

*Full Length Research Paper*

# Farmer Field Fora and adoption of yam integrated pest and disease management technologies in Northern Ghana

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**Justification for the use of public funds on programmes and the determination of their effectiveness among other factors call for their evaluation. This study was therefore conducted to investigate the effectiveness of Farmer Field Fora (FFF) and adoption of yam Integrated Pest and Disease Management (IPDM) Technologies in the Nanumba North and Kpandai Districts of the Northern region of Ghana. A multi-stage sampling technique was carried out to select 240 participants and non-participants from the study area. Primary data collection was done in 2012 through individual questionnaire administration and focus group discussions. Data were analyzed using descriptive statistics, regression analysis and budgetary techniques. From the findings, the farmers' perceptions of the effectiveness of the FFF were favorable and the FFF led to a close in knowledge gap and the adoption of IPDM technologies. Factors that positively affected adoption were training such as the FFF, farm size, and research contacts. Variables that had negative effects on adoption were age and house hold size. Also, while the benefit cost ratio for project participants was 2.5 that of non-participants in project community and non-participants outside project community were 1.9 and 2.1 respectively. FFF is therefore an appropriate mechanism to transfer IPDM technologies and the process could be adopted for extension activities. However, for a rapid adoption of the technologies, farmers should be supported with credit and more contacts with researchers. Also, younger farmers and large-scale farmers should be targeted for extra support without neglecting older farmers and small-scale farmers.**

**Key words:** Farmer Field Fora, benefit cost ratio, integrated pest and disease management, participation, technology adoption, yam.

## INTRODUCTION

A pre-requisite for the adoption of agricultural technologies is the acquisition of knowledge in the form of awareness, skills and principles (Rogers, 2003). The

willingness of farmers to adopt new technologies will, among other factors, include an effective mechanism through which technologies are made available to the

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end users. In Ghana, various approaches of agricultural extension have been used in this regard (MoFA, 2011). They range from the top-down transmission of information approaches such as the Training and Visit (T&V) to the more recent participatory approaches such as the Farmer Field School (FFS) and Farmer Field Fora (FFF) in addition to innovative ICT based approaches which provide advice to farmers on-line and other approaches such as the promotion of mobile phones and community radio stations. The strengths and weaknesses of the various extension approaches that have been adopted in Ghana have been discussed in MoFA (2011).

The Ghana government and International Fund for Agricultural Development (IFAD)-financed programme aimed at developing the Root and Tuber sub sector from 1999 to 2005 implemented the Root and Tuber Improvement Programme (RTIP), which focused essentially on developing crop production through research and extension (RTIMP, 2010). Due to challenges in the implementation of RTIP, the Root and Tuber Marketing Programme (RTIMP) is being implemented to address them. The programme became effective on the 8<sup>th</sup> November, 2006 and will end in December 2014. The goal of the RTIMP is to enhance income and food security in order to improve livelihood of the rural poor.

The FFF is under component B, namely, Support to Root and Tuber Production. The main objective of Component B is to enhance the productivity of root and tuber production by facilitating access to new, relevant and adoptable technologies. The thematic area of concern for this study is Integrated Pest and Disease Management (IPDM) which was arrived at through a Participatory Rural Appraisal (PRA) undertaken in the participating project communities. The FFF is a participatory approach to train farmers in relevant yam technologies. It is field based, season long, and based on the principle of learning by doing. The fields are essentially made of a Farmers' Practice (FP) plot where farmers implement what they do in real life and a Participatory Action Research (PAR), where farmers together with researchers and extensionists implement proven technologies. In the course of the training and finally at the end, farmers compare the two plots and make their own informed decisions. Interspersed with these field activities are special topics to boost participants' knowledge of the technologies taught.

The main technologies taught in this study were chemical pest control and botanical pest control using neem. To enhance the use of these pesticides, scouting for pests and safe use of pesticides were included. Participants were also taught how to space the yam mounds for optimum plant population. This training was therefore carried out to enhance farmers' skills with respect to the adoption of these technologies so as to increase their food and cash security.

However, since its inception no evaluation has been done, at least to the best of our knowledge, to find out

whether these technologies have been adopted. The aim of this study therefore was to evaluate the effectiveness of the FFF and the adoption of IPDM technologies as a means to increasing the output and incomes of farmers. The specific objectives were as follows:

- (i) Investigate farmers' perceptions about the effectiveness of FFF;
- (ii) Assess the knowledge change of the respondents (with respect to the IPDM technologies) as a result of the FFF;
- (iii) Investigate farmers' perceptions about the IPDM technologies;
- (iv) Measure the effects of FFF participation on adoption;
- (v) Determine the effects of FFF on the viability of IPDM adoption.

## MATERIALS AND METHODS

### Literature review-Theoretical framework

#### Technology adoption

According to Rogers (2003), adoption is a stage in the innovation decision process when an individual decides to use an innovation or reject it while diffusion means the spread of the innovation through certain channels among a community or social system.

Diffusion of Innovation Theories (Rogers, 2003) and Knowles' Adult Learning Theory of Andragogy (Knowles et al., 2011) explain how new ideas and technologies are spread and adopted in a social system over time. The theory of Individual Innovativeness states that in most social systems there are innovators, early adopters, early majority adopters, late majority adopters and laggards. These categories have certain socio-economic characteristics such as age, marital status, educational level, income, farm size, and years of experience, among others, which affect adoption. The Theory of Perceived Attributes also focuses on how programme participants view the characteristics of the practice under investigation. These have been typically categorized as those that relate to the complexity, compatibility, trialability, relative advantage, and observability of a practice or technology. They provide explanations as to why an innovation is accepted or rejected. The innovation decision process theory has five stages as follows: (1) Knowledge stage, where the individual is exposed to the innovation's existence and gains an understanding of how it functions; (2) Persuasion stage, where the individual forms a favorable or unfavorable attitude towards the innovation; (3) Decision stage, where the individual engages in activities that lead to a choice to adopt or reject the innovation; (4) Implementation stage, where the individual puts the innovation into use; and (5) Confirmation stage, where the individual seeks reinforcement for an innovation-decision already made but may reverse the decision if he/she is exposed to conflicting messages about the innovation.

Communication channels such as educational programme type and its characteristics are based on the principles and process of andragogy or how adults learn as is the case of the FFF.

#### Evaluation of agricultural training programmes

Evaluations of agricultural training have normally been on knowledge gained and adoption of practices (Erbaugh et al., 2010; Hubbard and Sandman, 2007; Amujal et al., 2005). The inclusion of the evaluation of the educational processes gives it a holistic approach since it is important to understand the absolute and

relative importance of the information presented and the programme experience. Effective implementation evaluation requires extension educators to clearly understand programme objectives and processes of implementation. This knowledge will empower educators to be able to better understand their current programme offerings, improve future services, and ultimately serve their target audiences better (Duerden and Witt, 2012; Hubbard and Sandman, 2007).

Effectiveness, according to Rogers (2003), is the degree to which an intervention programme fulfills its goals and objectives. The goal of an educational programme is a change in knowledge and behaviour (Hubbard and Sandman, 2007). Its scope of evaluation is the extent of adoption of disseminated technologies and determinants of adoption for a policy design and effective management of educational or extension programmes (Musaba, 2010). Equally important are the contents and conduct of training, participants' perceptions of procedures, techniques, materials, and products used, participants' background, the extent of instructors' credibility and effectiveness in identifying and addressing their needs (Strong et al., 2010; Rezvanfar et al., 2009; Coley and Scheinberg, 2000). Other qualities of a training programme are summarized in Tesfaye et al. (2009) and Wise and Ezell (2003).

### Agricultural programme participation

Participation is a concept that has been gaining increasing recognition and prestige in the development discourse and its practices, requiring a shift in the way individuals are considered, from passive recipients to active agents of development efforts (Mefalopoulos, 2008). Empirical studies on the effect of participation in training on project participants in the area of knowledge gained and adoption of agricultural technologies are presented in Erbaugh et al. (2010), Musaba (2010), Amujal et al. (2005), Nsabimana and Masabo (2005) and Mauceri (2004).

### Study area

The survey was carried out in the Nanumba North and Kpandai Districts in the Northern Region of Northern Ghana in 2012. These districts were purposively chosen for the study because they are important yam production areas and also the Savanna Research Institute (SARI) carried out FFF training in yam Integrated Pest and Disease Management (IPDM) in the area. The target groups were participants of the FFF in project communities, and a control group of non-participants within and outside the project communities. The project communities were Ganguyille and Taali in the Nanumba North District and Nbowura and Onyumbo in the Kpandai District. The non-project communities were Zibaga and Kpalsogu in the Nanumba North District, Balai and Katijeli Damanko in the Kpandai District. Stratified sampling was used to select 20 project participants (PP) from each project community, 20 non-participants in the project community (NPIPC) and 20 non-participants outside the project community (NPOPC). The individual farmers were then selected randomly by a list provided by the trainers. This brought the sample size to 240 consisting of 80 PP, 80 NPIPC and 80 NPOPC. Note however, that in the estimation of the adoption model the sample sizes were 80, 40 and 40 respectively. This was to ensure that the estimated results were not biased. Maddala (1983) argued that for unbiased estimation results, the number of adopters should be equal to or at least proportional to the number of non-adopters.

### Data collection

Data collection was done through individual questionnaire

administration and focus group discussion. Secondary data from project documents were sourced to know more about the project and the technologies that were extended to the farmers. Likert type scales were used in collecting data on farmers' perceptions of FFF processes, IPDM technology attributes and knowledge levels of both participants and non-participants before and after the training. Nominal scales were also used to collect some dichotomous demographic variables such as marital status and gender; adoption or non-adoption of yam technologies; source of knowledge of technology; and reasons for non-adoption, while numerical data were collected on the other demographic variables as well as input, output and income variables. To determine the reliability of the instruments a pilot survey was done with a group of people similar to those in the study communities.

### Data analyses

Data were analyzed using descriptive statistics, regression analysis and budgetary techniques. Specifically, the Chi square was used to test the statistical significance of the differences with respect to the effectiveness of the FFF as well as the knowledge and adoption levels of both participants and non-participants of the FFF before and after the training. Also, a Poisson regression model was estimated to determine the factors that influenced the adoption of IPDM technologies. Lastly, partial budget analysis was done to determine the differences between the Benefit cost ratios of participants and non-participants of the FFF.

### The Poisson regression model

According to Greene (1997), the Poisson regression is represented by the basic equation:

$$\Pr(Y = y) = \frac{e^{-\lambda} \lambda^y}{y!}, \quad y = 0, 1, 2, \dots \dots \dots \quad (1)$$

The parameter  $\lambda$  is assumed to be log-linearly related to regressors  $X_i$ . Therefore,

$$\ln(\lambda) = \beta' X_i \quad (2)$$

The log-likelihood function is given by the equation:

$$\ln L = \sum_{i=1,2,\dots,n} [-\lambda_i + y_i \beta' X_i - \ln y_i!] \quad (3)$$

The expected number of IPDM technologies per farm is given by the equation:

$$E[y_i | X_i] = \text{Var}[y_i | X_i] = \exp(X_i \beta' + \mu_i) \quad (4)$$

where,  $\beta$  is a  $1 \times k$  vector of parameters;  $x$  is a  $k \times 1$  vector.

According to Octavio and Shultz (2000), the equation can also be expressed as:

$$\begin{aligned} E[Y_i] &= \exp(\beta_1 X_{i1}) \exp(\beta_2 X_{i2}) \dots \dots \dots \exp(\beta_k X_{ik}) \\ &= \exp(\beta_j X_{jn}) C_i \quad (i = 1, 2, \dots \dots \dots n) \end{aligned} \quad (5)$$

where,  $j$  can take any value from 1 to  $k$  and identifies a specific explanatory variable and  $C_i$  is a constant representing the product of the remaining exponential terms in Equation (5). For

dichotomous explanatory variables, if  $x_{ji} = 0$ ,  $E(Y_i) = C_i$ , and when

$$x_{ji} = 1, E(Y_i) = \beta_j C_i. \quad (6)$$

Therefore,  $100 \times (\exp^{\beta_j} - 1)$  calculates the percentage change on  $E(Y)$  when  $x_j$  goes from zero to one, for all  $i$  observations. In general, for independent variables that take several integer values, the percentage change in the expected level of adoption when  $x_j$  goes from  $x_{j1}$  to  $x_{j2}$  can be calculated as:

$$100 \times \frac{\exp^{\beta_j x_{j2}} - \exp^{\beta_j x_{j1}}}{\exp^{\beta_j x_{j1}}} \quad (7)$$

### The empirical model

The empirical model estimated to determine the factors influencing the adoption of yam IPDM technologies in northern Ghana is as follows:

$$\text{Adoption} = \beta_0 + \beta_1 \text{Age} + \beta_2 \text{Experience} + \beta_3 \text{HHsize} + \beta_4 \text{Farmsize} + \beta_5 \text{Training} + \beta_6 \text{Research} \\ + \beta_7 \text{Office Dist} + \beta_8 \text{Market Dist} + u_i$$

The *a priori* expectations are that experience, household size, training and research contacts have positive influence, while age, office and market distances, have a negative influence on adoption. Farm size, however, is inconclusive (i.e. it may be either positive or negative).

### The Benefit/Cost ratio

The Benefit/Cost (B/C) ratio is given by:

$$\text{B/C ratio} = \frac{\sum_{t=1}^n \frac{B_t}{(1+r)^t}}{\sum_{t=1}^n \frac{C_t}{(1+r)^t}} \quad (8)$$

Where  $B_t$  is benefits in each year,  $C_t$  is costs in each year,  $n$  is number of years and  $t = 1, 2, 3, \dots, n$ , and  $r$ , the discount rate.

However this study used cross sectional data since data were collected in one year implying  $n = 1$  (that is, the  $B_t$  and  $C_t$  components could not be discounted). The formula therefore assumes:

$$\text{B/C ratio} = \frac{B_t}{C_t} \quad (9)$$

A benefit cost ratio of one means benefits just offset costs while any B/C ratio more than one indicates the business is profitable.

## RESULTS AND DISCUSSION

### Socioeconomic characteristics of respondents

Almost all the respondents were males (94%), with only 6% being women. The highest percentage of women farmers was recorded by PP (19%), followed by NPOPC (14%) and NPPIPC (1%). In terms of age, the highest percentage of the respondents were within the 21-40 age

group (58.3%) followed by the 41-60 age bracket (30.4%). While only 7.5% were under 21 years, the remaining 3.7% were over 61 years. The age distribution of the PP was not different from the others. Also, as high as 42.1% of the respondents had no formal education while 24.2% had non-formal education. This means that only 33.8% had formal education, out of which 16.3%, 15.0% and 2.5% had primary, secondary and tertiary education respectively. Among the groupings, NPPIPC recorded the highest percentage of respondents who had formal education (42.6%), followed by NPOPC (33.8%) and PP (23.8%). The mean household size was 9 ranging from 8 and 10, while the mean farm size was 5 acres. The percentages of respondents who said they had contacts with extension and research staff during the farming season under review were 66 and 45 respectively. Most of them were project participants. Only 2% of respondents indicated they had credit access, and finally 77% of respondents were involved in off-farm activities such as trading, teaching, bee keeping, drug peddling and food processing.

### Farmers' perceptions of the FFF process

Project participants were asked to state the extent to which they agreed or disagreed that the preparatory, implementation stages and other characteristics of the FFF were participatory and contributed to the success of the training. From Table 1, 92.6% of them held a very high positive and favourable perception of the effectiveness of the FFF. However, while 6.4% disagreed with the notion, 2.6% were undecided. In terms of the specific characteristics, the highest commendation was for the training needs assessment (98%), the venue for the training (98%) and the training staff (98%). The lowest commendation (80%), however, was for the timing and duration of the training; the respondents felt that the training should have come far earlier before the farming season and also it should have covered a longer period for a better understanding and application of the knowledge gained. In general, the farmers' perceptions of the effectiveness of the FFF were favorable and therefore the FFF and its procedures could be adopted as an appropriate mechanism to transfer IPDM technologies. This process, if adopted in the country's agricultural extension programmes, could lead to adoption of technologies. The findings of this present study are in sync with that of Knowles et al. (2011), Tesfaye et al. (2009), and Wise and Ezell (2003) who found that these variables are key to the success of non-formal adult education programmes like the FFF.

### Knowledge change of respondents as a result of FFF

The effectiveness of the FFF had led to a positive knowledge change among 75.7% of the respondents with

**Table 1.** Respondents' Perception of the Effectiveness of FFF.

Characteristic	S.D/D		U		A/S.A		Chi square value
	F	%	F	%	F	%	
Training needs assessment	1	1.3	1	1.3	78	98.0	83.3***
Participants selection criteria	3	3.8	1	1.3	76	95.0	73.0***
Content of training	2	3.0	1	1.3	77	96.0	74.1***
Relevance of training	2	3.0	1	1.3	77	96.3	69.7***
Timing of the training	16	20.0	0	0	64	80.0	36.1***
Duration of training	13	18.0	2	22.0	64	80.0	74.4***
Methodology of training	2	3.0	1	1.3	77	96.0	79.5***
Place of training	1	1.3	1	1.3	78	98.0	72.2***
Competence of training staff	1	1.3	1	1.3	78	98.0	77.1***
Participation during the training	3	3.8	1	1.3	76	95.0	67.4***
Sharing of experience	2	3.0	1	1.3	76	95.0	108.9***
Indigenous knowledge use	12	15.0	0	0	68	85.0	14.8***
Solution to problems	4	5.0	1	1.3	75	94.0	67.1***
Learning guide development	6	8.0	1	1.3	73	91.3	82.3***
<b>Mean</b>	<b>4.9</b>	<b>6.39</b>	<b>0.93</b>	<b>2.59</b>	<b>74.07</b>	<b>92.68</b>	

S.D, Strongly Disagree; D, Disagree; U, Undecided; A, Agree; S.A, Strongly Agree; F=Frequency; %=Percentage. Source: Field Survey, 2012.

**Table 2.** Knowledge change of respondents as a result of FFF.

Technique	PP (%)	NPIPC (%)	NPOPC (%)	Pooled (%)
Appropriate mounding	100	71.3	33.8	68.4
Insecticide application	100	81.3	61.3	80.9
Fungicide application	98.8	73.8	48.8	73.8
Weed management	100	91.3	87.5	92.9
Neem application	96.3	71.3	42.5	70.0
Scouting	96.3	52.5	42.5	63.8
Safe pesticide use	98.8	87.5	61.3	82.5
Pooled	98.6	75.6	53.0	-

PP, Project Participants; NPIPC, Non Participants in Project Community; NPOPC, Non Participants Outside Project Community. Source: Field Survey, 2012.

respect to the IPDM technologies. From Table 2, PP recorded the highest percentage of respondents who indicated there had been an increase in the knowledge gained with respect to the technologies (98.6%), followed by NPIPC (75.6%) and NPOPC (53.0%). The findings make sense, as the diffusion rate of a technology is likely to be higher in a project community than non-project communities. Across the technologies, the highest percentage of respondents indicated a change in their knowledge gap with respect to weed management (92.6) followed by safe pesticide use (82.5) and insecticide application (80.9). It should be noted that these techniques were relatively new to the respondents. The FFF therefore served as an eye-opener to them, hence the acknowledgement from a high percentage of them.

These findings also support that of Erbaugh et al. (2010) in their study of cowpea.

### Knowledge sources of IPDM technologies

The study however, found that SARI was the only source of the respondents' knowledge with respect to the IPDM technologies; while the participants gained the knowledge directly from SARI, the non-participants had their knowledge from their fellow farmers. This finding is consistent with Rogers' (2003) observation that an innovation will normally come from an external source, and then diffuse with time in other communities through the farmers themselves or other means. It needs to be

mentioned, however, that about a quarter of the project participants were not trained in neem application. Also, 20% of the farmers who were not originally part of the participating group had the opportunity to be trained in fungicide application. According to the project officers, a leeway was given to farmers who were not originally participants in some of the project communities to join if they so wished. Generally, the results indicate a diffusion of the technology within and outside the community in line with Rogers's (2003) concept of homophily and also knowledge being a prerequisite of the innovation decision process. The findings lend support to that of Mirani (2013) and Asiabaka and Owens (2002), who revealed that neighbouring farmers were a good source of agricultural information.

### **Perceptions of IPDM technology attributes**

When asked to what extent they agreed or disagreed with the attributes of the technologies, the participants had favourable responses. Apart from 45% who thought that the technologies were complex, more than 80% of the respondents respectively indicated that the technologies were trialable, observable, compatible with their practices and also had relative advantage (that is, were viable because the benefits far outweighed the costs). This finding is also in sync with that of Maina et al. (2008) and Asiabaka and Owens (2002).

### **Adoption levels of IPDM technologies**

The favourable perceptions of the technologies had led to their adoption by 64.1% of the respondents, especially among the project participants. Across the various groups, the percentages of respondents who had adopted the technologies as at the time of data collection were PP (76.6), NPPIP (38.8) and NPOPC (28.8). Across the technologies, the adoption of weed management was highest (85.4%). This is an indication of the economic importance of weeds in yam production. However, the adoption levels were relatively low for fungicide application (25%) and neem (28%). According to project participants, they did not use fungicide because it was not available. For neem, some of the project participants said they were not taught. Non project participants did not use neem and fungicides because they had no knowledge of them. The differences in the adoption levels were also significant at the 1% level except that of weed management which was significant at the 5% level. The significant differences in the levels of adoption could be attributed to the effect of participation in the FFF. This finding supports investigations by Erbaugh et al. (2010) who in a study to assess the impact of cowpea Farmer Field School (FFS), found that participation in training was effective in adoption of IPM

strategies. Similar findings were reported by Musaba (2010) and Nsabimana and Masabo (2005).

### **Reasons for non-adoption**

When asked why they did not adopt some technologies, a small proportion of project participants said the pesticides were unavailable, expensive and that they were not knowledgeable of their use. About a quarter of them did not use neem because they did not know how to use them. The results lend support to that of Asante et al. (2011), who stated that farmers did not adopt yam technologies because they were expensive. Sani and Bagna (2012), showed that high cost and unavailability of improved seeds and fertilizer constituted the major constraints to improve seeds utilization. Most of the non-participants did not adopt because they had no knowledge of the technologies. This shows that knowledge is a prerequisite to adoption of technologies (Rogers, 2003). Empirical findings similar to this are by Drost et al. (1996) and Ahmad et al. (2007).

### **Definition of variables and the determinants of IPDM technologies**

The second objective of the study was to determine the factors influencing the adoption of IPDM technologies. In this section, we discuss the extent to which demographic, farm-specific and institutional variables influenced the adoption of the technologies. We also compare the Benefit/cost ratio of PP with the non-participating groups. The section however, begins with the definition and descriptive statistics of variables used for the adoption model.

### **Definition of variables used in the adoption model**

Table 3 shows the definition of variables used in the estimation of the adoption model and their expected signs. Foltz (2003) and Feder et al. (1985), have discussed at length the extent to which household characteristics as well as farm-specific and institutional factors influence the adoption of agricultural technologies.

### **Descriptive statistics of the variables used in the Poisson model**

As indicated already, the total number of IPDM technologies in which the farmers were trained was 7, namely appropriate mounding, insecticide application, fungicide application, weed management, neem application, and scouting and safe pesticide use. The average number of technologies adopted was 3.4 (Table

**Table 3.** Definition of variables.

Variable	Definition	Expected sign
Age	Age of the farmer in years	+/-
Education	Dummy; 1 if farmer had formal education; 0 if otherwise	+
Household size	No. of people in farmer's house eating in the same bowl	+
Farm size	Size of farmer's yam plot in acres	+
Credit	Dummy; 1 if farmer had access to credit during farm season in question; 0 if otherwise	+
Extension	Dummy; 1 if farmer had access to extension service during farm season in question formal education; 0 if otherwise	+
Research	Dummy; 1 if farmer had made contacts with a researcher during farm season in question; 0 if otherwise	+
FFF Distance	Distance form yam farm to FFF center in kilometers	-
Market Distance	Distance form yam farm to market/input store in kilometers	-
Participation	Dummy; 1 if farmer participated in FFF; 0 if otherwise	+

**Table 4.** Descriptive statistics of variables.

Variable	Mean	Standard deviation	Minimum	Maximum
Adoption	3.36250	2.24397	.000000	7.00000
Age	37.0958	12.9874	15.0000	85.0000
Household size	8.97500	6.43274	1.00000	45.0000
Research	.454167	.498935	.000000	1.00000
Experience	17.4083	12.7227	2.00000	70.0000
Farms size	4.56042	3.38800	1.00000	30.0000
Office Distance	7.88750	4.01455	1.60000	19.3000
Market Distance	4.59375	2.47469	.100000	12.0000

Source: Field Survey, 2012.

4). Also, the mean age of the farmers was 37, which shows that the farmers in the study area are young adults. Yet on average, they had been farming yam for 17 years. However, the average size of their farms was small (4.5), which is slightly below the national average of 5 acres. The percentages of farmers who received training and also contacts with research officers such as the FFF officials from SARI were 41 and 45 respectively. Lastly the average distances from farmers plot to the FFF center as well as to the major market center were 7.9 and 4.6 km respectively.

### The determinants of IPDM technology adoption

In Table 5, the estimation results of the Poisson model are presented. We observe that the p-value of the chi square is zero. This means that the probability of all the coefficients, except the constant, is equal to zero and all the variables jointly determine technology adoption.

Age and Household size had significant and negative effects on adoption of IPDM technologies. On the other

hand, farm size, training and research contacts had positive and significant effects on the probability of adoption. Farmers' experience and the distance variables were however not significant.

The negative and significant coefficient of age implies that younger farmers had a greater probability of adoption than their older counterparts. Younger farmers have been found to be more innovative and willing to bear risk, as opposed to older farmers (Asiabaka and Owens, 2002). However, Asante et al. (2012), Wiredu et al. (2011), and Maiangwa et al. (2007) found a positive relationship between age and adoption. It is important that projects like the IPDM while targeting both older and young farmers, give priority to younger farmers because of their flexibility and willingness to try new things.

The probability of adoption was also negatively influenced by household size. This has been linked to increased consumption pressure associated with larger families. The argument is that larger households often have a lot of mouths to feed, to the extent that they do not have enough money to invest in technology adoption, as opposed to smaller families. In addition, farmers with



**Table 5.** Maximum likelihood estimation results of the poisson model.

Variable	Marginal effects	Standard error	t-ratio	P-value	Mean of x
Constant	3.240	0.735	4.404	0.000	
Age	-0.029	0.018	-1.663	0.096	37.096
Experience	-0.003	0.018	-0.167	0.867	17.408
Household size	-0.043	0.026	-1.674	0.094	8.975
Farm size	0.057	0.034	1.672	0.095	4.560
Training	2.467	0.441	5.594	0.000	0.413
Research	0.706	0.319	2.214	0.027	0.454
Office Distance	0.059	0.043	1.369	0.171	7.887
Market Distance	-0.011	0.068	-0.164	0.870	4.594
Chi Squared	165.471	-	-	0.000	-
Degree of Freedom	8	-	-	-	-

Source: Field Survey, 2012.

relatively large family sizes attach greater importance to other non-farm activities than farm activities such as the adoption of IPDM technologies (Maiangwa et al., 2007; Amaza et al., 2008). On the contrary, Baffoe et al. (2013), found a positive association between household size and adoption, arguing that larger families have greater labour force to be able to engage in the adoption of technologies. In general, from a policy point of view, smaller households should be targeted in promoting IPDM technologies while constraints of larger households are attended to with the view of increasing the probability of adoption.

The findings with respect to farm size in this present study also lend support to that of previous studies (Akudugu et al., 2012; Asante et al., 2012; Ayoade, 2012; Katengeza et al., 2012; Feder et al., 1985). The argument is that, normally farming households with bigger landholdings are supposed to have an enhanced ability to afford improved technologies and a greater capacity to cope with the loss, if the technology fails. These large-scale farmers would rather prefer carrying out recommended farming practices than risk ignoring them and incurring huge financial losses. Also, large scale farmers are often eager to try out new recommended practices in order to improve their yield and productivity. In addition, farmers with larger farm sizes are able to access support in terms of inputs, marketing and pricing much better than their counterparts with smaller farm sizes hence will be more willing to adopt a new technology so long as it will positively affect their farming activities. From the policy point of view, any promotional efforts aimed at boosting the use of IPDM technologies could target farmers with large farms. In addition, any policy which will educate, encourage and support small-scale farmers to expand their farms should be carried out so that their adoption may also be enhanced.

Similarly, the results indicate that farmers who interact with researchers and research organisations are more likely to adopt these technologies as compared to their

counterparts who do not get the opportunity. It implies that farm activities involving research such as the FFF, on farm research and demonstrations should be encouraged.

Finally, participation in training such as the FFF had a positive significant relationship with the probability of adoption of IPDM technologies. The FFF serves as a platform for knowledge as well as technology transfer. The platform is interactive and provides the opportunity for feedback and further clarification of technological packages associated with farming. Participation on the platform increased farmers' probability of IPDM technology adoption in the study area. This finding corroborates that of Erbaugh et al. (2010) in a study to assess the impact of cowpea Farmer Field School (FFS) on IPM technology adoption in Uganda. Similar results were found by Mauceri (2004), Musaba (2010), Nsabimana and Masabo (2005) and Amujal et al., (2005). Furthermore, our *a priori* expectations were that distances from the farmers plot to the FFF office as well as to the market would be negatively correlated with the probability of adoption. However, as indicated earlier the two variables were all not significant, compared with the findings of Bonger (2001). Farmers' experience was also not significant contrary to our *a priori* expectations that the longer the years of yam farming, the greater the probability of IPDM adoption.

### The benefit cost ratio

A Partial Budget Analysis (PBA) was carried out to find out the viability of yam production for the various farmer groups. From Table 6, we observe that even though the total variable cost for PP was higher than the non-participants, the average yield, and for that matter the revenue for the former, also far outweighed that of the latter. This translated into, again, a higher gross benefit than that of the non-participants. In general, the high total



**Table 6.** Results of partial budget analysis/acre.

ITEM	PP GH¢	NPPIPC GH¢	NPPOPC GH¢
Land preparation	30.50	32.50	32.00
Cost of setts	235.62	192.25	233.50
Cost of pesticides	14.90	10.42	8.33
Cost of stakes	54.74	51.94	52.87
Labour cost	253.49	283.78	272.96
Transportation	275.60	213.51	224.63
Total variable costs	864.86	784.39	824.29
Average yield( <i>gmani</i> )	10.10	7.47	7.76
Price / <i>gmani</i>	87.28	82.96	91.89
Revenue/gross income	2159.76	1519.29	1747.53
Gross benefits	1294.91	734.90	923.28
Benefit cost ratio	2.50	1.94	2.12

PP, Project Participants; NPPIPC, Non Project Participants in Project Community; NPPOPC, Non Project Participants Outside Project Community. Source: Field Survey, 2012.

variable cost came from the costs of more yam setts, pesticides, stakes and transportation. However, labour cost and other land preparation costs were lowest, perhaps as a result of the benefits from mutual assistance from the group to which project participants belonged. The net effect was that the benefit cost ratio for project participants was 2.5 while that of non-participants in and outside project communities were 1.9 and 2.1 respectively. Thus, the return to investment was higher for project participants than the non-participants. This finding lends support to similar studies that found a profitable net change of income in activities of participants of training as compared with their untrained counterparts (NORC, 2012; Davis et al., 2010; and Alam et al., 2008). This means that with time if the technologies are well-diffused yields returns for non-participants would also increase. However, it may be necessary for SARI to organize training for these non-participating communities for rapid results.

## Conclusions

From the findings, the farmers' perceptions of the effectiveness of the FFF are favourable. That is to say, the procedures used in the training met their expectations and led to the overall success of the training. The FFF achieved its outcomes by increasing the knowledge levels and the adoption by both participants and non-participants. While the FFF was the main information source of the FFF participants, the FFF participants were the main source of knowledge of IPDM technologies of the non-participants. This was an indication that the FFF was a conduit for diffusion of the technologies. Also, the adoption of IPDM technologies led to increased returns to farmers. Since the FFF served as an effective platform for knowledge creation, sharing and acquisition,

dissemination, and adoption of technologies leading to higher returns, it may be adopted as an appropriate mechanism for sharing of knowledge in yam IPDM practices and other extension programmes.

## FUTURE STUDIES

This study mainly looked at the effectiveness of the FFF educational process and factors likely to affect the probability of adoption of the technologies. It would be necessary to look at the cost effectiveness of the FFF, from the point of view of the organizers.

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## ABBREVIATION

**B/C**, Benefit cost ratio; **FFF**, Farmer Field Fora; **FFS**, Farmer Field School; **FP**, farmers' practice; **ICT**, Information and Communication Technology; **IFAD**, International Fund for Agricultural Development; **IFPRI**, International Food Policy Research Institute; **IPDM**, Integrated Pest and Disease Management; **MoFA**, Ministry of Food and Agriculture; **NPIPC**, non-participants in the project community; **NPOPC**, non-participants outside the project community; **PAR**, Participatory Action Research; **PBA**, Partial Budget Analysis; **PP**, project participants; **PRA**, Participatory Rural Appraisal; **RTIMP**, Root and Tuber Marketing Programme; **RTIP**, Root and Tuber Improvement Programme; **SARI**, Savanna Agricultural Research Institute; **T&V**, Training and Visit.

## Conflict of Interests

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

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