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ADOPTION OF IPM GROUNDNUT PRODUCTION TECHNOLOGIES IN EASTERN UGANDA

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ABSTRACT

Groundnut (*Arachis hypogea L)* is the second most widely grown food legume in Uganda. Currently average yield of groundnuts at farm level is about 800 kg ha^{-1}, but up to 3,000 kg ha^{-1} can be achieved. The most important constraints to its production are pests and diseases. Integrated pest management (IPM) technologies have been developed and demonstrated to farmers in Mayuge district. However, many farmers in the district have not adopted these technologies, for reasons not well known. The study was done to establish factors affecting adoption of IPM technologies. Socio-demographic and groundnut production data were collected for the second crop season of the year 2000 from a purposively and randomly selected sample of 76 farmers consisting of both IPM technology adopters and non-adopters. Adopters used improved technologies while the non-adopters used traditional technologies for groundnut production. Data analysis using the probit model indicated that adoption was significantly influenced by education ($P< 0.1$), family size ($P< 0.05$), association membership ($P<0.01$), extension visit ($P<0.05$), access to credit ($P<0.05$), size of cultivable land ($P<0.01$) and household income ($P< 0.05$). A descriptive analysis indicated that lack of seed, lack of information about the technologies, costly chemical, labour intensiveness, and lack of land were reasons for non-adoption. Intensification of extension services, farmers joining associations, establishment of farmer field schools (FFS), provision of credit to farm families by government, improvement of the seed delivery system and enforcement formal education as well as adult literacy programme are recommended to enhance adoption.

Key Words: *Arachis hypogea*, pests and diseases, probit model

RÉSUMÉ

L'arachide *(Arachis hypogea)* est la seconde nourriture légume la plus largement plantée en Ouganda. Présentement la production moyenne des arachides au niveau de la ferme est d'environ 800 kg ha^{-1}, mais jusqu'à 3000 kg peut être atteinte. Les plus importantes contraintes à sa production sont les pestes et maladies. Les technologies de gestion intégrée des pestes (IPM) ont été développées et démontrées aux fermiers dans le district de Mayuge. Cependant, beaucoup des fermiers dans le district n'ont pas adopté ces technologies, pour des raisons non connues. L'étude était faite pour établir les facteurs affectant l'adoption des technologies de l'IPM. Les données sociodémographiques et de production d'arachide étaient collectées pour la deuxième saison agricole de l'an 2000 à partir d'un échantillon délibérément et hasardeusement sélectionné de 76 fermiers consistant à ceux qui ont adopté et non adopté l'IPM. Les adoptants ont utilisé les technologies améliorées pendant que les non adoptants ont utilisé les technologies traditionnelles pour la production d'arachide. L'analyse des données utilisant le modèle de sondage a indiqué que l'adoption était significativement influencée par l'éducation ($P<0,1$), la grandeur de la famille ($P<0,05$), appartenance à l'association ($P<0,1$), visite d'extension ($P<0,05$), l'accès au crédit ($P<0,05$), la dimension de terre cultivable ($P<0,01$) et le revenu familial ($P<0,05$). Une analyse descriptive a indiqué que le manque de graine, le manque d'information à propos des technologies, le prix des produits chimiques, le travail non intensif et le manque de terre étaient les raisons pour la non adoption. L'intensification des services d'extension, les fermiers joignant les associations. L'établissement des écoles de terrain aux fermiers (FFS), la provision de crédit aux familles de fermier par le gouvernement, l'amélioration du système de livraison de plante et le renforcement de l'éducation formelle ainsi que le programme d'alphabétisation sont recommandés pour accroître l'adoption.

Mots Clés: *Arachis hypogea*, pestes et maladies, modèle de sondage

INTRODUCTION

Groundnut (*Arachis hypogea* L.) is one of the world's principal oil seeds. It provides food, animal feed and cash income. It also helps to improve soil fertility (Freeman *et al.*, 1999). In Uganda groundnut is the second most widely grown food legume after common beans (*Phaseolus vulgaries*). The total area planted with groundnuts varies between 120,000 and 190,000 ha. Yields have remained low at about 800 kg ha^{-1} of dry pods compared to 3000 kg ha^{-1} under good management. The constraints to production are rosette and leaf spot diseases, low yield potential of varieties grown by farmers, unreliable rainfall, poor agronomic practices, insect pests and improper storage conditions (Busolo-Bulafu, 2000).

The aphid-transmitted groundnut rosette disease and leaf spots are the most devastating diseases of groundnuts in sub-Saharan Africa. These diseases can respectively cause up to 60-100% yield losses in groundnuts. Chemicals, cultural practices (early planting and close spacing), and host plant resistance have been used to control pests and diseases in groundnuts. However, these control measures are usually limited to specific pests and diseases. To overcome these limitations, scientists have developed the integrated pest management (IPM) technologies. With the IPM approach, different pest control techniques are combined and integrated into the overall farming system. The Integrated Pest management Collaborative Research Support Programme (IPM CRSP) at Makerere University has developed technologies to control pests in different crops.

Adipala *et al.* (1998) under the IPM CRSP started on-farm research to expose farmers in Uganda to some of the improved technologies for managing groundnut rosette. The improved *Igola* 1 variety showed low levels of rosette and yielded twice as much as the local varieties (*Erudurudu* and *Etesot*). Mukankusi *et al.* (1999) developed IPM technologies to control the groundnut rosette disease and leaf spot diseases in groundnuts. These included use of resistant variety, early planting, close spacing (30cm x 10cm or 45cm x 15cm) and the use of 2-3 well-timed insecticide sprays. With these technologies, yield increases in groundnuts of between 16.2% and 51.3% were obtained. Application of these strategies has advantages such as reducing the use of chemicals, input costs and reducing environmental pollution (Xiesong and Weibo, 1996).

In a number of adoption studies, factors that affect adoption of new technologies have been established. For example Feder *et al.* (1985) found that lack of credit and inadequate farm size constrained adoption. Increased labour availability and proximity of household to urban centers had positive effects on adoption probabilities, whereas age had an inverse relationship with adoption (Dimara and Skuras, 1998). Education and farming experience were found to have positive effects on adoption (Lin, 1991). In addition unavailability of inputs, cost of technology and environmental factors have been found to negatively influence adoption (Katinila *et al.*, 1998). Bisanda *et al.* (1998) established that extension visits and livestock ownership had positive effects on the probability of adoption. The use of hired labour was also found to positively affect the probability of adoption (Ntege-Nanyenya *et al.*, 1997; Kato, 2000). Byerlee and Hesse de Polanco (1986) cited that farmer adoption of technologies followed a stepwise manner. Further still, Maumbe and Swinton (2000 unpubli.) in studying the adoption of IPM on cotton observed that improved IPM practices were adopted independently and variety characteristics played a major part in adoption. These characteristics include high yielding potential, resistance to bacterial wilt and jassids (*Empoasca* spp.) and tolerance to aphids (*Aphis gospii*) and drought. Other factors that influenced adoption were area under cotton crop and awareness about IPM practices. It is clear that these factors greatly impact on adoption of IPM practices.

Although groundnut IPM technologies have been demonstrated to farmers in Mayuge district for over 2 years, many have not taken them up. The reason for this was not clearly known. This study was a follow up of the previous work undertaken by IPM CRSP. It was aimed at identifying the IPM technologies that had been adopted and factors that affected the adoption of these technologies in groundnut production in Mayuge district.

METHODOLOGY

Study area. Mayuge district is located in Eastern Uganda. It was formerly part of Iganga district. The district was chosen because it has been the site for the IPM demonstration trials since 1999 (Mukankusi *et al.*, 1999). The sites, which consisted of Musiita, Bugodi and Wainhya, villages were identified with the help of the area extension officer.

Sampling and data collection. A sample of farmers used in this study was obtained using a combination of purposive and simple random sampling procedures from the areas within the IPM CRSP demonstration sites. The IPM sites were purposively selected and a list of farmers in these sites was formulated. A list of adopter and non-adopter farmers was obtained with the help of the extension officers in the area. From this list forty adopters were randomly selected and interviewed. The adopters in this study were defined as farmers who had been growing the rosette resistant *Igola* 1 variety and either planted early, used close spacing or sprayed 2-3 times using insecticides. Also farmers who were growing the local varieties but applied at least two of the recommended IPM practices (early planting, close spacing or three well timed insecticide sprays) were considered as adopters. On the contrary, non-adopters were defined as groundnut farmers who grew *Igola* 1 variety and did not apply any of the recommended practices or those growing the local varieties and used at most only one of the recommended IPM practices. The term non-adopters was loosely used in this case to mean partial adopters of IPM technologies as well. Among the farmers identified as non-adopters, thirty six farmers were randomly selected and interviewed. This gave a total sample size of 76 farmers consisting of both adopters and non-adopters of IPM technologies. Data were collected from these farmers for the second season (August-December) of 2000. This was done using a structured and pre-tested questionnaire. Information comprising of socio-demographic characteristics of farmers and groundnut production data was collected. This information included farmers age, sex, education, farming practices, groundnut growing experience, occupation, household size, income, land ownership, area under groundnuts, labour source, support services (extension and credit) and distance to main road.

The analytical model. The data were initially analysed using descriptive statistics to summarise information on the socio-demographic characteristics of the respondents. Exploratory data analysis methods (EDA) were used. These involved checking for symmetry, skewness and data distribution. Household income and cultivable land area were transformed using natural logarithms to correct for skewness, symmetry and data distribution (Mukherjee *et al.*, 1998). Multicollinearity was tested for and highly correlated variables were dropped (Koutsoyiannis, 1977).

In addition a probit model was run to determine the factors affecting adoption of IPM technologies in groundnut production. Robust standard errors were generated. The probit model was chosen because it gives efficient, unbiased and normally distributed estimators. It was also chosen because of convenience and availability of the computer package for estimation. Lapar and Pandey (1999) and Goodwin and Schroedder (1994) used the probit model to study adoption. Variables used in the probit model were age, education, log of cultivable land, log of household income, access to credit, extension visit, association membership, sex, hired labour, distance to the main access road and household size. The STATA computer package was used in analysis of data.

The probit model, according to Kmenta (1986), was stated as:

$$Y_i = \beta_o + \beta_i x_i \quad \text{..........} (1)$$

Y_i = A dichotomous dependent variable representing adoption

(1 = adopter 0 = non -adopter)

β_o = constant term

β_i = Vector of parameters to be estimated.

X_i = Vector of explanatory variables

From equation (1) functional form of the probit model was specified as:

$$Y_i = \beta_0 + \beta_1 \, RESAGE + \beta_2 \, RES\,EDYR + \beta_3 \, LN\,CAREA + \beta_4 \, CRD + \beta_5 \, EXTV + \beta_6 ASSM + \beta_7 LBR + \beta_8 SEX + \beta_9 FSIZE + \beta_{10} ACCR + \beta_{11} LNHHY + e \quad \text{..........} (2)$$

Where

Y_i = 1 if farmer adopted IPM, = 0 otherwise.

β_O	= Constant term
RESAGE	= Age of the farmer in years
RESEDYR	= Education of farmer in years spent in school
LNCAREA	= Natural log of cultivable land in hectares
CRD	= Farmer accessibility to credit (1 = Yes, 0 = no access)
EXTV	= Extension visit (1 = Yes, 0 = No)
ASSM	= Association membership (1 = Yes, 0 = No)
LBR	= Used hired labour (1 = Yes, 0 = No)
SEX	= Sex of farmer (1 = Male, 0 = Female)
FSIZE	= Household size (number of people in the household)
ACCR	= Distance to main road in km, proxy for market accessibility.
LNHHY	= Natural log of household income
e	= error term
β_1-β_{11}	= parameters estimated

Household income was measured by establishing the farmer's income from the various sources including remittances from relatives less the taxes paid.

In the probit model, marginal effects of a variable x_i on the response probability is given as

$$\delta P_i/\delta x_i = f(x\beta)\beta_i \quad \text{..........} (3)$$

Where if $(x\beta)$ is the normal marginal density function. The transformed variables are interpreted as elasticities just like the untransformed ones.

RESULTS AND DISCUSSIONS

Socio economic characteristics of groundnut farmers. The socio economic characteristics of the farmers were analysed to give a comparison between adopters and non-adopters. The survey results indicated that the mean age of the respondents was 41 years (Table 1). Adopters were on average older (43 years) than the non-adopters (39 years). The majority of the respondents were females (74%). Among the adopters, females still formed the majority (60%). Adopters had more years of formal education (9 years) compared to the non-adopters (5 years) and this was significant (P<0.001). The adopters had less annual income (U Shs. 699,953) compared to the non adopters (UShs. 795,000) but the difference in the incomes was not significant. Household sizes of adopters were smaller comprising of 6 members on average compared to 7 members for the non-adopters but the difference was not significant.

Adopters had more cultivable land size (3 hectares) compared to that of the non-adopters (1 hectare) and the difference was significant (P<0.01). The land adopters and non-adopters put under groundnut production was 0.1 of a hectare. Adopters had less experience in growing groundnuts (13 years) compared to the non-adopters (15 years) but this difference was not significant. Adopters received about 2 extension visits per season compared to the non- adopters (1 visit) and the difference was significant (P<0.05).

IPM technologies adopted. Farmers in Mayuge district applied IPM technologies in different forms. The technologies employed were growing the improved and rosette resistant variety (*Igola* 1) with improved or traditional practices and growing the local varieties (*Erudurudu* and *Etesot*) using improved practices shown in Table 2. The improved practices were early planting, spacing of 30cm x 10cm and 45cm x 15cm and 3 chemical sprays.

Among the IPM adopters, 90% grew the improved and rosette resistant *Igola* 1 variety, while the rest grew the local varieties. Table 2 shows that the majority of the IPM adopters grew the resistant variety (*Igola* 1) early in the season at a close spacing of 45cm x 15cm (53% of the farmers) or 30cm x 10cm (25%). Since *Igola* 1 yielded well even without spraying, farmers found it profitable to take it up. Considering the IPM adopters who grew the local varieties, about 13% grew *Erudurudu* early in the season at 30cm x 10cm spacing with three sprays), while 5% grew *Etesot* early in the season at 45cm x 15cm and applied 3 sprays. *Etesot* variety was not popular in Mayuge as a result of lack of seed in the area.

Among the adopters, the reasons given for applying IPM practices were ease of weeding, spraying and harvesting (as reported by 75% of the adopters), higher yields (as reported by 68%), resistance to pests and diseases (50%) and resistance to drought (13%). The ease of weeding, spraying and harvesting was because of the row planting, while higher yields was attributed to appropriate spacing, use of improved variety and early planting. Resistance to drought, pests and

TABLE 1. Socio-economic characteristics of groundnut farmers in Mayuge district

Characteristic	Group mean	Adopters (N = 40)		Non-adopters (N = 36)		t statistic
		Mean	SD	Mean	SD	
Age (years)	40.7	42.6	12.3	38.6	13.7	1.37
Sex: Male	26.3	40		11.1		
Female	73.7	60		88.9		
Formal education (years)	6.7	8.5	4.1	4.6	4.1	4.0***
Annual household income ('000 Shs.)	744.8	700.0	582.1	795.0	955.2	0.53
Household size	6.4	6.0	2.5	6.9	3.74	1.19
Cultivable land (ha)	2.38	3.27	3.24	1.39	1.20	3.29***
Groundnut area (ha)	0.12	0.14	0.11	0.11	0. 09	1.40
Number of extension visits per season	1.26	1.73	1.69	0.75	1.762	2.46**
Groundnut growing experience (years)	14.1	13.1	12.1	15.3	11.20	0.4

***, **, * Significant at 1%, 5% and 10%, respectively

TABLE 2. IPM technology components used in groundnut production

Groundnut variety	Technology	% users (N = 40)
Igola 1	planted late at 30cm x 10cm	5.0
	planted late at 45cm x 15cm	5.0
	planted early at 30cm x 10cm	25.0
	planted early at 45cm x 15cm	52.5
	planted early in intercrop with maize	2.5
Erudurudu	planted early at 30cm x10 cm with 3 sprays	12.5
	planted late at 30cm x 10cm with 3 sprays	2.5
	planted early at 30cm x10 cm with 4 sprays	5.0
Etesot	planted early at 45cm x 15cm with 3 sprays	5.0
	planted early at 45cm x 15 cm	2.5

Note: The percentages do not add up to 100 because there were cases where farmers had applied IPM technologies with more than one groundnut variety diseases was attributed to the improved variety and early planting.

The technologies that the IPM non-adopters applied were growing local varieties using traditional practices; chop and drop, 0-2 sprays and continuous line planting (Table 3).

All the non-adopters grew local varieties (*Ensoga* and *Erudurudu*). No sampled farmer in this category grew *Etesot*. Of these 68% used the chop and drop method without any chemical spray. This method involves the farmer moving in the field with a hoe while making a planting hole where he/she sees as appropriate. Katinila *et al.* (1998) observed that cost of technology affected adoption of maize technologies. It was easier for farmers to plant groundnut by chop and drop method since one person could do this as opposed to the recommended IPM technologies that would require extra investment in labour and inputs like improved seed and chemicals.

Only one farmer grew *Erudurudu* early in continuous line (following the plough furrow) and spraying once. This farmer did not have the information about the recommended spacing and could not afford the recommended sprays. Similarly the farmers who practiced the chop and drop method and sprayed 1-2 times did not have knowledge about the recommended practices. Feder *et al.* (1985) cited lack of information about technologies as one of the factors hindering adoption. Reasons given for not using IPM practices were lack of seed (by 63% of the farmers), lack of information (by 43%), labour intensiveness (reported by 38%), expensive chemical (by 35%), and inadequate land (by 5%).

Factors affecting the adoption of IPM technologies. Among the factors that affected adoption of IPM technologies, education, household size, the size of cultivable land, extension visit, household income, access to credit and membership in an association were significant (Table 4). Sex of the farmer, distance to main access road and use of hired labour had positive effects on adoption but were not significant. Age was negatively related to adoption though not significant.

Education was positively related to adoption as expected (P<0.1). The probability of adoption increased by 4% for every additional year spent in school. This was consistent with the findings of Goodwin and Schroeder (1994) and Kato (2000). A possible explanation is that the more educated farmers are in a better position to search for and process information as well as understand the technical aspects of a technology, especially spacing and insecticide use in the case of IPM. They were more likely to apply IPM technologies as compared to their less educated counterparts who would not want to risk with new technologies until they have seen the benefits. Household size was negatively related to adoption (P< 0.05). The probability of adoption was decreased by 6.7% for every increase in family size by one member. Nuwamanya (1994) established the same relationship. This was contrary to the findings of Kato (2000) that increase in family size increased the adoption of improved bean variety. This could be explained by the fact that as family size increased, the cost of maintaining the family increased thus, leaving less money for purchase of inputs such as improved seed and chemical.

Access to credit was positively related to adoption as expected (P<0.05). The probability of adoption increased by 33% if a farmer had access to credit. This concurs with the findings of Goodwin and Schroeder (1994) that adoption of forward pricing increased with rise in leverage. This could be explained by the fact that access to credit enables the purchase of inputs. Membership

TABLE 3. Technologies employed by non-users of IPM in groundnut production

Groundnut variety	Technology	% users (N = 36)
Ensoga	planted early by chop and drop with no spray	13.9
Erudurudu	planted early by chop and drop with no spray	55.6
	planted late by chop and drop with 1 spray	16.7
	planted late by chop and drop with 2 sprays	11.7
	planted early in continuous line with 1 spray	2.7

in an association had a strong positive relation with adoption of IPM technologies (P< 0.05). The probability of adopting IPM increased by 46.5% if a farmer belonged to an association. Ntege-Nanyenya *et al.* (1997) and Lapar and Pandey (1999) established the same relationship. Extension agents and non-governmental Organisations (NGOs) tend to pass agricultural messages through groups and interpersonal linkages during group meetings makes information flow faster (Ntege-Nanyenya *et al.*, 1997).

Extension visits had a positive impact on adoption of IPM technologies (P< 0.05). This is consistent with findings of Bisanda *et al.* (1998) and Beyene *et al.* (1998). The probability to adopt IPM technology increased by 40.5% if an extension agent visited the farmer. Extension visit enables the farmer to get information about new or improved technologies and the extension workers encourage them to adopt. Extension agents also establish relationships with these farmers who then act as contact farmers and thus can be selected to participate in training and demonstrations (Bisanda *et al.*, 1998).

Household income was negatively related to adoption (P< 0.05). This was contrary to the findings of Erbaugh (1997) that total household income was positively correlated with use of pesticides. An increase in household income by 1% decreased the adoption by 0.16%. The explanation for this could be that as the income of a farmer increased he/she shifted away from agriculture or even kept in agriculture but invested in other agricultural enterprises such as production of cash crops. Groundnut is regarded as a food crop and farmers may not necessarily invest in the use of IPM practices to produce it. The size of cultivable land was positively related to adoption. An increase in the size of cultivable land by 1% increased the adoption of IPM technology by 0.21%. The plausible explanation of this could be that since land size is an indicator of wealth, these farmers with larger land sizes are in a better position to obtain information about new technologies and apply them.

CONCLUSIONS AND RECOMMENDATIONS

Adopters of groundnut IPM technologies were older and more educated compared to the non-adopters, though non-adopters earned more income annually compared to adopters. In addition the adopters had more cultivable land and received more extension visits compared to the non-adopters. The IPM technologies employed were growing the improved and rosette resistant variety (*Igola* 1) with improved or traditional practices

TABLE 4. Estimated parameters of the probit model and the marginal effects of explanatory variables

Variable	Estimate	Probability of adoption
Sex of farmer	0.195 (0.461)	0.079 (0.183)
Education in years	0.098 (0.054)*	0.039 (0.021)*
Household size	-0.168 (0.065)*	-0.067 (0.026)*
Natural log of cultivable area (ha)	0.518 (0.2097)*	0.206 (0.084)*
Extension visit	1.077 (0.433)***	0.405 (0.149)***
Access to credit	0.855 (0.404)**	0.331(0.146)**
Association membership	1.277 (0.469)***	0.465 (0.132)***
Hired labour	0.316 (0.398)	0.125 (0.157)
Age in years	-0.009 (0.0219)	-0.003 (0.009)
Natural log of household income	-0.388 (0.185)**	-0.155 (0.077)**
Distance to main road (Km)	0.111 (0.267)	0.044 (0.106)
Constant	3.599 (2.621)	

N = 76
Model chi square = 39.26***
Degrees of freedom = 11
Mc Fadden's R^2 = 0.50
Log likelihood = -25.67

*** , **, * = Significant at 1%, 5% and 10% respectively; Figures in parentheses are robust standard errors and growing the local varieties (*Erudurudu* and *Etesot*) using improved practices. Non-adopters grew local groundnut varieties and employed traditional technologies. The advantages achieved by using IPM technologies were ease of farm operations such as weeding, high yields, resistance to pests, diseases and drought. Constraints in the adoption of IPM technologies were lack of information, labour intensiveness of the practices, lack of seed, expensive chemical, inadequate land and susceptibility to pests and diseases. A number of factors affected adoption of IPM technologies but the significant ones were education, household size, access to credit, membership in an association, extension visits, household income and size of cultivable land.

It is recommended that extension services be intensified so as to enable farmers get adequate information about IPM technologies. Training more extension workers and farmer extensionists could help in facilitating the transfer of information. Farmers should be encouraged to join associations especially those involved in agricultural activities to enhance flow of information about new farming technologies. Establishment of farmer field schools (FFS) may also enhance adoption since farmers will be able to learn by doing. There is also need for government to craft policies to enable micro finance institutions to provide credit to farm families. This will enable farmers to access funds to purchase inputs such as chemical and improved seed. The government should improve on the seed delivery system so that farmers have access to improved seed. Ready availability of seed will enhance adoption. As education is seen to have an impact on adoption, there is need to enforce formal education as well as adult literacy programme. This will help to increase the literacy levels and thus facilitating adoption of these technologies. Government should also enforce policies that can enable people in the area to acquire more land. This will enhance adoption of IPM.

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