

*Full Length Research Paper*

# Farm household level impacts of information communication technology (ICT)-based agricultural market information in Ghana

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Accepted 13 March, 2013

This paper assesses the impact of the information communication technology (ICT)-based market information service (MIS) on farm households in the eastern corridor of Northern Ghana. Data was collected from 346 farm households in the eastern corridor of Northern Ghana where an ICT-based market information project was implemented between 2006 and 2009. The sample included 159 participants and 187 non-participants. The logit model was used to identify factors which influence the probability of participation in the ICT market information project, while propensity score matching (PSM) was used to assess the project impact. Results indicate that age and value of assets were negatively related to the likelihood of participation in ICT-based MIS. A unit increase in age reduced likelihood of participation by 0.5%, while a unit increase in value of assets reduces likelihood of participation by 7%. Previous participation in a development project increased likelihood of participation by more than 60%. Participation in the ICT-based project increased expenditure on pesticides, and food security by 11%. More participants (13%) used improved seed than non-participants. It is recommended that younger persons are made the target/focus group for ICT projects and that the private and public sectors collaborate to facilitate wide availability and expanded use of ICT MIS.

**Key words:** Information communication technology (ICT), agricultural market information, smallholders, Ghana.

## INTRODUCTION

Development of the agricultural sector in many African countries hinges on the development of the smallholder systems that have sustained African agriculture to date but continue to face challenges of low productivity and limited access to remunerative markets. Non-competitive value chains and limited information about remunerative markets, and risk aversion of smallholders limit their integration into markets.

Ghana's agricultural growth has been erratic and at

5.2%, it has lagged behind Gross Domestic Product (GDP) growth of 5.9% [Institute of Statistical Social and Economic research (ISSER), 2005 - 2010]. Ghana's development strategies since 2001 have sought to turn the agricultural sector around through modernisation and commercialisation of smallholder agriculture (Republic of Ghana, 2003a, 2006). The Food and Agriculture policy has as one of its key objectives, integration of smallholders into domestic and international markets

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Republic of Ghana, 2007) with improvement in access to market information as a key strategy. The information communication technology (ICT) for Accelerated Development (Republic of Ghana, 2003b) policy also aims among others, to facilitate the modernization of the agricultural sector through the deployment and exploitation of ICTs to improve the sector's efficiency and productivity. Initiatives taken to improve investments in ICT deployment include the privatisation of the telecommunications industry, establishment of a regulatory authority, and investments in infrastructure such as an internet backbone, and masts for mobile phones. Community Information Centres (CICs) have also been provided in several districts to facilitate training in ICT on a wide scale.

The focus on ICT-based methods of information provision is driven by the role they can play in communicating knowledge and information to rural farmers. Access to market information can enhance farmers' access to markets through better negotiation and meeting the demands of the market (Barrett, 2008; Moser et al., 2005), on condition that constraints to access to inputs are addressed. The ICT tools have included modern tools such as the internet, mobile telephony, and interactive video and CD-ROM programs, as well as traditional ICTs of the radio and television (Munyua, 2007).

There has been an increase in the use of ICT applications in rural Ghana in response to the enhanced policy environment, although issues of availability of the ICTs, electricity, literacy, telecommunications and content are still prevalent (Sampong et al., 2007; Alemna and Sam, 2006). An ICT-based agricultural market information service (MIS) was introduced by the private sector [Busy Lab through its TradeNet (now Esoko) platform]. In 2006, the Sustainable Enterprise Development Foundation (SEND Foundation), a non-governmental organisation operating in the north-east of Ghana, adopted the TradeNet market information platform to access market information for smallholder farmers. Specifically, farmers were trained to access and provide market information through text message alerts using cellular phones. Prior to this intervention, SEND Foundation had been promoting agricultural activities and cooperative credit unions with the goal of enhancing food security in the area. The objective of introducing the ICT-based MIS was to link the smallholder farmers to markets and promote their commercialisation process. The project was implemented for 3 years between 2006 and 2009. Initiatives such as this are widespread in several African countries (for example, Kenya Agricultural Commodity Exchange (KACE) and DRUMNET in Kenya; Malawi Agriculture Commodity Exchange (MACE) in Malawi, Market Information Systems and Traders' Organisation in West Africa (MISTOWA) (Tollens, 2006; Munyua, 2007; Okello and Ndiragu, 2009).

However, information on the impacts of the initiatives on smallholders and the markets they operate in is rather

sparse. This paper assesses impact of the ICT-based MIS implemented in north-east of Ghana. Specifically, it identifies factors which influenced participation in the ICT-based market information project, and assesses the impact of the use of the ICT-based MIS on the level of commercialisation and food security, which are the SEND project goals.

## METHODOLOGY

### Methods of analysis

The decision to participate is modelled as a random utility function. The farmer decides to participate if the utility derived from participation exceeds that from not participating. That is,  $U^a > U^b$ , where  $a$  denotes participation and  $b$  denotes non-participation.  $U^a$  and  $U^b$  are modelled as:

$$U^a = x' \beta_a + \varepsilon_a \text{ and } U^b = x' \beta_b + \varepsilon_b$$

Since  $U^a$  and  $U^b$  are latent, it is the probability of the observed decision (participate or do not participate) that are modelled:

Let  $Y^*$  be the binary response variable,  $Y_i^* \in \{0, 1\}$ ,  $i = 1, \dots, n$  farm households and  $P$  is the probability that  $Y_i^*=1$  given  $X_i$ ,

$$\begin{aligned} \text{For } P(Y_i^*=1 | X_i) &= \text{Prob}(U^a > U^b) \\ &= \text{Prob}[x' \beta_a + \varepsilon_a - x' \beta_b - \varepsilon_b > 0 | X_i] \\ &= \text{Prob}[x'(\beta_a - \beta_b) + \varepsilon_a - \varepsilon_b > 0] \\ &= \text{Prob}[x' \beta + \varepsilon > 0] \end{aligned}$$

The above binary choice model is estimated as a logistic model specified as follows:

$$\text{Log} \left( \frac{P}{1-P} \right) = \alpha + \beta_j X_j + \varepsilon \quad (1)$$

Where  $\left( \frac{P}{1-P} \right)$  is the odds of  $Y^* = 1$  given that  $X_j$  and  $\beta_j$  is a vector of regression coefficients.  $\beta_j$  for variable,  $X_j$  is the log-odds and the exponential form of  $\beta_j$  is the multiplicative change in the odds for  $Y^* = 1$  when the  $j^{\text{th}}$  variable increases by one unit, holding all other variables constant (Finger and El Benni, 2011). This model is used to explain farmers' decision to participation in the ICT-based market information system in the context of adoption.

Following the adoption literature, decisions to participate in an innovation programme depend on attributes of the innovation, channels of communicating the innovation and extent of promotion, as well as social systems (Rogers, 2003). In this paper, the explanatory factors are hypothesized to be observable personal characteristics of the farmer or their household which set the social context (for example, education, age and gender), awareness of ICT-based market information project (determined by promotion and communication), capital endowment, and level of output commercialization (indicator of economic empowerment as well as need for the innovation). Membership in a producer organization, and number of crop enterprises are also indicators of capital endowment. Being a member of producer organization is included because it creates opportunity for social interaction which the phone can facilitate. The radio and TV are substitutes for the mobile phone as a means of accessing information but they may also expose potential users, through marketing, to the capabilities of the mobile phone. Previous participation in an agriculture development project is both a measure of social capital and the farmer's appreciation for social interaction. Distance to main market is included to control for the trading environment, which influences need for information and therefore likelihood of participating in the

**Table 1.** Explanatory variables in Logit model participation in ICT-based MIS project.

| Variable                          | Description  | Expected sign of coefficient |
|-----------------------------------|--|------------------------------|
| Age                               | Age of farmer (number of years)  | -                            |
| Gender                            | Gender dummy (1 if farmer is a male and 0 otherwise)   |                              |
| Education                         | Number of years of schooling of farmer   | +                            |
| Participation                     | Participation in ECAMIC project (1 if farmer is a participant and 0 otherwise)                                       |                              |
| Awareness                         | Awareness of the ECAMIC project (1 if farmer is aware and 0 otherwise)   |                              |
| Radio                             | Radio dummy (1 if farmer had a radio and 0 otherwise)  |                              |
| TV                                | Television dummy (1 if farmer had a television and 0 otherwise)  |                              |
| Radio/TV                          | Radio and TV dummy (1 if farmer had a radio and/or TV and 0 otherwise)   | +/-                          |
| Land                              | Size of land cultivated before ECAMIC project inception (acres)  | -                            |
| Member of FBO                     | Dummy for FBO membership (1 if farmer hold any membership a farmer-based organization and 0 otherwise)               |                              |
| Past agricultural program         | Ever participated in an agricultural program in the last 5 years (1 if farmer has ever participated and 0 otherwise) | +                            |
| Needed credit                     | Dummy for need for credit (1 if farmer needed credit for an agricultural activity and 0 otherwise)                   | +                            |
| Enterprises                       | Number of crops produced by the farmer (number)  | +                            |
| Sold-out                          | Proportion of total output sold  |                              |
| Distance to local market          | Distance (in kilometers) to nearest local market (natural logged)  | +                            |
| Distance to nearest phone service | Distance (in kilometers) to nearest mobile phone service (natural logged)  |                              |
| Asset                             | Value of farmer's assets (natural logged)  | +                            |

project to access information. Although owning the cell phone is not a requirement for participation, those who own mobile phones are more likely to participate in the ICT-based market information project; the reverse is true because in both situations the mobile phone is the tool for accessing the information. The explanatory variables for participation in the ICT-based MIS project are summarized in Table 1.

The impact of participation in the ICT-based MIS project is assessed via the method of propensity score matching (PSM), which is used to correct selection bias in the assessment of impact based on a control group of non-participants (Becerril and Abdulai, 2009; Ali and Abdulai, 2010). The aim of matching is to line-up comparison individuals to sufficient observable factors to remove systematic differences in the outcome between treated and non-treated (Blundell and Costa Dias, 2008; Deheja and Wahba, 2002). PSM takes two individuals that are exactly similar in all characteristics except the treatment (in this case, participation in ECAMIC) and computes the difference in the outcome between them.

The outcome variables used in this study are, income from crop sales, the extent of commercialisation, and level of food security. Household commercialisation is measured by the share of crop output sold; this is a partial measure that captures

commercialisation on the output side only. Food security is measured by the number of months the farmers' major staple last through the year and also a dummy variable with 1 if the household calorie intake per person meets the recommended daily allowance.

In this study, the observable characteristics by which participants and non-participants are paired are age, education, value of assets and distance to nearest local market and distance to centres with electricity. Kernel based matching (KBM) of participants and non-participants are used.

#### Data

The data is from a sample survey of 346 households, using a structured questionnaire. The study area was stratified into project and non-project communities. A total of 159 beneficiary and 112 non-beneficiary respondents were selected randomly from beneficiary communities. The remaining 75 households were randomly selected from non-project communities.

Household level data included household characteristics, awareness of existence of ICT-based MIS in the locality, number of ICT-based MIS used, other information sources used, participation in farmer organizations, access to formal and informal financial

**Table 2.** Estimates of logit model explaining participation.

| Variable                  | Coefficient | S.E  | z     | p-value  | Marginal effects (dy/dx) |
|---------------------------|-------------|------|-------|----------|--------------------------|
| Age                       | -0.04       | 0.02 | -2.11 | 0.035**  | -0.005                   |
| Youth                     | 0.51        | 1.34 | 0.38  | 0.704    | 0.057                    |
| Education                 | 0.03        | 0.05 | 0.52  | 0.601    | 0.002                    |
| Household size            | 0.13        | 0.11 | 1.18  | 0.239    | 0.014                    |
| Radio/TV                  | 0.54        | 0.54 | 1.00  | 0.319    | 0.065                    |
| Land                      | 0.10        | 0.35 | 0.31  | 0.755    | 0.012                    |
| Needed credit             | 0.70        | 0.63 | 1.11  | 0.265    | 0.093                    |
| Distance to local market  | -0.64       | 0.31 | -2.11 | 0.035**  | -0.072                   |
| Past agricultural program | 4.01        | 0.57 | 7.00  | 0.000*** | 0.617                    |
| Asset                     | -0.73       | 0.25 | -2.94 | 0.003*** | -0.081                   |
| Constant                  | 3.63        | 1.67 | 2.16  | 0.031    |                          |

Dependent variable = Participation (dummy = 1 if a participant); Number of observation = 213; Pseudo R<sup>2</sup> = 0.43; Log likelihood = -68.43; LR Chi<sup>2</sup>(9) = 104.32; Prob > Chi<sup>2</sup> = 0.0000; S.E = Standard error; M.E = Marginal effects.

services, asset levels, crop and livestock production, participation in input and output markets, the types of markets used, and sources of income.

## RESULTS AND DISCUSSION

### Participation in ICT-based MIS project

The analysis of determinants of participation was conducted on the 187 households in beneficiary communities, who were aware of the project and therefore could choose to participate or not. Participants who were aware of the project were identified as ex-post (after the sampling) through their response to a question in the questionnaire, which asked if the respondent was aware of the project or not. Table 2 presents results of the logit model estimation for the identification of factors that influenced participation in the ICT-based market information intervention. The likelihood of participation decreased by 0.5 and 7%, respectively, for a unit increase in age and distance to a local market. A unit increase in the value of assets decreased the likelihood of participation by 8%. Those who had participated in an agricultural project were 61% more likely to participate in the MIS project. There is therefore a tendency for repeated participation in projects. This suggests a multiplicity of projects targeting same beneficiaries, and likely creation of dependency of some farmers on external interventions.

Contrary to expectations, farmers who accessed distant markets were less likely to participate in the project. Ordinarily one expects these farmers to have need for information; however the conduct of markets in the study area is such that those who sell or buy in distant markets usually have established trading partners (commonly called 'customers') and therefore will have less need for an MIS. Participation in such projects also demands time, and distant traders who are more likely to be frequently

absent from the community are not likely to participate in the projects.

### Impact of participation in ICT-market information project on smallholder farmers

The effect of participation in the ICT-MIS project on smallholder farmers was estimated with the KBM method and the results are presented in Table 3. The clustering of participants and non-participants in the propensity score range of 0.4 and 0.7 (Appendix 1) shows good matching based on the observed characteristics.

Thirteen percent more of participants than non-participants used improved seed and this was significant at 1%. More participants than non-participants also attained higher level of food security indicators of Recommended Daily Allowance (RDA) of caloric intake, for example, at the higher level of indicator based on IFPRI's RDA. Participants also spent more on pesticides but the level of significance was at 10% only. Since the use of pesticides is linked to growing of maize, it suggests that participants were growing more maize than non-participants.

## Conclusions

This paper assessed the factors influencing the likelihood of participation in an ICT-based MIS, and the impact on farm households.

Participants in the ICT-based MIS project tended to be younger than non-participants and slightly more literate. The current study in Northern Ghana shows that participants of the ECAMIC project used more improved seed, spent more on pesticides and attained higher levels of food security. The enhanced access to market information has increased their orientation to produce for the market. Since the analysis explicitly considered the

**Table 3.** Average treatment effect on treated: effect of participation.

| Outcome variable                 | ATT           | Critical level of hidden bias (r) | Number treated | Number control |
|----------------------------------|---------------|-----------------------------------|----------------|----------------|
| Commercialization index          | 0.03(1.02)    | 2.90 - 2.95                       | 159            | 187            |
| Food secure in maize             | 0.05(0.09)    | 3.30 - 3.35                       | 159            | 187            |
| Food secure (100% IFPRI RDA)     | 0.11(2.01)**  | 5.00 - 5.05                       | 159            | 187            |
| Food secure (80% IFPRI RDA)      | 0.09(1.54)    | 3.50 - 3.55                       | 159            | 187            |
| Food secure (100% WFP/UNHCR RDA) | 0.13(2.12)**  | 2.80 - 2.85                       | 159            | 187            |
| Food secure (80% WFP/UNHCR RDA)  | 0.10(1.58)    | 2.20 - 2.25                       | 159            | 187            |
| Crop income                      | 349.89(0.23)  | 3.15 - 3.20                       | 159            | 187            |
| Value of pesticides              | 1.38(1.71)*   | 3.90 - 3.95                       | 159            | 187            |
| Value of fertilizer              | -1.85(-0.18)  | 2.25 - 2.30                       | 159            | 187            |
| Use of improved seed             | 0.13(2.80)*** | 5.65 - 5.70                       | 159            | 187            |
| Store for future sale            | 0.01(0.30)    | 1.00 - 1.05                       | 159            | 187            |

Values in parentheses are t-values. ATT is the average treatment effect for the treated. \*, \*\* and \*\*\* denote significance of t-statistics of mean difference at 10, 5 and 1%, respectively.

causal relationship between participation in ICT-MIS and household adoption of improved farm technology (seed, fertilizer and pesticides), it addressed the counterfactual questions that may be significant in predicting the impacts of policy change.

### Policy implications

The policy implication of the findings is that promotion of high technology such as ICTs for communication with farmers should be targeted to youth in agriculture because they are already familiar with the communication tools and require little additional training for their use. Such programmes or interventions should be supported with complementary services such as financial services, because project participants tend to have multiple needs. In addition, access to production inputs should be improved because the use of such inputs is the route to commercialization and the ultimate realization of the benefits of enhanced market information.

There is a latent potential for ICTs, especially the mobile phone to facilitate transactions of rural farm households, which can be realized through positive partnership between the private and the public sectors; the latter has the responsibility to identify the needs of rural farm households that can be addressed most effectively by modern ICTs, while the former's role is to innovate to deliver the services cost effectively. Policies that improve farm level adoption of improved technology and facilities, and road surface conditions and networks will be needed to ensure that the farmers can produce more (through higher use of inputs and yields) and increase sales in more lucrative markets.

### ACKNOWLEDGEMENT

Authors acknowledge the funding support provided by the

International Development Research Centre (IDRC) to conduct the research project on the Role of ICTs in Linking Farmers to Markets in Africa. We also extend appreciation to all team members of the eARN project especially Dr Julius Okello and members of the advisory council for their counsel and support in various ways.

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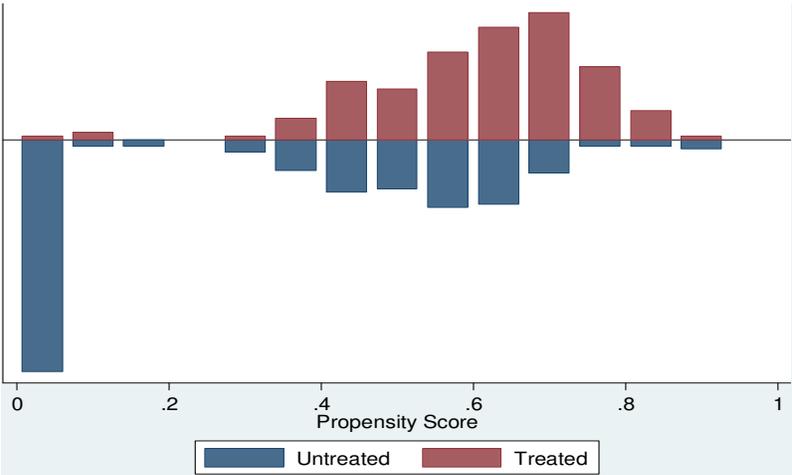
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APPENDIX



Appendix 1. Distribution of propensity scores.