodzi, 2006; Killebrew and Plotnick, 2010). Moreover, studies on broiler agribusinesses in Ghana focused mainly on profitability (Anang et al., 2013) and not competitive advantage. The objective of this study is therefore to econometrically analyze the factors affecting competitive advantage of broiler agribusinesses in Ghana. This study will help broiler producers to know the key factors affecting their competitive advantage in order to take appropriate steps to reduce cost to make the sector competitive and more profitable.

MATERIALS AND METHODS

Study area

The study was based on farm level data from small-scale commercial broiler agribusinesses in the Greater Accra, Ashanti and Brong Ahafo Regions of Ghana. These are regions where considerable amount of commercial broiler production takes place. The Greater Accra Region is located in the coastal belt of Ghana and lies between longitudes 1° 8'E – 0° 30 W and latitude 5° 70' – 6° 8' N of the equator and has a total land size of 3.24 thousand square kilometers. The Ashanti Region also has a total land area of 24.39 thousand kilometers and is located in the middle belt of Ghana, between longitudes 0° 15' W – 2° 15' and latitude 6° N – 7° 30' N of the equator. The Brong Ahafo Region on the other hand lies in the forest zone and covers an area of 39,557km^2. It has a tropical climate, with high temperatures averaging 23.9°C as well as a double maxima rainfall ranging, from an average of 1000 mm in the northern parts to 1400 mm in the southern parts. These three regions of the study have a high concentration of commercial activities, infrastructural facilities like vertinary care as well as climate that favour the production and marketing of poultry meat products.

Population, sample size and technique

The target respondents for the study were small-scale commercial broiler agribusinesses who were members of the Ghana National Poultry Farmers Association (GNPFA, 2009). Multi-stage and purposive random sampling techniques were used to select 441 small-scale broiler producers with stock size of between 50 and 5000 birds in a batch and use the deep litter system. The first stage involved purposive selection of the three main broiler producing regions in Ghana. Five districts from each of the three regions were selected in the second stage after interviewing officials of the regional branches of the GNPFA to find out districts and communities where broiler is predominantly produced. Two (2) communities from each of the five districts were then selected to obtain a total of 30 communities. Since small-scale commercial broiler producers are not evenly distributed within the communities selected in the regions, simple random sampling technique was used in the last stage to select and interview 462 poultry meat producers in a ratio proportional to their population. However, 441 questionnaires which contained the needed information were used for the analysis.

Sources and method of data collection

Structured questionnaire was used to collect primary data on farm and farmer socio-economic characteristics as well as input and output quantities and their respective prices used during the 2010 production cycle. The questionnaire which was pre-texted consisted of both open-ended and close ended questions as well as yes and no questions.

Analytical framework

The analytical framework developed for this study was based on the one proposed by Porter (1990). According to Porter, the environment in which firms compete and promote the creation of competitive advantage is shaped by a number of broad attributes. Among these attributes are factor conditions, demand conditions, related and supporting industries and firm strategy, structure and rivalry. As one of the broad attributes, factor conditions depend on the quantity, quality and cost of the human, physical, knowledge, capital as well as infrastructural resources of a firm.

These factors determine the competitive environment in which a firm competes and shapes its success. When a firm uses its resources and capabilities to achieve a lower cost structure, then it creates a competitive advantage (Porter, 1985). The agribusiness of broiler production involves the use of resources or inputs such as feed and day-old chick among others. The quantity, quality and cost of these inputs are likely to determine the factor condition, production cost and ultimately competitive advantage in the broiler sector.

Moreover, the ability of the broiler producer which depends on the technical and scientific know-how in broiler agribusiness is also likely to determine how effectively these inputs and operational activities in broiler production are organized and hence per unit production cost and competitive advantage. A lower per unit cost of production obtained from effective use of resources promotes and creates competitive advantage of broiler agribusiness. Therefore, the analytical framework used for the study is based on the fact that competitive advantage created through a lower per unit costs of production is likely to be determined directly or indirectly by the cost of production inputs as well as operational activities of the producer. Based on this, average variable cost (C) of producing broiler at market age in a batch, used as a proxy for competitive advantage, was modeled to be influenced by explanatory variables (X) such as broiler output produced at market age, cost of production inputs per bird as well as extension service contacts, market age of broilers and capacity utilization of respondents. The general form of this cost/competitive advantage model used for the study is specified as:

$$C_i = f(Y, X, \beta) + \varepsilon_i \qquad (1)$$

Where *C* represents average bird variable cost per for selected broiler agribusiness, β are coefficients to be estimated, *i* represent the farm surveyed, *Y* is output *X* is a vector of independent input costs and other variables hypothesized to influence cost/competitive advantage and ε represents the error term assumed to have a zero mean and constant variance. Following the model used by Mumba et al. (2012) and Olubiyo et al. (2009), the implicit econometric cost/competitive advantage regression model used for the study is specified as:

$$\ln C_i = \beta_o + \beta_1 \ln Output_i + \beta_2 \ln CstDoc_i + \beta_3 \ln CstFeed_i + \beta_4 \ln CstLab_i + \beta_5 \ln CstMed_i + \beta_6 \ln CstOthers_i + \beta_7 \ln DvCap_i + \beta_8 \ln ExtCon_i + \beta_9 \ln MktAge_i + \beta_{10} \ln CapUt_i + \varepsilon_i \qquad (2)$$

Where *ln* is natural logarithm, C_i is the competitive advantage of broiler agribusiness proxied by average variable cost of producing broiler at market age, Output is the number of broilers produced at market age in a batch, CstDoc is the per unit cost of one day-old chick, CstFeed is cost per kilogram of feed per bird, CstLab is the sum of hired and imputed family costs of labour per bird, CstMed is cost of medications and vaccines per bird, CstOthers is the cost of other inputs per bird and DvCap is the cost of capital input per bird. ExtCon is extension service contact measured as the number of extension contacts broiler agribusiness had in a batch, MktAge is market age of broilers measured as the deviation from the standard 56 days for a broiler to be ready for the market and Caput is the proportion of the installed capacity of broiler farm utilized by the producer; β_i are the parameters to be estimated and measures the percentage changes in the dependent variable (cost) and ε is the error term. Output of broiler producers represents the number of survived day-old chicks that are ready for sale by the end of the production cycle. All things being equal, the more day-old chicks stocked in a cycle, the more output will be produced and the more the cost. Output variable in the model is hypothesized to have a positive effect on cost. The main variable inputs required in broiler production include feed, day-old chick, labour, vaccines, medication, water, energy among others. These inputs are essential in the production of broiler and their costs have the tendency to affect the cost of production. The higher the cost of these variable inputs, the higher the cost of broiler production will be and hence reducing competitive advantage. These variable inputs costs are expected to have positive effect on cost, hence hypothesized to have a positive sign. The cost of capital input was measured as the depreciation value of farm structure and equipment and was hypothesized to have a positive sign.

Extension service contact is another variable included in the cost/competitive advantage function model. Broiler producers need to be abreast with modern production technologies and practices in broiler businesses that can be obtained from extension service contacts. Through extension service farmers get access to modern production techniques that enhances their abilities to effectively organize inputs purchased. Therefore, the more extension service contacts broiler producers get, the more they are expose to proper and modern farm management practices and the better their capabilities. This in turn ensures that broiler producers effectively organize their production inputs to reduce cost to achieve competitive advantage. It is therefore hypothesized to negatively affect cost. The number of days/weeks broilers are raised and ready for the market is another important factor that can affect the cost of broiler production and competitive advantage of the sector. The standard number of days required for broilers to be ready for market when fed with the right quality and quantity of feed is between 42 and 56 days. A broiler producer who deviates from this standard number of days is likely to incur more cost, since the birds will have to be fed until they gain the right market weight. Market age is therefore hypothesized to have a positive effect on the cost of broiler production, hence competitive advantage. Finally, the proportion of capacity utilized by a broiler agribusiness may also affect the cost of production and hence competitive advantage. Capacity utilization represents the extent to which broiler producers are optimally utilizing their fixed farms structures. Broiler agribusinesses that optimally use their installed production capacity are able to spread the cost of fixed input over larger outputs to reduce cost and to create competitive advantage. As a result, the higher the proportion of installed capacity utilized by the producer, the less the cost of production and vice versa. Capacity utilization is therefore hypothesized to have a negative effect on cost.

Table 1. Descriptive statistics of farm specific socio-economic characteristics.

Farm-specific variable	Mean	Minimum	Maximum	St.Dev
Average variable cost (GH¢)	8.48	3.34	18.30	2.62
Average cost per broiler (GH¢)	8.78	3.46	19.63	2.73
Farm size (No. of birds stocked)	1050.73	50.00	5000.00	946.77
Broiler output (No. of birds)	1011.82	45.00	4950.00	927.91
Age of farmer (years)	43.36	20	74	11.27
Formal education (years)	12.23	0	28	6.43
Experience (years)	7.61	0.42	51	6.75
Extension service contact/batch	1.38	0	6	0.79
Training/seminar in poultry	0.26	0	1	0.44
Market age of broilers (days)	57.29	28	77	12.36
Market access to sell broilers	0.93	0	1	0.26
Capacity utilization (%)	0.58	0.03	1.00	0.33
Number of batches in a year	1.87	1	3	0.68
Mortality rate (%)	2.61	0.00	16.00	3.46

Source: Author's Computation from Survey Data, 2010.

RESULTS AND DISCUSSION

Descriptive statistics of socio-economic characteristics of respondents

Table 1 shows the descriptive statistics of the socio-economic characteristics of small-scale commercial broiler agribusinesses sampled. It shows that the average age of broiler producers in the study area was 43 years, suggesting that the average broiler producer is old. The youth needs to be encouraged and supported to go into broiler production as a business and also to take over from older farmers in their demise to ensure continuity of the broiler sector. Sixty-three (63) percent of the respondents have up to secondary education, implying that majority of broiler producers sampled have some level of formal education. The education level attained by the farmer not only increases his productivity, but also enhances his/her ability to read, understand and evaluate new production technologies (Obasi, 1991). The average years of experience of broiler production in the study area was about 8 years. The longer the years of broiler production, the more exposed the farmer becomes to broiler production techniques for cost to be minimize to promote competitive advantage. In addition to having an average extension service contact of 1.38 visits per batch, the result also shows that small-scale broiler farmers produce an average of 1.87 batches of broiler in a year. This is less than the potential five batches per year (Atibudhi, 2004). Increasing the number of extension contacts broiler businesses receive in a batch as well as the number of batches of broilers produced will reduce the cost of broiler production to make the local industry gain competitive advantage. Furthermore, the result of the study shows that the average market age at which birds are ready for the market was 57.29 days. This is higher than the standard 42 to 56 days or average of 49 days required for broilers to attain the right market weight for sale. Small-scale commercial broiler producers need to feed their birds with the right quality and quantity of feed to enable the birds gain the right market weight by week eight. This will ensure that feed resources are efficiently utilized to reduce expenditure on feed to make the broiler sector competitive.

The average stock size of broiler agribusinesses sampled in a batch was about 1,051, while the average output produced in a batch was 1,012 broilers. This is an indication of the small size nature of broiler farms in the study area. Increasing the scale of broiler production is necessary to increase output to meet the increasing broiler demand. The result further shows that small-scale broiler producers are producing a little above half of their installed capacity. The average capacity utilization of respondents was 58%, implying 42% less of their installed capacity. This may be due to difficulty of broiler producers' to have access to market to sell their products. Increasing the capacity utilization in broiler production will ensure maximum use of farm structure and other fixed inputs for returns on investment to be maximize. This will help spread cost over wider output to reduce average variable cost of production for the broiler sector to be competitive. The average mortality rate among the respondents was 2.6%, indicating less than 5% mortality rate.

Table 2 shows that the average variable cost of broiler production was GH¢8.48. This is equivalent to US$5.93 at 2010 cedi-dollar exchange rate (footnote of Table 2). Of this cost, feed and one day-old chick costs together constitute GH¢6.12 (US$4.28), representing 72% of total variable cost of production. Feed alone represents about

Table 2. Cost structure in broiler agribusiness production.

Variable	Mean (GH¢)	Percentage (%)
Day-old chick	1.84	21.83
Feed	4.28	50.51
Labour	1.49	17.66
Medication/vaccines	0.33	3.91
Other costs	0.52	6.10
Average variable cost	8.48	96.54
Average fixed cost	0.30	3.46
Average Cost	8.78	100.00

Source: Author's Computation from Survey data, 2010. NB: GH¢1.44 = US$1 at 2010 rate.

51% of the average variable cost while one day-old chick cost represents 22%. This is an indication of the importance of these two inputs in broiler production. Efforts directed at reducing the cost of these imputs will go a long way to reduce production cost for the sector to gain competitive advantage. This result is almost similar to the 79.5% found by Shaikh and Zala (2011) in their study. With the continuous increase in feed prices, small-scale commercial broiler producers need to adopt better feed management practices to ensure efficient use of feed by broilers. This will help reduce expenditure on feed by broiler producers. Besides, feeding broilers with the right quality and quantity of feed starter and finisher will improve the feed conversion ratio (amount of feed consume to gain a kilogram weight) to reduce production cost and promote competitive advantage of the sector.

Labour cost which is divided into hired and imputed labour costs, was the third largest component, representing about 18% of the total variable cost. The mean labour cost per bird was GH¢1.49, equivalent to US$1.03. Of this amount, hired labour cost per bird represents 65.05%, while imputed family labour cost represents the remaining 34.95%. This indicates the importance of hired labour in small-scale commercial broiler production in the study area. This result agrees with Shaikh and Zala (2011) who found labour cost to be the third largest in the total variable cost of small-scale broiler production in their study. Medication and vaccine costs constitute about 3.9% of the total variable cost of broiler production, while other operating costs on water, energy, transport and litter management represents about 6.1%. The mean medication/vaccines and other operating costs per bird were GH¢0.33 (US$0.23) and GH¢0.52 (US$0.36) respectively. Broiler production is prone to diseases and as such, increases in cost of drugs and medication will make it difficult for broiler producers to control mortality in production. There is the need to provide medications and vaccines to broiler producers at competitive price to enable the control of diseases. Moreover, the costs of water and energy should be made affordable to producers to ensure maximum returns on investments. The average fixed cost per broiler, including depreciation of equipment and maintenance represents 3.46% of average cost of production. With the 42% excess capacity, small-scale broiler producers could relatively reduce production cost by about 14.7% (0.42 × 0.35), if they increase capacity utilization to 100% and the number of 1.87 batches to five in a year. This will cause less increase in consumer price of broilers and make the broiler sector competitive.

Factors affecting competitive advantage of broiler agribusinesses

The econometric regression results of the parameters of the factors affecting competitive advantage of broiler producers sampled are presented in Table 3. All the parameter estimates except depreciation value of capital input have the expected signs. The parameter estimates of costs of day-old chick, feed, labour, medicine/vaccines, other cost and broiler market age in the model are positive and highly significant at 1 and 5% level respectively, while capacity utilization is negative and significant at 1% level. This means that these factors are significantly different from zero and are therefore important in explaining competitive advantage in broiler agribusiness production. Though extension service contact was not significant, it met the expected negative sign. The coefficients of the parameter estimates represent percentage change in cost of broiler production when the explanatory variables change by one percent. The diagnostic statistic results show a mean dependent variable of 2.09, with a standard deviation of 0.30 and an F-value of 23.3 which is statistically significant at 1%. The coefficient of determination (R^2) means that about 94% of variability in per unit variable cost was accounted for by the explanatory variables in the model. Indeed, the explanatory factors in the cost function model explain competitive advantage of broiler producers. Thus, the cost function regression model was adequate. According to Gujarati (2004) in determining model adequacy, broad features of results, such as the value of coefficient of determination (R^2) and *F*-value should be looked at.

Table 3. Regression result of factors affecting competitive advantage of respondents.

Variable	Coefficient	Std. error	t-Statistic
Constant	1.152***	0.087	13.281
Output	0.011	0.009	1.262
Day-old chick cost	0.270***	0.019	14.349
Feed cost	0.454***	0.013	34.602
Labour cost	0.137***	0.006	23.035
Medicine/vaccine cost	0.084***	0.011	7.366
Other operating cost	0.060***	0.010	6.198
Depreciation value	-0.001	0.005	-1.162
Extension contacts	-0.003	0.009	-0.368
Market Age	0.058**	0.022	2.564
Capacity utilization	-0.016***	0.005	-3.011
R-squared	0.939	Mean dependent var	2.091
Adjusted R-squared	0.938	S.D. dependent var	0.299
S.E. of regression	0.075	Akaide info criterion	-2.323
Sum squared resid	2.361	Schwarz criterion	-2.219
Log likelihood	513.898	Hannan-Quinn criter	-2.28
F-statistic	649.673***	Durbin-Watson stat	1.911

Source: Author's Computation from Survey Data, 2010. Asterisks indicate significance level for one-tail tests; *** denote 1%, and ** denote 5%.

These diagnostic statistics are both statistically significant in this study. Moreover, the value of the Durbin-Watson statistic of 1.91 is closer to two, indicating that there is no autocorrelation among the explanatory variables in the model. This suggests the reliability of the parameter estimates.

As indicated by Porter (1985), competitive advantage is created when a firm uses its resources and capabilities to achieve a lower cost structure. Based on this, factors that reduce per unit cost of production promote competitive advantage of broiler agribusiness. Thus, a positive parameter estimate indicates that reduction in the explanatory factor will result in reduction in per unit cost, hence promotes competitive advantage. On the other hand, a negative parameter estimate means that an increase in the explanatory factor will result in reduction in per unit cost and hence promotes competitive advantage.

The parameter estimates of all the variable input costs used in the model are positive and statistically significant at 1%, implying that the cost function monotonically increases in variable input prices. A percentage increase in the costs of one day-old chick, feed, labour, medication and other operating cost will significantly increase cost of broiler agribusinesses by 0.27, 0.45, 0.14, 0.08 and 0.06%, respectively. This implies that reducing the cost of all these variable inputs will lead to a significant reduction in the per unit variable cost of broiler agribusiness, hence creating competitive advantage of the broiler sector. It is clear from this results that feed and one day-old chick costs have the highest impact on cost, confirming their significance in broiler production in the study area. All other things being equal, if broiler producers could have access to day-old chick at competitive price and also adopt proper feed management practices, they would be able to reduce production cost significantly to gain competitive advantage and maximize profit. Efforts should be directed at reducing the cost of these two inputs to promote competitive advantage of the broiler sector. This result is consistent with Singh et al. (2010) who found one day-old chick and feed costs to be the two main factors affecting the cost of broiler production in their study. The number of days that broilers are raised to be ready for sale is vital in determining the feed conversion ratio as well as the production cost of a broiler business. The result of the parameter estimate for market age variable in the model was also found to be positive and significant at 5%level. This indicates that the more broiler producers deviate from the standard 42 to 56 days required for birds to be ready for market, the more the cost incurred. This in turn reduces the competitive advantage of the broiler sector. As broilers are kept for longer days to gain the right market weight, the quantity of feed utilized increases. This increases the value of feed conversion ratio. Broiler producers therefore incur extra cost when they keep their birds for extra days beyond the required number of days. There is the need for broiler producers to feed broilers with high quality feed for the right market weight to be gained by week eight. This will improve the feed conversion ratio to reduce production cost and to make the sector gain competitive advantage. This result corroborates Rajendran et al. (2008)

who found market age to affect broiler production cost in their study.

The negative coefficient of extension service contacts and capacity utilization implies that broiler producers who have more extension service contacts and utilizes more of their installed capacity reduce their production cost than those who do not have more extension service contacts and utilize less of their installed capacity. Though extension service contact variable was not significant, the negative coefficient means that if broiler agribusinesses have more extension service contacts their abilities in broiler production is enhanced. This is because they have more access to information on new production techniques. With the technical know-how and information from the extension service contacts, broiler producers are able to adopt modern and better production methods to reduce production cost. This will in turn promote competitive advantage of broiler agribusinesses. Moreover, increasing production capacity utilization of broiler producers will ensure that cost is spread over larger output. This reduces per unit cost of production to promote competitive advantage of the broiler sector. Policies directed at encouraging broiler producers to increase their production capacity to reduce production cost are recommendable. This finding corroborates with Farooq et al. (2010) who found that small-scale broiler producers that optimally utilized their installed capacity have lower cost of production than those who do not utilize their installed capacity optimally.

CONCLUSION AND RECOMMENDATIONS

The results obtained in this study revealed that feed and one day-old chick costs constitute almost three-quarters of the average variable cost of broiler production. This indicates the relative importance of feed and one day-old chick in broiler production. Reduction in the cost of these two inputs will increase profitability of broiler production. The study also discovers that feed cost, one day-old chick cost, labour cost as well as market age of broilers and capacity utilization are the main factors that significantly affect competitive advantage of broiler agribusinesses in Ghana. Reduction in the cost of feed, one day-old chick cost, labour cost and market age at which broilers are ready for sale will promote competitive advantage in broiler production. Similarly, increase in capacity utilization will significantly reduce production cost to promote competitive advantage of the broiler sector. Recommended policy actions should therefore be directed at building the capacity and technical know-how of broiler producers to adopt proper farm management practices to ensure efficient utilization of feed resources. This will reduce expenditure on feed and consequently production cost to ensure competitive advantage of broiler agribusinesses. In addition, measures that aim at encouraging broiler producers to increase capacity utilization of farm structures is recommended as a policy option to reduce production cost and to promote competitive advantage of the sector. Given that market age significantly affects competitive advantage, broiler producers should be encouraged through appropriate policy options to raise their birds for the market by the eight week to reduce expenditure on feed. Producers should also feed birds with high quality feed to enable birds gain the right market weight by the eight week.

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