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Full Length Research Paper

Factors affecting proportions of land allocated to the mini-sett technology by yam producers in Northern Ghana

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The study investigated factors affecting proportions of land allocated to the yam mini-sett technology among 120 randomly selected farmers in Northern Ghana. About 41% of the farmers allocated about 33% of their yam land to the technology. Results from the Tobit regression model suggest that the dissemination of the technology must also target farmers who are non-natives, household heads, less experienced, have large household sizes, and record low yields. The process must consider the type of cropping systems, seed yam production and collaborations with non-formal educational programs. Training must promote positive perception about the technology and proliferation of off-farm income generating activities.

Key words: Adoption, Northern Ghana, Tobit, yam mini-sett.

INTRODUCTION

The yam production systems in Ghana are largely managed by smallholders for subsistence and cash (Asante et al., 2011). Overall, the crop occupies about 10% of total arable area in the country with average yields of about 15 MT/ha. Northern Ghana plays an important role in the yam industry, contributing about 37% of total yam area and 33.52% of total production (MoFA/SRID, 2011). The yam sector in Ghana is obviously important for household and national income as well as food security.

Discussions with officials of the Ministry of Food and Agriculture (MoFA) in Ghana revealed that the yam mini-sett technology is also being promoted as part of activities of the Roots and Tuber Improvement and Marketing Programme (RTIMP) and the West Africa Agricultural Productivity Programme (WAAPP).

Efforts to ensure sustainable availability of adequate seed yam include the introduction of the yam mini-sett technology by the International Institute of Tropical Agriculture (IITA), in collaboration with National Agricultural Research Systems (NARS) (Asante et al., 2011). Discussions with officials of the Ministry of Food and Agriculture (MoFA) in Ghana revealed that the yam mini-sett technology is also being promoted as sub-activity of the Roots and Tuber Improvement and Marketing Programme (RTIMP) and the West Africa Agricultural Productivity Programme (WAAPP).

The yam mini-sett technology has the potential of minimizing the use of over 30% of harvested tubers as seed yam. The technology is expected to contribute to the reduction of the cost of planting materials, which is estimated to be between 33 and 50% of total cost of production (Kambaska et al., 2009). Instead of using a

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Abbreviations: FFF, Farmer field fora; **IFAD,** international fund for agricultural development; **IITA,** international institute of tropical agriculture; **MCA,** millennium challenge account; **NARS,** national agricultural research systems; **NRGP,** northern rural growth program; **OLS,** ordinary least squares; **RTIMP,** root and tuber improvement and marketing program.

Figure 1. Political map of Ghana.

whole tuber of yam as planting material, it can be split into several pieces. After splitting the full tuber of yam into several pieces of reasonable sizes, the mini-setts are dressed with fungicides and nematicides before they areplanted. A standard mini-sett weighs between 50 and 100 g (Kenyon and Fowler, 2000).

Since the introduction of the yam mini-sett technology, feedbacks on the performance of the technology have not been documented. The success of the mini-sett technology is determined by its adaptation and adoption by the targeted beneficiaries. Besides, changes in natural conditions, psychological, socioeconomic and institutional factors are capable of influencing the decision making processes of farmers. These also affect the extent to which the technology is applied (Asuming-Brempong et al., 2011; Tambo and Abdoulaye, 2011; Wiredu et al., 2011; Diagne and Demont, 2007).

Information on these factors is useful in the promotion of improved agricultural technologies. In order to maximize adoption and impact of the yam mini-sett technology, this study identifies factors that can be manipulated by policy makers and development planners. Furthermore, knowledge of the factors influencing adoption or non-adoption of the mini-sett technology for producing seed yams is essential to the yam scientists, agricultural extension agents and other stakeholders for refining their research and development strategies. Existing literature on the yam industry in Ghana have largely focused on the nutrition, agronomy and marketing with some few on adoption studies (Kambaska et al., 2009; Kenyon and Fowler, 2000). On the other hand, most adoption studies conducted in the country are also biased against the yam industry (Asante et al., 2011; Asuming-Brempong et al., 2011). The closest was Asante et al. (2011) who analyzed the determinants of willingness to adopt the yam vine technology.

The adoption studies have generally revealed low rates of uptake of newly improved agricultural technologies in the country. The studies further revealed that adoption decisions in the country are largely influenced by socioeconomic, institutional and technical factors. Specific conditions such as poor access to credit, high cost of inputs and the existing land tenure arrangements serve as constrains to effective adoption of agricultural technologies. In these studies, adoption is computed as a binary variable where a person is assigned a value of 1 for adoption and 0 for non-adoption. The studies have mostly applied Probit regression models to estimate the determinants of adoption (Asante et al., 2011; Asuming-Brempong et al., 2011).

This approach is limited because it only informs stakeholders and policy makers about the instantaneous decision to use the technology (Tambo and Abdoulaye, 2011; Kristjanson et al., 2005). This study went a step further to apply the Tobit regression procedure to estimate the determinants of proportion of land allocated to the technology.

METHODOLOGY

Study area

Yam is an important crop in Ghana. The crop provides food, employment and income to many farm families in the country. Northern Ghana contributes about 33.52% of the total yam produced in the country. Production is however limited to the Northern and Upper West regions which have been circled in Figure 1. Estimated yields from the two regions are relatively higher, ranging between 12.53 MT/ha in Northern region and 20.3 MT/ha in Upper West region (MoFA/SRID, 2011).

By virtue of its location in the Guinea and Sudan Savannah agro-ecological zones, northern Ghana is characterized by a uni-modal rainfall pattern which begins in April/May and ends in October/November. Recorded annual rainfall ranges between 900 and 21000 mm. Yam producers in the study area therefore benefit from a single crop cycle per annum which last for one half of each year. Temperatures are high during most of the year with the highest of about 42°C recorded mostly in March. With the occurrence of global warming and climate change, these climatic patterns have become unpredictable (Hodson et al., 2002).

Farmers in the study area are beneficiaries of initiatives that targets poverty reduction and economic growth through increased production and productivity of high-value and staple food crops, and their enhanced competitiveness in local, regional, and international markets (MiDA, 2008). Notable among these is the program to improve rural livelihood through productive and competitive yam systems in Ghana. The program which was funded by the International Fund for Agricultural Development (IFAD) through International Institute of Tropical Agriculture (IITA), was intended to adapt and promote improved yam technologies such as yam mini-sett technology in Ghana. The technology dissemination process included training in mini-sett preparations, field demonstrations and field days.

Northern Ghana is also within the intervention zones of the Root and Tuber Improvement and Marketing Program (RTIMP) which is promoting high-tech technologies in the root and tuber crop systems in Ghana through farmer field fora (FFF) approach. The FFF approach is highly participatory and allows farmers and researchers to compare their knowledge and experiences. Two major agricultural development programs - the Ghana compact of the Millennium Challenge Account (MCA) and the Northern Rural Growth Program (NRGP) - are also being implemented in northern Ghana (Wiredu et al., 2010).

Sampling technique and data

The study was conducted in the Northern and Upper West regions of Ghana between October and November 2011. Some secondary data, literature sources and interviews with experienced officials supported the justification of the study. The basic information for the analysis was obtained from primary data collected with the aid of objective oriented structured questionnaire. The data described the yam producer, production characteristics and access to information.

Sampling was designed to provide representative description of the yam production systems in Northern Ghana. A total of 120 yam producers, 60 per region, were systematically selected and interviewed. The selection of the farmers followed a multi-stage systematic random sampling procedure. In the first stage, two districts were randomly selected from a list of yam producing districts in each region. Secondly, 6 communities were selected from a list of yam producing communities from each of the randomly selected districts. Within the selected communities, 5 yam producers were further selected from a list of yam producers.

Estimation of determinant of adoption

The decision by yam producers to use the mini-sett technology is what Rogers (1995) termed as adoption. The instantaneous decision is not entirely sufficient in the description of the adoption status of the yam producers. The adopters also make decisions concerning the extent of adoption. Although the two decisions can be made separately (Tambo and Abdoulaye, 2011), this study assumed that the farmers jointly decided on adoption and the proportion of land allocated to the mini-sett technology.

Based on this assumption, any farmer who decided to produce yam seeds using yam mini-sett technology allocated between 0 and 1 unit (0 and 100%) of their farm land to the technology. A non-adopter did not use the yam mini-sett technology and was assigned a value of 0. The proportion of land allocated to yam mini-sett seeds (M) was computed as the ratio of the land area under mini-sett ($L_{\min i-sett}$) and total land area under yam (L_{yam}) as follows:

$$M_i = \frac{L_{\min i-sett}}{L_{yam}} \quad (1)$$

Following Tambo and Abdoulaye (2011), the model for the proportion of land allocated to the mini-sett technology was explicitly expressed as:

$$M_i = \alpha_0 + \sum_{k=1}^{K} \alpha_{h,k} H_{k,i} + \sum_{k=1}^{K} \alpha_{S,k} S_{k,i} + \sum_{k=1}^{K} \alpha_{X,k} X_{k,i} + \sum_{k=1}^{K} \alpha_{y,k} Y_{k,i} + \gamma_i \quad (2)$$

$H_{k,i}$ represented a set of variables that described the characteristics of the sampled yam producers including their respective socioeconomic status. $S_{k,i}$ represented the set of variables that described the access to information among the sampled yam producers. $X_{k,i}$ represented farm level characteristics and $Y_{k,i}$ represented the expectation of the yam producers about the returns or challenges of the mini-sett technology. The intercept term and the parameter estimates of the response of adoption to changes in the exogenous variable are represented by α.

The computation of the ratio of the land area under mini-sett, M, suggests that the proportion of yam land allocated to the yam mini-sett technology is truncated for the non-adopters. Ordinary least square estimators (OLS) of the determinants of model with M as the dependent variables were bound to be characterised by a heteroskedastic error term (Pindyck and Rubinfeld, 1991). Tobit regression procedure was therefore applied to eliminate the heteroskedastic error associated with the truncated dependent variable. The Tobit model estimated the probability of adoption and extent of use for a randomly selected farmer (Wiredu et al., 2011; Asfaw et al., 2010; Kristjanson et al., 2005; Pindyck and Rubinfeld, 1991).

RESULTS

Characteristics of the sampled yam producers by adoption

The results in Table 1 show the characteristics of the sampled households differentiated by adoption status. Table 1 also shows results of chi-square and student t-test statistics for the discrete variables and the continuous variables respectively, which are represented by their probabilities.

The maximum allowable error was set at 10%. In general, there was no much difference in the characteristics of the yam producers across the adopter categories. Significant difference existed in their ages, education status and access to alternative income sources across the adopter category.

About 41% of the sampled yam producers were adopters of the yam mini-sett technology. The only female yam producer in the sample was also an adopter of the mini-sett technology. The variable for gender was assigned the value of 1 for male and 0 for female. Over 99% of the sampled farmers were all male. Nativity was also assigned the value of 1 for natives and 0 for non-natives. The results show that the majority (80%) of the sampled yam producers were natives of their communities. There was however no significant difference in the percentages of adopters and non-adopters who were natives of their community.

The yam producers who adopted the mini-sett technology were on the average, about 4 years younger than non-adopters. The average age of the sampled farmers was around 46 years. Age was also expected to influence adoption of the mini-sett technology. In a similar manner, education was expected to significantly affect adoption of the yam mini-sett technology. Educated farmers however constitute 23.33% of the sampled farmers.

Table 1. Characteristics of yam producers by adoption.

Characteristics	Adopters	Non-adopters	Overall	Prob.
Sample distribution (N, %)	49 (40.83)	71 (59.17)	120 (100)	-
Male (%)	97.96	100.00	99.17	0.23
Female (%)	2.04	0.00	0.83	0.23
Age (years)	43.84	47.96	46.28	0.03
Education (%)	22.45	23.94	23.33	0.04
Nativity (%)	79.59	80.28	80.00	0.93
Head (%)	81.63	91.55	87.50	0.11
Household size (N)	15.37	14.94	15.12	0.70
Available family labor (N)	7.76	8.11	7.97	0.53
Alternative income sources (%)	81.63	64.79	71.67	0.04
Livestock ownership (%)	95.92	71.00	98.33	0.86
Total livestock unit (unit)	5.95	4.38	5.02	0.37
Membership of association (%)	65.31	42.25	51.67	0.013
Access to extension (%)	57.14	47.89	51.67	0.319
Number of extension visits	2.31	1.82	2.02	0.528
Training (%)	65.31	29.58	44.17	0.00
Field days (%)	24.49	8.45	15.00	0.016

The sampled yam producers included about 88% household heads. Their status in terms of household headship was therefore expected to significantly affect adoption of the mini-sett technology.

Farmers who were heads of their households were assigned the value of 1 and 0 otherwise. Each of the sampled yam producers was part of an average of about 15 member household either as the head or an ordinary member.

Access to off-farm income was also relatively high among the adopters. Overall, 70% of the sampled yam producers were involved in off-farm income generating activities such as artisanship, trading, civil servants and drivers. The results also show that about 98% of the sampled farmers owned about 5 livestock including cattle, sheep, goats and poultry. Off-farm income is expected to facilitate the adoption process. Hence, farmers who had access to off-farm income were assigned the value of 1 and 0 for those without off-farm income.

The results of the study identified four possible sources of information on the yam mini-sett technology, namely; membership of association, at least 2 extension visits and participation in training and field days. Apart from extension visits, the proportions of adopters who had access to information through their associations, training and field days were significantly high. These information sources were expected to have significant effect on adoption of the yam mini-sett technology. These variables that described access to information were all dummy in nature. A farmer was assigned the value of 1 to signify access to information source and 0 to signify no access to the particular information source. By virtue of low rate of education, a relative few farmers were able to process the information.

Yam production characteristics and technology

Table 2 also presents the production characteristics of the yam farmers. Production characteristics fairly varied across the adopter categories. Significant differences exist in their access to credit, yield, perception about land availability, those who tried and willingness to buy mini-setts as seed yam.

The results show that the yam producers have spent about one quarter of their life time in yam production. With almost 16 years of experience in yam production, the yam producers were expected to make informed decisions regarding adoption of the yam mini-sett technology.

Regardless of the years of experience, recorded yields (MT/ha) obtained by the yam producers were low and significantly higher, at the 10% level, for the non-adopters of the mini-sett technology. In addition to yields, land area under yam, land availability and land suitability were also expected to influence adoption of the yam mini-sett technology. Land availability and suitability were dummy variables with the value of 1 if farmers responds that land is available or suitable and 0 for non-availability or non-suitability.

The farmers who adopted the technology allocated about 33% of their yam fields to it. To every hectare of land under yam, the yam producers obtained an average of about USD 1641.79. In this study, income from yam production was therefore expected to significantly affect adoption and use of the mini-sett technology. The results show that the majority of the farmers (about 94%) had no

Table 2. Yam production characteristics.

Parameter	Adopters	Non-adopters	Overall	Prob.
Experience in yam production (years)	15.12	15.79	15.52	0.730
Yam income per ha (USD/ha)	1307.45	1872.54	1641.79	0.106
Access to credit (%)	12.24	1.41	5.83	0.010
Yield (MT/ha)	1.43	2.06	1.80	0.100
Average farm size (ha)	2.02	1.86	1.93	0.350
Land availability (%)	91.84	74.65	81.67	0.020
Land suitable (%)	85.71	74.65	79.17	0.140
Sole cropping (%)	22.45	35.21	30.00	0.130
Inter-crop (%)	77.55	64.79	70.00	0.130
Planting materials from own source	81.63	78.87	80.00	0.710
Planting materials from other farmers	26.53	28.17	27.50	0.840
Planting materials from market	22.45	19.72	20.83	0.720
Use of small tubers	100.00	98.59	99.17	0.400
Tried mini-sett	100.00	30.99	59.17	0.000
Preference for tubers	83.67	85.92	85.00	0.740
Preference for mini-sett	12.24	11.27	11.67	0.870
Willingness to buy mini-setts as seeds	75.51	47.89	59.17	0.000
Proportion of land allocated to mini-sett	0.3287	-	0.3287	-
Mini-sett can produce more seed yam	7.04	55.10	26.67	0.000
Mini-sett is time consuming	8.45	6.12	7.50	0.634

access to credit facilities. Due to the skewed nature of access to credit, it was not expected to affect adoption and for that matter, the intensity of application of the technology.

The sampled yam producers were shown to operate both sole cropping (30%) and inter-cropping (70%) systems of yam production. The majority of the yam producers cultivated yam together with cereals, legumes, vegetables and fibre crops as well as some root and tuber crops together with yam. The variables for cropping system were also dummies with 1 if the farmer responded yes and 0 for no.

Planting materials for yam cultivation was obtained from farmers' own source (80%), neighboring farmers (27.50%) and market (20.83%). Both adopters and non-adopters of the yam mini-set technology used small tubers as seed yam. While all the adopters had tried the mini-sett technology, about 31% of the non-adopters had tried the technology. The variables for planting materials sources, type of seed yam used and tried mini-sett were all dummies with the value of 1 for yes and 0 for no.

Despite the fact that the farmers had tried the mini-sett technology, the majority continued to prefer the small tubers as seed yam. Preference of yam tuber attracted a value of 1 and 0 for non-preference. In spite of the low preference, more than 50% of the sampled yam producers expressed their willingness to adopt the yam mini-sett technology. The results from this study revealed that perceptions about the quantity of seed yam were significantly higher among the adopting farmers. It was therefore expected to significantly affect adoption. A farmer was assigned the value of 1 if willing to buy the mini-sett as seed yam or perceived it to generate more seed yam or perceived it to involve a lot of time.

Estimated adoption parameters

Table 3 presents the results of the Tobit regression model for adoption. The study did not reject a 10 percent error in the estimation of the coefficient of the explanatory variables and general test statistics. The general test statistics for the models included the likelihood ratio test, pseudo R2 and the predicted adoption state. The significant likelihood ratio revealed joint significance of the independent variables in explaining the disturbance of the error terms in the model. The results also included the marginal effect of the explanatory variable which expresses the relative change to adoption as a result of changes in the explanatory variables.

The results show that the decision to adopt the yam mini-sett technology was influence by nativity, role of farmer in the household (headship), household size, access to alternative income sources, years of experience in yam production, yields obtained per hectare of yam cultivated, the cropping system, source of planting material, income from yam production and perception about the length of time involved in producing seed yam from the mini-sett technology.

There were positive relationships between extent of

Table 3. Tobit regression results for adoption of yam mini-sett technology.

Explanatory variables	Marginal effects	Standard error	P>|z|
Nativity	-0.173255	0.09485	0.088
Head of household	0.3634878	0.08736	0.000
Household size	0.0234436	0.00461	0.000
Alternative income	0.3345868	0.12436	0.007
Membership of association	0.0443295	0.09257	0.632
Extension visits	-0.001605	0.00776	0.836
Training	-0.102033	0.07321	0.163
Field days	-0.112949	0.07455	0.130
Willingness to buy seed yam	0.0038421	0.06205	0.951
Years of growing yam	-0.010553	0.00373	0.005
Yield	-0.158707	0.08945	0.076
Area	-0.04782	0.06105	0.433
Land availability	-0.2347	0.15246	0.124
Land suitability	0.1071109	0.08878	0.228
Inter cropping	0.184797	0.07865	0.019
Planting materials from other farmers	-0.316204	0.07594	0.000
Yam income	0.0000961	0.00005	0.040
Total livestock unit	-0.002286	0.00298	0.443
Long duration	0.2221745	0.12	0.064
More seed	-0.071697	0.05247	0.172

N=49; LR chi^2 (20)=42.6; Prob>chi^2=0.002; predicted adoption=0.3295.

adoption and heads of households, household size, and access to alternative income, intercropping, yam income and perception about the duration of the production. Negative relationships were on the other hand identified with nativity, years of experience, yield and neighboring farmers as source of planting materials.

The identified sources of information including membership of association, number of extension visits, participation in training activities as well as participation in field days did not significantly affect adoption of the yam mini-sett technology. Willingness to buy yam mini-setts as seed yam was not necessarily an important determinant for the adoption decision and intensity cultivation.

Access to land and livestock resources were not significantly related to adoption and use of the yam mini-sett technology. Perceptions about land availability, land suitability as well as expectation of more seed yam from the mini-sett technology were also not relevant in the adoption decisions of the sampled farmers in northern Ghana.

DISCUSSION

The study investigated the decisions on adoption and use of the mini-sett technology among yam producers in northern Ghana as a joint process. The observations about the yam producer and production characteristics and their adoption behaviors informed subsequent discussions and recommendations about strategies for effective targeting, in the promotion of the yam mini-sett technology in Ghana.

Implication of household characteristics on adoption

With the exception of one female who was also a non-adopter of the yam mini-sett technology, all the sampled farmers were males. The observed male dominance in the yam production system in Northern Ghana was an obvious and unique characteristic of the agricultural based production systems in the country (Wiredu et al., 2011).

For the yam producers, male dominance is informed by the fact that the operations on the farms were drudgery, mostly requiring the labor efforts of adult males (Asante et al., 2011). For the yam production system in Northern Ghana, gender sensitive interventions should first of all encourage active participation of females.

Another attraction of male farmers in Northern Ghana to the yam production system was that as heads, they needed incomes from the sale of the cash crop to finance household expenses. As mainly household heads, the yam producers make critical decisions concerning farming activities (including technology adoption) and serve as a liaison between the household and neighbours (Wiredu et al., 2010). The results of the study affirmed this assertion in that farmers who are heads of their households were more likely to adopt and allocate their lands to the mini-sett technology. In addition to adoption decisions, the farm household heads in Ghana are responsible for ensuring the general wellbeing of the members of their households. With an average of about 15 members per household, the yam producers were compelled to take measures to sustain the food security of their families (Asuming-Brempong et al., 2011). The decision to adopt the mini-sett technology was therefore very critical to ensure food self-sufficiency of the households of the sampled yam producers. Savings of roughly 30% of harvested tuber which were otherwise destined for seeds yam production can be used as food or can be sold to generate additional income. Meanwhile, access to an average of about 8 man/days of labour resource from the household also enhances the livelihoods of the yam producer. The household labour resource can be exploited for farm operations or hired to generate direct income (Wiredu et al., 2011).

Access to off-farm income was an important determinant of adoption of the yam mini-sett technology. Off-farm income is expected to facilitate the adoption process as it served as a source of alternative finance for farm operation including the experimentation process (Tambo and Abdoulaye, 2011). The implications are that interventions that promote the proliferation of off-farm income generating activities can lead to more sustainable financing of the farm level production activities.

According to Wiredu et al. (2011), nativity as a social status in Ghana, assures unconditional access to communal resources such as land. The sense of security exceeds the sense of risk of adoption and investments in the cocoa hybrid technology. This study revealed the opposite for the yam mini-sett technology. Unlike the cocoa production systems, where investments are long-term for the perennial tree crops, the yam production systems involved short-term investments for the annual vines. There were therefore relatively lower risks in terms of investments in land as a resource. The motivation of the non-native farmers for rapid returns placed them in a comfortable position to adopt and allocate over 30% of their land to the technology.

The age of investors has been used in some studies as a proxy to measure experience (Greenwood and Nagel, 2009). The average age of 46 years suggest that the farmers had reasonable life time experience to make informed decisions. They had also spent almost 16 years of their lives as yam producers. Experience was however shown to be inversely related to adoption and use of the yam mini-sett technology. The results suggest that less experienced farmers were more likely to adopt and allocate their land resources to the technology. Wiredu et al. (2011), in his justification, explained that the less experienced were aggressive to learn new things. The same can be said for farmers in the study area. Due to their predisposition, the young yam producers were easily convinced about the potentials. To obtain the full benefits of the technology, they adopted and allocate their lands to it.

Apart from experience, the ability to process information about an innovation is enhanced by the educational status of a person. In addition, the educated farmers appreciate the need for information and are therefore better motivated to look out for innovations. Evidence from research studies indicates positive relationship between education and technology adoption (Tambo and Abdoulaye, 2011). The low rate of education suggests that few of the sampled farmers were effectively able to understand or follow up on information related to the yam mini-sett technology. Certainly, in the short term, the design of agricultural interventions should consider promotion of education as a major component. In the long term, the country needs to develop strategies to ensure that the citizens have at least basic education.

Information has been shown to significantly affect adoption of improved agricultural technologies (Asuming-Brempong et al., 2011; Tambo and Abdoulaye, 2007; Diagne and Demont, 2007). The study captured important information sources including membership of association, extension visits and participation in training and field days. Membership of association facilitates easy access to credit, land and labor resources, and support in times of hardship and conflict resolution. There is the tendency of obtaining information about new technologies, quality seeds and inputs.

Apart from extension visits, the proportions of adopters who had access to information through their associations, training and field days were significantly high. The identified sources of information were however not significant as determinants of adoption and use of the yam mini-sett technology. Negative relationships were even identified between adoption and participation in training and field days. Perhaps the potentials of these information sources have not been fully utilized to maximize the adoption outcomes. The dissemination of the yam mini-sett technologies should, among other things, integrate these sources of information into the strategies. Moreover, the contents of training activities and field days should be adequately packaged to meet the needs of the respective audience.

Implications of farm level characteristics on adoption

The effect of yam on adoption varies across different agricultural production systems in sub-Saharan Africa (Asante et al., 2011; Asuming-Brempong et al., 2011; Tambo and Abdoulaye, 2011). However, land as an indicator of the yam production systems together with the perceptions about land were not significant determinants of adoption. With an average area of about 2 ha, the sampled yam producers can be described as smallholders. Perceptions about land availability and land suitability were high across the adopter category. The perceived availability and suitability of land were important to encourage adoption and use of improved technologies.

Needless to say, the yields obtained by the sampled yam producers were below the 15 MT/ha national average yield (MoFA/SRID, 2011). There was also a negative relationship between yields and adoption of the technology. The farmers who obtained low yields decided to adopt the yam mini-sett technology in order to save their already few tubers for food and cash. Subsequently, they allocated a reasonable proportion of their farm land to the technology.

Yam production activities generated an average of about USD 1641.79 per ha. Tambo and Abdoulaye (2011) showed that farm income had positive effect on adoption of improved agricultural technology. This was confirmed by the study which also revealed that a unit increase in income will increase the probability of adoption and land area allocated to the technology. The income was expected to be used for the finance of agricultural operations including payment for the cost of the mini-sett technology.

Together with income, credit was expected to provide important source of finance for farm operations. Lack of credit resources therefore serves as constraints to adoption of improved technologies. The situation inhibits the ability of the yam producers to invest into the technology (Wiredu et al., 2011).

The type of cropping systems has been shown to influence adoption of improved agricultural technologies in Africa (Diagne and Demont, 2007). The cropping system reflects the level of intensification and use of improved technologies. Sole cropping systems, for instance, were input intensive with high expected returns. In order to maximize land use, increase income and food and also to spread the risk of diseases, the majority of the yam producers cultivated yam together with cereals, legumes, vegetables and fibre crops as well as some root and tuber crops together with yam. Yam mini-sett technology adoption was therefore expected to be significantly affected by the type of cropping system.

Planting materials for yam cultivation was obtained from three sources. The source of planting material can expose the yam producers to existing seed yam technologies. Availability of planting materials can also be assured through these sources of planting materials. Access to planting materials has actually been shown to significantly affect adoption of improved technologies (Tambo and Abdoulaye, 2011). The study however showed that the source of planting materials inhibits adoption. Neighboring farmers are usually involved in the distribution of seed yams from small tubers. As such, the assurance of reliable supply of the small tuber seed yams did not encourage them to adopt the yam mini-sett technology. This suggests that the promotion of the yam mini-sett technology should simultaneously include the production of seed yam from the mini-sett technology to satisfy the demand created.

Both adopters and non-adopters of the yam mini-set technology used small tubers as seed yam. While all the adopters had tried the mini-sett technology, about 31% of the non-adopters had tried the technology. Farmers who tried the technology had the practical opportunity to evaluate the technology (Wu, 2005). Experiences with small tubers and mini-sett as seed yams can shape the preference of yam producers. Despite the fact that the farmers had tried the mini-sett technology, the majority continued to prefer the small tubers as seed yam. Again, the contents training and field days should be well organized to send the appropriate signals.

In spite of the low preference, more than 50% of the sampled yam producers expressed their willingness to adopt the yam mini-sett technology. Willingness to adopt did not necessarily imply adoption, in that, about 48% of the non-adopters were also willing to adopt the technology. It however provided information about the overall impression of the sampled farmers about the technology. There is the need to continue to promote the technology with strong emphasis on the benefits in order to increase interest and willingness to adopt.

Kristjanson et al. (2005) showed that perceptions about technology characteristics were important determinants of adoption of improved agricultural technologies. The results from this study also revealed that significantly higher percentage of the non-adopters expected more seed yam from the mini-sett technology. On the other hand, most of the adopters did not expect more seed yam from the mini-sett technology. Their perceptions were however shown to be insignificant in their decision to adopt and use the yam mini-sett technology.

Conclusions

Yam mini-sett technology adoption was estimated at about 41% of yam producers in Northern Ghana. The adoption decision process is affected by nativity, role of farmers in the households, household size, access to alternative income sources, years of experience in yam production, yields obtained per hectare of yam cultivated, the cropping system, source of planting material, income from yam production and perception about the length of time involved in producing seed yam from the mini-sett technology.

Some measures are definitely necessary in order to improve the current rate of adoption. Proper targeting of dissemination activities to capture the relevant categories of the production systems is required. The content of the training and field days should also be reviewed in order to send the proper message and feedback. Moreover, there is the need for seed yam production alongside the dissemination effort to satisfy the demand created.

Gender balance and access to education should be cross cutting in the design of new strategies. The strategies should encourage active participation of women in the yam production system. In addition, there is the need to collaborate with non-formal educational programs to ensure the attainment of basic education in the study area.

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