Factors constraining Farmers' adoption of new Agricultural Technology Programme in Hambantota District in Sri Lanka: Perceptions of Agriculture Extension Officers

K.N.N. Silva*(*nadeeds@gmail.com)*
University of Ruhuna, Sri Lanka

T. Broekel *(broekel@wigeo.uni-hannover.de)*
Leibniz University of Hannover, Germany

Abstract

This paper examines the major factors constraining the adoption of a newly introduced paddy improvement technology programme by farmers in the Hambantota district, as seen from the perspective of Agricultural extension officers. Further, the adoption pattern of those technological programmes by farmers was analyzed. A structured interview schedule was used to collect data from a purposively selected sample of 30 AI officers. Data was analyzed using the principal factor model with iteration and Varimax rotation. Later, the simple linear regression analysis was done to explain any relationship between the adoption levels of farmers in each of the adoption stages. The results showed that a majority of AI officers perceived that only 40-60 per cent of farmers actually adopted the new technology programme. As for the percentage of farmers who proceeded to adopt each stage of the multi-stage process, the majority of the farmers in the community progressed to the awareness stage but only about 50 per cent of farmers continued until the final adoption stage was reached. Among the factors constraining the adoption could be cited a lack of resources, incompatibility and complexity of new technology, socio-economic and cultural constraints. Inadequacies in extension intervention, technical training and information were the main constraints that compromised the information and knowledge network. Moreover, the Yaya 2 programme was hindered by environmental and economic barriers, poor educational competencies of farmers and weak information links with the other actors of the network. Further, the study was unable to predict any significanct relationship between the adoption levels of farmers in each of the adoption stages. These findings suggest that there is an urgent need for researchers, policy makers and administrators of the extension service to consider these constraints seriously so as to overcome them to increase the adoption rate by farmers of the new paddy technology programme in Hambantota.

Keywords: Agricultural Technology, Farmers, Adoption Stages, Adoption, Constraints

INTRODUCTION

Technological change has been a major factor shaping agriculture in the last few decades. The rapid development of the agriculture sector may be attributed to technological innovations. Much of the agricultural innovation originated in developed countries and so some of the technologies are difficult to apply in developing countries. Though agricultural technologies are seen as an important route to poverty alleviation, the rate of adoption of these technologies has remained low in most of the developing countries (Mwangi & Kariuki, 2015; Bandira & Rasul, 2002). Nevertheless, the adoption of new technology remains a crucial requirement for the positive transformation of the agriculture sector. Therefore, the literature has focused on the individual adaptations of new technology and on farmers' learning behaviour as seen in many studies (Conley & Udry, 2010).

There exists a vast store of literature dealing with the factors that determine agricultural technology adoption (Katungi & Akankwasa, 2010; Akudugu et al., 2012; Loevinsohn et al., 2012; Adesina & Baidu-Forsen, 1995). Basically, literature on agriculture has highlighted two major driving factors behind successful agricultural technology adoption in developing countries. The availability and affordability of new agricultural technologies and farmers' expectations of long-term profitability promised by the new technology are two major determinants of technology adoption (Foster & Rosenzweig, 2010). Further, the factors that influence the adoption of modern agricultural technologies are categorized into three groups: economic factors, social factors and institutional factors. According to Akudugo (2012), the economic factors included farm size, cost of adoption, access to credit, expected benefits from the adoption and the off-farm income generation activities. The social factors included the age of farmers, the level of education and the gender. The institutional factors included access to extension services.

Technology dissemination is a key vehicle for technology adoption. Efficient dissemination of news about technology requires reliable information and technical guidance. Literature provides evidence of the importance of the technology dissemination process for invigorating the agriculture sector (OECD, 2001; Rogers, 2003).

Farmers who wish to keep abreast of new agricultural technology now have access to multiple sources of information. According to Rogers (1995), farmers may learn from their own experimentation, from agricultural extension services in the area, and from neighbouring farmers. In the case of developing countries, farmers often learn through the social learning approach. Further, traditional farmers have been assumed to be passive recipients of knowledge that is provided to them by change agents. Those change agents in rural communities are the extension officers or sales agents representing producers of new technologies (Rogers, 1995).

Conley and Udry (2010) have explained the effect of farmer organizations on technology adoption. The literature describes both the positive and negative impacts of the social network on technology adoption (Katungi & Akankwasa, 2010; Foster & Rosenberg, 1995; Bandiera & Rasul, 2002). Moreover, the impact of the extension service on technology adoption has been explained by Muwangi and Kariuki (2015), Genius et al. (2010), and Uaraeni et al. (2009) in their studies. Availability and access to extension services has been found to be a key aspect of technology adoption. Anyhow, only a limited number of studies have analyzed the role of the extension worker in the technology adoption process. This research gap might have crucial implications since the extension officers directly contact the farmer in the technology dissemination process. Further, much of the literature has explained the different factors which affect the individual decisions on technology adoption (Akudugo, 2012; Adesina & Baida-Forson, 1995; Ngoc Chi & Yamada, 2002). In addition, many studies have analyzed farmer perceptions regarding effectiveness of extension service on technology adoption (Agbarevo, 2013). Moreover, extension workers conduct awareness programmes and field demonstrations about new technology. Therefore, the perceptions of extension workers regarding how farmers adopt new technologies being introduced to them and the factors that affect technology adoption are deemed worthy of study. Further, this analysis would pinpoint the exact factors that drive the technology adoption. Additionally, drawing on an extensive review of the literature on adoption of agricultural technologies, analysing the perception of extension officers would be an alternative approach for determining the motivating factors behind the technology adoption process. Hence, the study will attempt to analyze the technology adoption pattern of paddy farmers in *Hambantota* district through the Agricultural extension officers' perception. Though a number of studies have been conducted across the world on technology adoption and these have identified various factors that determine technology adoption, there is a dearth of literature on the specific factors that influence modern agricultural production technologies, especially among small scale paddy farmers in Sri Lanka. This is an acknowledged research gap that is going to be bridged through this study, which is based on the perception of AI officers in the *Hambantota* district in Sri Lanka.

The purpose of this study was to determine the factors influencing adoption of new agricultural technology by paddy farmers. In addition, the factors constraining farmers' adoption of new technology will be analyzed based on the perception of Agricultural Extension officers in *Hambantota* district. The study has mainly considered two paddy technological programmes.

LITERATURE REVIEW

Technology Adoption

Adoption and diffusion are the processes governing the utilization of innovations. Diffusion can be interpreted as aggregate (widespread) adoption. There is a significant time lag between the invention of new technology and its adoption by farmers. Adoption behaviour of new technology may be affected by many factors. The vast literature on this topic mentions several different factors that influence technology adoption (Ngoc Chi & Yamada, 2002; Adebiyi & Okunlola, 2013; Adesina & Baidu-Forsen, 1995; Akudugo, 2012).

There are a number of factors that determine the extent of adoption of technology, such as attributes of the technology, objective of the farmer, characteristics of the change agent as well as the socio-economic, biological, and physical environment in which the technology is introduced. Socio-psychological traits of farmers such as their age, educational attainment, income, family size, tenure status, credit use, value system, and beliefs are positively related to adoption (Stunding & Zilberman, 1999). Apart from that, the personalities of extension officers in the area too can influence the farmers' adaptation. The credibility, good rapport with farmers, and communication ability of extension officers acting in combination with effectiveness of the technology transfer mechanism affect the adoption. In addition, the biophysical environment of the farming area such as infrastructure facilities and resources availability to the farm positively influence the farmers' social network.

Further, Rogers (2003) has drawn attention to an adoption category based on the innovation-decision period. The innovation-decision period is the length of time required to pass through the innovation-decision process. The time that elapses between awareness-knowledge of an innovation and the decision made to adopt it by an individual is measured in days, months, or years. Moreover, the innovation decision model of Rogers (1983) shows the stages through which the decision making process proceeds from first knowledge of an innovation to the decision made to adopt or reject it, to implement the new idea if accepted, and to confirm this decision (Rogers, 2003).

Technology Diffusion and Dissemination to Farmers

Diffusion can be interpreted as aggregate adoption (Stunding & Zilberman, 1999). Further, Rogers (1983) has defined Diffusion as the process by which an innovation is communicated through certain channels over a period among the members of a social system. An OECD (2001) study has defined diffusion as the process by which a new idea, practice or technology spreads in a given population. Similar to technology adoption, the characteristics of technologies, such as relative advantage, complexity, divisibility, and compatibility affect their diffusion (OECD, 2001). In respect of the technology diffusion process, Rogers in 1957 and other rural sociologists found in their studies that generally this process followed an S-shaped function of time.

Dissemination of information relating to technology among farmers is crucial for technology adoption. In general, farmers have conservative attitudes and need much time and information to be persuaded to adopt new technologies (OECD, 2001). Efficient promotion of new technology/ innovation requires reliable information and technical guidance. Therefore, demonstration plots and neighbouring farmers who have already converted are more persuasive to those who are debating whether to adopt new technology. Demonstration plots can provide practical information to guide farmers to make a smooth transition to new technology.

Determinants of Agricultural Technology Adoption

Foster and Rosenzweig (2010) mention that availability, affordability and farmers' expectations of long-term profitability of new technology are the major determinants in respect of technology adoption. Education level and income level of the farmers also affect the decision. An OECD (2001) study has identified further reasons for adopting new technologies. Progressive farmers who believe in science and technology adopt the new technologies more quickly than hidebound, non-progressive farmers. Similarly, educated and younger farmers also tend to adopt new technologies more readily compared to less educated and older farmers (Katungi & Akankwasa, 2010). Age of the farmer and size of the farm are other important determinants of technology adoption. Age was found to positively influence adoption of sorghum cultivation in Burkina Faso (Adesina & Baidu-Forson, 1995). According to Adesina and Baidu-Forson, larger scale commercial farmers adopted new high-yielding maize varieties more readily than smallholders.

Extension Services and Technology Adoption

The extension service is the key driving factor behind technology development in the agricultural sector in developing countries. Availability and access to extension services has also been found to be a key aspect in technology adoption (Mwangi & Kariuki, 2015).

Akudugo (2012) has explained that access to extension services can counteract the negative effect of lack of formal education of farmers which hinders technology adoption. Thus, extension services create the platform for acquisition of the relevant information that promotes technology adoption. Moreover, information received through the extension services reduce the uncertainty about a new technology's performance, helping to make a positive change in the individual's decision on adoption. Therefore, access to extension services was also found to be positively related to the adoption of modern agricultural production technologies (Mwangi & Kariuki, 2015; Akudugo, 2012). Farmers usually become aware of new technologies through the extension officers in developing countries.

In addition, the extension agent acts as a link between the innovators of the technology and end users of that technology. Therefore, extension services help reduce the transaction cost associated with information sharing among the larger heterogeneous farming population (Genius et al., 2010). In developing countries, extension agents usually select a particular contact farmer who is recognized as the most influential agent to deliver new technology. Many authors have reported a positive relationship between extension services and technology adoption (Mwangi & Kariuki, 2015; Uaiene et al., 2009).

METHODOLOGY

The study was conducted in *Hambantota* district in Sri Lanka. Two major technological programmes that were considered in this study were named Farmer Field School (FFS) and *Yaya 2*. 30 Agricultural Instructors (AIs) were randomly selected for the data collection and semi-structured questionnaires were used using interview method. To determine the magnitude of the constraints as perceived by the AI officers, a five point Likert-type scale was used. The response options ranged from “not at all” to “a very great extent,” scaled from -2 to +2.

Factor analysis using the principal factor model with Varimax rotation was used to determine major variables constraining the use of two improved paddy technologies. The loading under each factor represents a correlation between the identified constraint factors and has the same interpretation as any correlation coefficient. Simple linear regression analysis was done to explain any relationship between the adoption levels of farmers in each of the adoption stage.

RESULTS AND DISCUSSION

Measurement of Adoption of New Technologies

Measurement of the rate of adoption of agricultural innovations is essential for ensuring effective knowledge transfer process by extension officers. The perceptions of AI officers concerning the percentage of farmers who adopt the given technology were measured. Table 01 shows the percentage of farmers who adopted new technology as perceived by AI officers.

Table 01: Farmers’ technology adoption and knowledge dissemination process

Percentage of farmers who effectively adopt new technology and share information	Mean response of AI officers (Percentage)
Almost all farmers	0
80-100 % of farmers	3
60-80 % of farmers	10
40-60% of farmers	37
20-40 % of farmers	27
10-20 % of farmers	23
Only wise farmers	0

Source: Author’s own data (2015)

According to Table 01, nearly 37 per cent of AI officers have perceived that 40-60 per cent of farmers in the district effectively adopted the given technologies. None of AI officers had an experience of 100 per cent adaptation by farmers of the given technologies. Further, 27 per cent of AI officers in *Hambantota* district have perceived that only 10 per cent of farmers in their area have adopted the given technology due to several issues and constraints which are identified later in this study. The adoption rate of the farmers was greatly influenced by the socio-economic factors of the farming community. In addition, the effect of the knowledge and information network invariably influences the adoption rate of the farmers.

Stages of Adoption of the New Technology

The adoption of agricultural technologies is a dynamic process and follows hierarchical or pyramidal stages, namely awareness, interest, evaluation, trial and adoption. George and Bohlem as cited by Ovwigho (2013) have explained those five steps in detail in their study. Awareness simply means the individual's awareness about the existence of the innovation. When the individual wants more information about the new technology to assess if the innovation can help him, then that is interest. The evaluation stage implies the mental examination of the information gathered by the individual, who tries to determine whether it will really impact his work. In the trial stage, the individual tests the innovation to see if it actually measures up to his expectations. Finally, the individual reaches the adoption stage when he decides he really likes the innovation and wants to adopt the new technology and use it for his work. Though the individual could go through this adoption process steadily, some people are slower to transition between steps (Ovwigho, 2013).

The study intends to analyze each stage of the adoption process for two major technological programmes in *Hambantota* district and so the percentage of farmers passing through each stage as perceived by AI officers in the district will be recorded. After the initial awareness of new technology, extension offices in the areas will follow the progress of the farmers through each stage of adoption to get an idea about the individual adoption process. Based on that, Table 02 shows the percentage of farmers reaching each adoption stage as perceived by AI officers in the district.

Table 02: Percentage distribution of farmers by the level of adoption as perceived by AI officers

Adoption stage	Percentage of farmers	
	FFS Programme	**Yaya 2 Programme**
Unaware	0	0
Aware	80	83
Interest	60	76
Evaluation	57	71
Trial	54	64
Adoption	45	50
Discontinuance	16	9

Source: Author's own data (2015)

The differences in farmer participation for each stage have been explained in previous literature. Onweremad and Njoku (2007) reported that low participation in some stages were caused by poor field contact between the extension agents and farmers. Efficacy of any agricultural extension is judged by the level of mass adoption by farmers and scientific practices among farmers.

Factors Constraining Farmer Adoption

To determine the level of constraints as perceived by Extension agents, five point Likert-type scales were used. The responses ranged from 'not at all' to 'a very great extent' along the scale. The FFS programme and *Yaya 2* Programme were used as the new paddy technology programmes in this study. Further, two major categories of variables were used for analysis. Eight variables were included under socio-economic and cultural constraints and six variables were included under the constraints associated with the knowledge and information network.

Factor analysis, using the principal factor model with iteration and Varimax rotation was used to determine major variables constraining the use of improved paddy technologies. The loading under each factor represents a correlation of the identified constraint factor. Kaiser´s criterion using factor loading above 0.5 was adopted in naming and interpreting the factor and constraint variables (Agwu & Anyanwu, 1999).

Socio-Economic and Cultural Constraints Influencing the Adoption of FFS Programme:

Data in Table 03 show the socio-economic and cultural constraints influencing the adoption of the FFS programme. Based on the factor loading, four major sub-groups of variables were extracted.

Table 03: Varimax Rotated socio-economic and cultural factors influencing farmer adoption

Rotated Component Matrix[a]

	Component			
	1 Lack of resources to use new technology	2 Incompatibility of new technology	3 Complexity of new technology	4 Environmental barriers of using new technology
High cost of using new technologies	.715		-.430	
Lack of adequate technical knowledge about new technologies	.654			
Lack of resources to carry out necessary activities associated with new technologies	.593			
Difficulty of integrating new technologies into the existing farming system		.790		
Cultural incompatibility of technology adoption		.666		
Complexity in carrying out associated practices related to new technologies in the field			.876	
Environmental barriers against using new technologies				.745
Lack of adequate educational qualifications and experiences				.681

Source : Author Own data (2015)
Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 12 iterations.

As in this study, Adesina and Baidu-Forson (1995) have shown the socio-economic, demographic and institutional factors constraining the adoption of new technology. Cost of production and lack of access to extension services have been cited as the factors affecting adoption (Akudugo, 2012). In any event, the relationship between cost of production and adoption level of farmers has been found to be negative.

Constraints Associated with the Knowledge and Information Network of FFS Programme:

Table 04 shows the constraints associated with the knowledge and information network which influence the adoption of FFS programme. Based on the factor loading, three sub-groups of variables were extracted. The first group was named as ‘inadequate extension intervention’ while the second group of factors was named as ‘poor technical training’. The third group was named as ‘inadequate information on new technologies’.

The loading factors under the inadequate extension intervention include one positive factor loading variable (0.765). Anyhow, the study has shown that the availability of necessary information regarding new technology is satisfactory (-0.835). The second group of variables includes the ‘lack of technical training and meetings with technical specialist’ (0.739). The study shows that farmers have good information links with other actors of the network showing negative factor loading value for the given variable (-0.728).

Table 04: Varimax Rotated factors associated with information network influencing farmer adoption

Rotated Component Matrix^{a}

	Component		
	1 Inadequate extension intervention	2 Poor technical training	3 Inadequate information on new technologies
Unavailability of important information associated with new technologies	-.835		
Lack of influence of extension services and social learning	.765		
Lack of technical training and meetings with technical specialist		.739	
Poor information links and sharing with other actors of the network		-.728	
Lack of adequate information sources on new technologies			.730
Lack of trust in available information and information sources			.688

Source : Author Own data (2015)
Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 5 iterations.

Supporting the above facts, Adebiye and Okunlola (2013) have claimed that the probability of adoption by farmers was determined by availability of information. According to them, when the available information was adequate, 52 per cent of farmers had successfully adopted new technology. That study has highlighted the important role played by extension officers in encouraging farmers to adopt new technology.

Socio-economic and Cultural Constraints Militating Against the Adoption of *Yaya 2* Programme:

Similar Factor loading procedures were followed to ascertain the important variables which constrain the adoption of the *Yaya 2* Programme in *Hambantota* district. Based on the analysis, four major sub-components have been identified.

Table 05: Varimax Rotated factors associated with socio-economic and cultural constraints

	Rotated Component Matrix[a]			
	Component			
	1 Environmental and economic barriers	2 Poor educational competency	3 Inadequate resources	4 Incompatibility of new technologies
Environmental barriers against using new technologies	.834			
High cost of using new technologies	.630	.605		
Complexity in carrying out associated practices related to new technologies in the field	.505			
Lack of adequate educational qualifications and experiences		.893		
Lack of resources to carry out necessary activities associated with new technologies			.855	
Cultural incompatibility of technology adoption			.696	
Difficulty in integrating new technologies into the existing farming system				.793
Lack of adequate technical knowledge about new technologies				.732

Source : Author Own data (2015)

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 7 iterations.

Table 06: Varimax Rotated factors associated with information network influencing farmer adoption

Rotated Component Matrix[a]			
	Component		
	1 Inadequate Extension intervention	2 Limited access to information	3 Weak information link with actors
Lack of influence of extension services and social learning	.762		
Lack of trust on available information and information sources	.707		
Lack of technical training and meetings with technical specialist		.768	
Lack of adequate information sources on new technologies	-.463	-.716	
Poor information link and sharing with other actors of the network			.874
Unavailability of necessary information associated with new technologies		.498	.570

Source : Author Own data (2015)
Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 5 iterations.

Peer effect of technology adoption has been explained by Oster and Thornton (2011), focusing on the peer impact on technology usage. He has described that peer impact has less effect on individual decision for technology adoption. Further, Foster and Rosenzweig (1995), Conley and Udry (2010) and Bandiera and Rasul (2006) have discussed the positive impact of peer exposure on technology adoption. Anyhow, farmers in *Hambantota* district are constrained by poor information links with other peer actors of the network.

1.1.Regression analysis with the level of adoption with the constraining factor

For the simple linear regression analysis, study has converted the dependent variable into a binary variable: 1 for all stages in which at least a certain percentage of the farmers have reached a threshold level and 0 if not reach that level. Depending on the percentage of the adoption level at different stages of the study, different values were used as the threshold level as shown in Table7 and 8.

The Table 7 and 8 shows the model summary of regression analysis of each adoption stage of both technological programmes. *FFS 1* and *Yaya 1* represent the eight independent variables under socio-economic and cultural constraints and *FFS 2* and *Yaya 2* represents the six independent variables under the constraints associated with the knowledge and information network.

Table 07: Model summary of FFS programme

Model	**Threshold adoption level**	**R**		**R square**		**Adjusted R square**	
Adoption stage		**FFS 1**	**FFS 2**	**FFS 1**	**FFS 2**	**FFS 1**	**FFS 2**
Awareness	75 %	.718	.502	.515	.252	.330	.057
Interest	60 %	.607	.643	.369	.413	.129	.260
Evaluation	50%	.465	.438	.216	.192	-.083	-.019
Trail stage	50%	.473	.281	.224	.079	-.072	-.161
Adoption	40 %	.506	.555	.256	.308	-.028	.127
Discontinues	20%	.625	.494	.394	.244	.156	.047

Source: Author's own data (2015)

Table 08: Model summary of *Yaya* programme

Model	**Threshold adoption level**	**R**		**R square**		**Adjusted R square**	
Adoption stage		**Yaya 1**	**Yaya 2**	**Yaya 1**	**Yaya 2**	**Yaya 1**	**Yaya 2**
Awareness	75 %	.502	.408	.252	.167	-.033	-.051
Interest	60 %	.642	.444	.413	.197	.189	-.012
Evaluation	50%	.243	.472	.059	.223	-.299	.021
Trail stage	50%	.475	.464	.226	.215	-.069	.011
Adoption	40 %	.530	.511	.281	.261	.007	.068
Discontinues	20%	.506	.406	.256	.165	-.028	-.053

Source: Author's own data (2015)

Indicators of the above tables measure the quality of the prediction of the dependent variable. Anyhow, only few models shows significant values showing a good level of prediction and two models indicate poor level of prediction showing lowest value. (0.281 at trail stage of Table 01 and 0.243 at evaluation stage of Table 02).

Further, following two Tables show the statistical significance of the model at each stage using F value and significant value. Based on those tables the independent variables do not reliably predict the dependent variables of many models except awareness and Interest stages of FFS programme.

Table 05: Anova table for FFS programme

	F value		**Significance level**	
Adoption stage	FFS 1	FFS2	FFS 1	FFS2
Awareness	2.789	1.294	.028	.299
Interest	1.198	2.696	.347	.039
Evaluation	.723	.909	.670	.506
Trail stage	.756	.329	.643	.915
Adoption	1.687	1.706	.160	.165
Discontinues	.901	1.237	.533	.324

Source: Author's own data (2015)

Table 06: Anova table for FFS programme

Model	**F value**		**Significance level**	
Adoption stage	**Yaya 1**	**Yaya 2**	**Yaya 1**	**Yaya 2**
Awareness	.885	. .767	545	.603
Interest	1.843	.942	.125	.485
Evaluation	.165	1.101	.993	.392
Trail stage	.765	1.051	.636	.419
Adoption	1.025	1.354	.448	.275
Discontinues	.901	.759	.533	.609

Source: Author's own data (2015)

DISCUSSION AND LIMITATIONS OF THE STUDY

The results of the study have some interesting research implications, of which some are supported by previous studies, while some new facts have emerged in the context of the Sri Lankan scenario. First, the study has shown the perceptions of AI officers concerning the attitudes of farmers who are thinking of adopting new technology. The majority of AI officers perceived that only 40-60 per cent of farmers in their areas effectively adopted a given technology. Anyhow, the adoption rates of new technologies by farmers heavily depend on internal and external determinants of the farmers' network. Irrespective of those factors, the literature also supports the fact that only 40-60 per cent of farmers in the community effectively adopt the given technology (Muange & Schwarze, 2014; Uaiene et al., 2009; Bandiera & Rasul, 2002).

Secondly, the study has shown the percentage distribution of farmers by level of adoption as perceived by AI officers. The seven stages of the adoption process have been described by Ovwigho (2013) and the study used these seven stages for the analysis. Almost all farmers become aware of new technological programmes that are introduced by extension officers. Following up to the subsequent stages, nearly 50 per cent of the farmers finally adapt to the FFS and *Yaya 2* programmes in *Hambantota* district. Importantly, 16 and 9 per cent of the farmers who adopted these two programmes have discontinued. The prevailing constraints and issues have affected the programmes leading to the discontinuation of the technology. Onweremad and Njoku (2007) have pinpointed the specific factors influencing the information network that are responsible for causing the differences in participation at each stage of adoption. Further, the literature has strongly supported the fact that farmers' age, experience, and educational qualification would cause differences in the distribution at each stage. The AI officers in the *Hambantota* district also supported the above findings and have emphasized the importance of personal qualifications of farmers for the variation in adoption at different stages. In addition, active involvement of AI officers in those technological programmes would positively affect the adaptation of farmers at the different stages.

Concerning the constraints affecting the adoption of technology by farmers, the study shows constraints under two major categories separately for the FFS and *Yaya 2* programmes. Socio-economic and cultural constraints which influence adaptation to the FFS programme were divided into four major classes. Lack of resources to adopt new technology, incompatibility, complexity of new technology and environmental barriers against adopting FFS programme have been identified by the study. As in the case of the FFS programme, four major sub-components have been identified under the socio-economic and cultural constraints category that militate against the adoption of the *Yaya 2* programme. Environmental and economic barriers, poor educational competency, inadequate resources and incompatibility of new technologies with prevailing conditions are the four sub-groups of constraints that were extracted by the study.

Just as in the case of socio-economic and cultural constraints, the constraints associated with the knowledge and information network which impact on the adoption of the FFS programme were also extracted through the factor loading technique. Based on that, three sub-groups of variables were extracted. Inadequate extension intervention, poor technical training and inadequate information on new technologies were the three major groups of constraints on adoption of FFS programmes. Concerning the *Yaya 2* programme, three major groups of variables were identified. Poor extension intervention, limited information access and weak information link with actors were the extracted constraints associated with the knowledge and information link.

The study has a few limitations in respect of its methodological approach. One is the Questionnaire used to measure the adoption of new agricultural technology based on the perception of AI officers who serve as the external influencing agent for adoption. Many of the previous studies have measured the technology adoption based on the farmers' perception. Therefore, the study has limitation of justify the research findings based on limited literature supports which has done using perception of external influencing agent such as extension officers. Moreover, the major data collection approach of the study was based on a field survey using a semi-structured questionnaire. AI officers in *Hambantota* district come under two administrative divisions and mainly work at field level. Therefore, practical problems were encountered during field level data collection. The pre-identified variables were analyzed using the factor loading techniques with Varimax rotation techniques used to extract major subgroups of variables. It is also possible that there might be other important variables that were neglected in this study. Previous literature has also given evidence of similar variables which influence the farmer adoption. Since the study was based on the individual perceptions of AIs in *Hambantota* district, it can only be said that those factors would depend on the subjective opinions of AI officers as well as the location and socio-economic characteristics of the farming community. Also, the results could be different with respect to the other determinants and country specific factors.

CONCLUSION

The results of this study have some interesting research implications. First, the study shows that the adoption of new paddy technology by farmers in *Hambantota* district varied from 40-60 per cent. The study was based on the collective perceptions of AI officers in the district since the major source of knowledge and information for the paddy farmers are the Agricultural extension officers and public extension services in *Hambantota* district. The results showed that distribution of farmers at each stage of adoption were different percentage wise for FFS and *Yaya 2* programmes. Another striking result was that awareness about new technology was high in *Hambantota* district in Sri Lanka implying effective information sharing between extension workers and farmers. Further, this study showed that at all stages of adoption there was active involvement of AI officers while a significant percentage of farmers discontinued the use of new technology after a period due to prevailing circumstances. Another key outcome of the results was in pinpointing the major constraints which influence the farmer adoption for FFS and Yaya 2 programmes. Those constraints were categorized under two headings; socio-economic and cultural constraints and constraints associated with the knowledge and information network in the district. These findings seem to suggest a few policy implications in the Sri Lankan context. Particularly, the constraints associated with the extension services might lead to a slight change in the extension approach that is currently being used in *Hambantota* district for the two technology programmes. Concerning the adoption stages, the success of the awareness stage has to be followed up until the adoption stage is reached through intervention at every stage of adoption by the extension officers. Finally, the study has categorized the constraints and barriers facing farmers in *Hambantota* district when adopting any new paddy technology programme. The study has provided strong evidence to prove that it is essential to overcome the constraints which hinder the adoption rate through the intervention of extension services. The study has also shown the need for immediate action to eliminate barriers such as the lack of resources to adopt new technology programmes by introducing certain policy reforms in the agricultural sector.

REFERENCES

Adebiyi, S and Okunlola, J.O., 2013, Factors Affecting Adoption of Cocoa Farm Rehabilitation Techniques in Oyo State of Nigeria, World Journal of Agricultural Sciences 9 (3): 258-265, 2013, ISSN 1817-3047, IDOSI Publications, 2013, DOI: 10.5829/idosi.wjas.2013.9.3.1736.

Adesina, A.A, and Baidu-Forsen, J, 1995, Farmers' perceptions and adoption of new agricultural technology: evidence from analysis in Burkina Faso and Guinea, West Africa, Elsevier Science B.V. *SSDI* 0169-5150(95)01142-0.

Agbarevo and Machiadikwe N. B., 2013, Farmers' Perception of Effectiveness of Agricultural Extension Delivery in Cross-River State, Nigeria, IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS) e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 2, Issue 6 (Mar. - Apr. 2013), PP 01-07.

Agwu, A.E, and Anyanwu, A.C, 1999, Factors influencing the use of improved cowpea Technologies among farmers in Bauchi and Gombe states of Nigeria, Journal of Agricultural Extension, Vol.3.

Akudugu, M, A et al, 2012, Adoption of Modern Agricultural Production Technologies by Farm Households in Ghana: What Factors Influence their Decisions?, Journal of Biology, Agriculture and Healthcare, Vol 2, No. 3, 2012, ISSN 2224-3208 (Paper) ISSN 2225-093X (Online).

Bandiera, O., and Rasul, I., 2002, Social Networks and Technology Adoption in Northern Mozambique. Discussion Paper Series. London, UK, Centre for Economic Policy Research CEPR. April 2002.

Bandira, O and Rasul, I, 2002, Social Networks and Technology Adoption in Northern Mozambique, STICERD, London School of Economics and Political Science, London.

Chi, T.T.N, and Yamada, R., 2002, Factors affecting farmers' adoption of technologies in farming system: A case study in Omon district, Can Tho province, Mekong Delta, Omonrice 10: 94-100 (2002).

Conley T.G., Udry C., 2010, Learning about a new technology: Pineapple in Ghana. American Economic Review. 100, 35-69.

E.U. Onweremadu, E.U, and Njoku, E.C.M, 2007, Adoption Levels and Sources of Soil Management Practices in Low – Input Agriculture, Nature and Science, 5(1), 2007.

Foster A.D., Rosenzweig M.R., 1995. Learning by doing and learning from others: Human capital and technical change in agriculture. Journal of Political Economy. 103, 1176-209.

Katungi, E and Akankwasa, K. 2010, Community-Based Organizations and Their Effect on the Adoption of Agricultural Technologies in Uganda: a Study of Banana (Musa spp.) Pest Management Technology, AGRIS, Food and Agriculture Organization of the United Nation.

Loevinsohn, M, et al, 2012, Under what circumstances and conditions does adoption of technology result in increased agricultural productivity?, Social Science Research Unit, University of London.

Malhan, I.V. and Shivarama, R, 2007, Agricultural Knowledge Transfer in India: a Study of Prevailing Communication Channels, Library *Philosophy and Practice (e-journal).* Paper 110. .

Muange. E and Schwarze, S, 2014, Social networks and the adoption of agricultural innovations: The case of improved cereal cultivars in Central Tanzania, Socioeconomics Discussion Paper Series, Series Paper Number 18, The International Crops Research Institute for the Semi-Arid Tropics (lCRISAT).

Munshi, K, 2004, Social learning in a heterogeneous population: technology diffusion in the Indian Green Revolution, Journal of Development Economics 73 (2004) 185– 213

Mwangi, M and Kariuki, S., 2015, Factors Determining Adoption of New Agricultural Technology by Smallholder Farmers in Developing Countries, Journal of Economics and Sustainable Development, Vol.6, No.5, 201.

OECD, 2001, Adoption of Technologies for Sustainable Farming Systems, Wageningen Workshop Proceedings, Paris, France.

Oster, E and Thornton, R, 2012, Determinants of Technology Adoption: Peer Effects in Menstrual Cup Take-Up, Journal of the European Economic Association December 2012, DOI: 10.1111/j.1542-4774.2012.01090.

Ovwigho, B.O, 2013, A framework for measuring adoption of innovations: improved cassava varieties in Delta Nigeria, Extension System Farming Journal, Vol, 9, Research Forum, online access: http:// www.apen.org.au/extension-farming -system-journal.

Rogers, E. 1995, Diffusion of Innovations. New York: Simon & Schuster.

Rogers, E. M., 2010, Diffusion of Innovations. New York: Simon and Schuster.

Rogers, E.M., 2003, Diffusion of Innovations, New York: Free Press. 551 p

Sunding, D and Zilberman, D, 1999, The Agricultural Innovation Process: Research and Technology Adoption in a Changing Agricultural Sector, Handbook of Agricultural Economics, DOI: 10.1016/S1574-0072(01)10007-1.

Uaiene, R., Arndt, C., Masters, W. (2009) Determinants of Agricultural Technology Adoption in Mozambique. Discussion papers No. 67E, National Directorate of Studies and Policy Analysis Ministry of Planning and Development, Republic of Mozambique.