A framework for measuring adoption of innovations: improved cassava varieties in Delta State Nigeria

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Abstract. This study was designed to develop a framework for the measurement of adoption of innovations with particular reference to some improved cassava varieties. Simple random sampling was used to select extension cells and respondents. The sample size was thirty-four (34) cassava farmers. The adoption scale to measure the adoption of TMS cassava varieties was constructed using the Sigma scoring method. Data were analysed by use of percentage, mean and multiple regression. An r^2 value (0.87) showed that level of education, cosmopolitan outlook, membership of cooperative society and farm size were good predictors of adoption behaviours of the cassava farmers. The framework and procedure used in measuring adoption in this study are recommended to other researchers develop measures of adoption.

Keywords: framework, measurement, adoption, scale, innovations

Introduction

In its original concept, the term agricultural extension was used to mean the transfer of innovations or technologies from the research institutes, Universities, government and non-governmental organisations to farm families. Swanson (2008) stated that the term agricultural extension has changed over time. It was no longer restricted to the emphasis on technology transfer reflected by the Training and Visit System but has moved towards broader concepts which include developing the skills and management capacities of farming families. Extension helped to facilitate the access of farmers, their organisations and other market actors to knowledge and technology, and facilitate their interaction with partners. Today, the terms agricultural extension and advisory services are used interchangeably to denote a range of services rendered to farmers including transfer of technologies, out-of-School education, health care and hygiene, home economics, rural youth extension as well as variegated techniques for solving rural farmers' agricultural production problems.

CTA (2011), USAID (2011), and Ghiasy and Mirakzadeh (2012) maintained that extension and advisory services were designed to help farmers boost crops and livestock production. These services enable farmers to adopt new technologies for increase production and profitability. According to them, the specific objectives of agricultural extension and advisory services were to:

1. provide advice to farmers on problems or opportunities in agricultural production, marketing, conservation and family livelihood
2. facilitate development of local skills and organisations, and to serve as links with other programmes and institutions;
3. transfer new technologies to farmers and rural people
4. address public interest issues in rural areas, resource conservation, health and food security, monitoring agricultural production,, monitoring food safety, nutrition and family education as well as youth development.

Adoption of innovations has remained the major yardstick for determining the success or impact of agricultural extension services on the intended beneficiaries. Fishbein (1980), Oladele (2005), Pannell et al. (2006), and Parminter (2011) stated that the term adoption could be described as conscious decision to implement a new practice or apply a new technology on a continuous basis. It described the process of decision making and behaviour change. They agreed that during this decision-making process the intended beneficiaries could reject a change and seek to re-establish the previous practice or technology.

In the view of Parminter (2011), individuals appeared to have a number of adoption stages when they adopted a new technology and these stages have different requirements for industry support to encourage successful behaviour change. The works of Rogers (2003) gave historical and landmark credence to the stages of adoption of innovations. He divided the stages of adoption into awareness, interest, evaluation, trial and adoption. The stages were first published in the book, *'Diffusion of Innovations'* and have been used widely to study the stages of adoption. Other measures which could be used to measure the impact of agricultural extension services include positive changes in income and other socio-economic variables, record keeping, resource use efficiency, cosmopolitan outlook, attitude, perception, change proneness, social participation, fatalism and health care

Review and criticisms of approaches to measurement of adoption of innovations

Measurement is often intuitively defined as the assignment of numerals to objects or persons according to a rule. Measurement enables researchers to verify the true nature or characteristics of an object or person in order to make a decision and draw a relationship to other objects or persons within the environment. Thorndike and Hagen (1977) explained that measurement in any field involved three main stages: identifying and defining the quality or attribute that was to be measured; determining a set of operations by which the attribute might be made manifest and perceivable; and establishing a set of procedures or definitions for translating observations into quantitative statements of degree or amount.

Proper measurement of adoption of agricultural innovations is essential because of its relationship to the goal of transfer of technology enshrined in agricultural extension delivery. However, researchers have adopted various uncoordinated approaches to the measurement of adoption. The yes or no dichotomous responses appear the commonest approach to the measurement of adoption (Agwu 2001; Ovwigho and Ifie 2007; Imbur et al. 2008; Ifejika et al 2008; Hill and Linehan 2011; Sezgin et al. 2011). Agbamu (2006) mentioned five (5) procedures which could be used to measure adoption of agricultural technologies. These were: (i) obtaining adoption index through the use of the Sigma scoring method; (ii) calculating the percentage of adopters; (iii) assigning numerical values to each stage of the adoption process; and (iv) use of Likert scale; and (v) mean scores for disaggregated levels of adoption. He stated that the Sigma scoring method involved converting frequency counts to normal scores (Table 1). The use of percentage involved asking farmers to respond yes (1) or no (0) to the technologies they have adopted. The adoption level was a summation of the numerical values of the yes responses. Iwueke (1990) explained that the use of Likert scale involved assigning numerical values to each stage of adoption. The values he assigned were 0 (unaware), 1 (aware), 2 (interest), 3 (evaluation), 4 (trial), 5 (adoption), 0 (reject), and 4 (discontinuance). Imbur et al. (2008) divided the adoption stages into not aware, aware, interest, evaluation, trial, (Figure 1) using (adoption) and rejection and measured each of these stages as percentage of the total respondents. The fault in this method was that number of respondents who are not aware ought to have been excluded in calculating the percentage adoption for the remaining stages.

Table 1. Adoption scores for eleven soil management practices

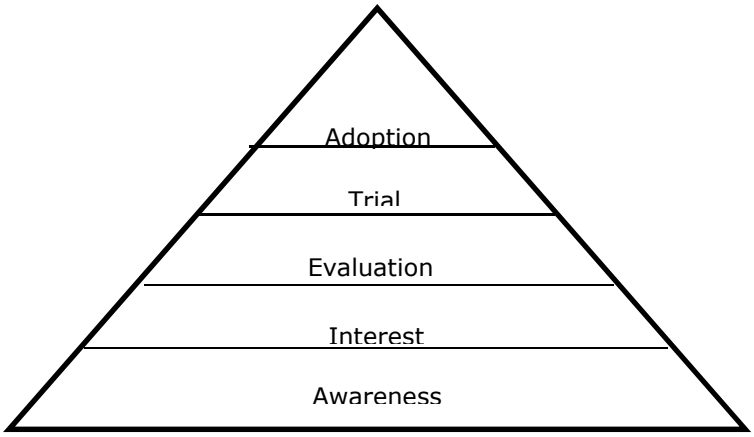
S/N	*Soil Management Practices*	*No. of Adopters*	*% of Adopters N=160*	*Adoption Score*
1	Use of inorganic fertilisers	56	35	4.13
2	Use of organic matter	12	8	2.50
3	Organic manure + inorganic fertilisers	1	0.6	0.51
4	Soil testing before fertiliser application	2	1.3	0.98
5	Minimum tillage	76	47.5	4.57
6	Zero tillage	84	52.5	4.73
7	Slash and manual removal of biomass	9	6.0	2.24
8	Slash and burn	126	79.0	5.47
9	Use of light equipment for ploughing the soil	2	1.3	0.98
10	Soil conservation (mulching and erosion control)	15	9.4	2.65
11	Multiple cropping practices	94	59.0	4.92
	Total Score = 33.68,	Mean = 3.1		

Source: Agbamu, J. U. 2006

Virtually all the scales used by researchers in the field of adoption were nominal and ordinal. The inability of researchers in the field of adoption of agricultural innovations to go beyond the use of indexes and percentage apparently negates drawing a relationship between adoption and variables that are measured at close to interval or interval level such as socio-economic status, income, academic performance and level of education. Ovwigho (2011) noted that adoption was

a psychological construct related to socio-economic status. It is necessary to appropriate a higher statistical measurement because of its relative importance to agricultural extension development. This study is, therefore, designed to develop a framework and scale for the measurement of adoption. The specific objectives were to: (i) develop a framework for the measurement of adoption of innovations; (ii) construct a scale to measure adoption of a package of TMS cassava varieties; (iii) describe adoption scores of the improved cassava varieties; and (iv) find the relationship between adoption and level of education, cosmopolitan outlook, membership of cooperative society and farm size.

Figure 1. Stages of adoption



Source: Williams et al (1984)

Methodology

Sampling technique and sample size

Simple random sampling was used to select extension cells and respondents. An extension cell is a village of average of about ten farmers under the supervision of an extension agent. Ten percent of the extension cells corresponding to 3, 5 and 6 were randomly selected from Delta South, Delta Central and Delta North agricultural zones respectively. One percent of the cassava farmers corresponding to 7, 12 and 15 were randomly selected from the cells in each of the agricultural zones. Thus the sample size was thirty-four cassava farmers.

Measurement of variables

The major variables of study were adoption, level of education, membership of cooperative society, farm size and cosmopolitan outlook. Ekong (2003) stated that a person with a good cosmopolitan outlook was one whose interest and experience was broader than his local community. Thus cosmopolitan outlook was measured by the number of times the respondent has travelled out of his immediate community to seek agricultural information for the past two years. Farm size was measured in hectares. Local measurements provided by a farmer were converted to hectares. Membership of cooperative society was measured by yes or no dichotomy. Level of education was measured in years, which correspond to the level of formal education of the respondent. Adoption was measured with the adoption scale constructed for the purpose of the study.

Method of data collection and analysis

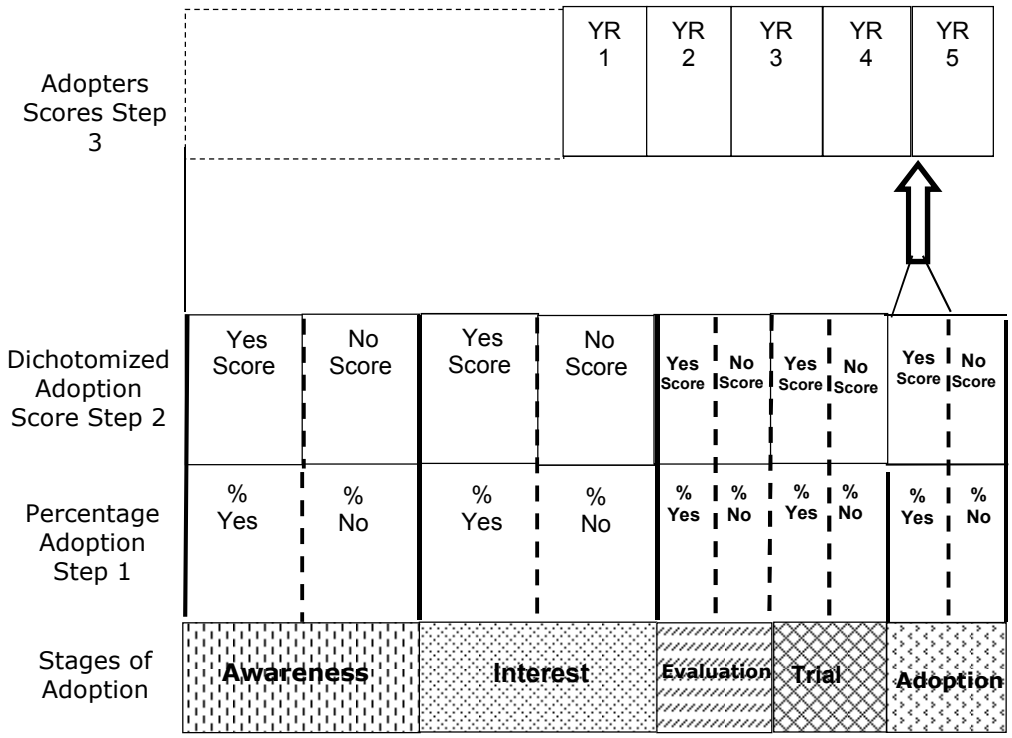
Data were collected by the use of an interview schedule. The data were collected from both primary and secondary sources. The secondary sources consisted of literature on the processes of adoption. These processes were used to construct the framework for the measurement of adoption. The primary sources consisted of information collected from sampled cassava producers on adoption of a package of five (5) proven cassava varieties. The improved cassava stem cultivars were Tropical *Manihot* Selection TMS 30555, TMS 30572, TMS 4(2)1425, TMS 30395, and TMS U/41045. These varieties of cassava were developed by the International Institute for Tropical Agriculture, Ibadan. The adoption scale was constructed by the use of the Sigma scoring method. Ovwigho (2011) made use of the Sigma scoring method in the construction of a socio-economic status scale for heads of rural farm families in the Delta north agricultural zone of Delta state, Nigeria. Data were analysed by use of simple percentage, mean and multiple regression.

Results and discussion

Framework for the measurement of adoption

Many researchers, including Williams et al. (1984), Rogers (2003) and Vijayabhinandana (2007) agreed that adoption of agricultural innovations followed hierarchical or pyramidal stages namely awareness, interest, evaluation, trial and adoption (Figure 1). Furthermore, Singh (1965) as cited by Vijayabhinandana (2007) argued that the five-stage process of adoption was dynamic and not static. He developed a seven stage processes of adoption namely need, awareness, interest, deliberation, trial, evaluation and adoption. In this study, the five stage processes of adoption were used to develop a framework for the measurement of adoption (Figure 2). The five stages are awareness, interest, evaluation, trial and adoption. More people were usually aware during the introduction of a new technology. The cassava farmers were asked to tick yes or no against the stages of adoption of the packaged TMS cassava varieties. The percentage yes or no were calculated. The percentage values were transformed to Sigma scores and standard scores. Adopters were further asked to indicate the number of years they have made use of the new technology. The percentage values were scored and standardised using Sigma scoring method. The total scores for an individual were added up from stage one to three of the framework. A five-year period was considered long enough for farmers to have fully adopted the technology.

Figure 2. Bar chart framework for measuring adoption



Construction of scale for measurement of adoption of the TMS cassava varieties

The scale for adoption of the five packaged improved cassava varieties was developed using the bar chart framework depicted by Figure 2. The first stage involved calculating the percentage scores for the five adoption stages (Table 2). The frequency of the yes and no responses were transformed to standard scores using Sigma scoring method as shown in stage 2.. The standard scores for the five stages are shown in the last column of Table 2. In Table 3, the frequencies of response to the years of adoption were transformed to standard scores. The scores are shown in the last column. The scores in Tables 2 and 3 were used to construct the adoption scale for the packaged TMS improved cassava varieties. This gave rise to the scale shown in Table 4. The scale consisted of aware (4), not aware (0); interested (4), not interested (0); evaluated (4), did not evaluate (0); tried (4), did not try (1); adopted (4), did not adopt (0); one year adoption (0), two years adoption (2), three years adoption (3), four years adoption (5) and five years adoption (7). The maximum and minimum scores on the scale were 27 and 1 respectively. In other words, a respondent who did not try the use of the TMS cassava varieties would still score one (1). This scale overcomes the lack of empirical validity caused by arbitrary assignment of numbers to adoption stages by most researchers. The scale constructed in this

study approximates the interval scale since there is no true zero point. Joe (1992) noted that the interval scale of measurement lacks an absolute zero. A zero score on the scale is not a complete absence of the property being measured.

Table 2. Sigma scores for stages of adoption (N=34)

Adoption Stages	*Response Categories*	*F*	*%*	*Proportion*	*Z*	*Standard score (Z + 2) × 2*	*Z Rounded*
Awareness	Yes	32	94.12	*P* = 0.529	0.073	4.146	4
	No	2	5.88	*P* = 0.029	-1.896	0.208	0
Interest	Yes	32	100	*P* = 0.50	0.00	4.000	4
	No	0	0.00				0
Evaluation	Yes	32	100	*P* = 0.50	0.00	4.000	4
	No	0	0.00				0
Trial	Yes	27	84.38	*P* = 0.578	0.197	4.394	4
	No	5	15.63	*P* = 0.078	-1.419	1.162	1
Adoption	Yes	27	100	*P* = 0.50	0.00	4.000	4
	No	0	0.00				0

Table 3. Sigma scores for years of adoption (N=27)

Years Adopted	*F*	*CF*	*CFM*	*CPM*	*Z*	*Standard Scores (Z + 2) × 2*	*Z rounded*
5	5	27	24.5	0.907	1.323	6.646	7
4	9	22	17.5	0.648	0.380	4.760	5
3	8	13	9	0.333	-0.432	3.136	3
2	3	5	3.5	0.130	-1.126	1.748	2
1	2	2	1	0.037	-1.787	0.426	0

Note: F- Frequency; CF – Cumulative Frequency; CFM – Cumulative Frequency to Mid-point; CPM – Cumulative Proportion to Mid-point; Z – Sigma score (checked from the Table of Z normal deviates

Table 4. Adoption scale for packaged TMS cassava varieties (N=34)

Level of Adoption	*Response Categories*	*Score*
Awareness	Yes (aware)	4
	No (not aware)	0
Interest	Yes (interested	4
	No (not interested)	0
Evaluation	Yes (evaluated)	4
	No (did not evaluate)	0
Trial	Yes (tried)	4
	No (did not try)	1
Adoption	Yes (adopted)	4
	No (did not adopt)	0
Years of Adoption	5	7
	4	5
	3	3
	2	2
	1	0
	Minimum = 1	Maximum=27

Description of the adoption scores for TMS cassava varieties

The scale was applied in the measurement of adoption of the packaged TMS cassava varieties by the farmers. The adoption scores generated were presented in Table 5. The distribution of the adoption scores were: 18 (23.53%), 19 (14.71%), 21 (8.82%), 15 (8.82%), 14 (8.82%), 9 (8.82%), 27(5.88%), 23 (5.88%), 7 (5.88%), 26 (2.94%), 10 (2.94%), and 5 (2.94%). The mean score was 16.74 and mode 18

Table 5. Frequency distribution of adoption scores (N =34)

Adoption Score	*Frequency*	*Percent*	*Mean*
27	2	5.88	
26	1	2.94	
23	2	5.88	
21	3	8.82	
19	5	14.71	16.74
18	8	23.53	
15	3	8.82	
14	3	8.82	
10	1	2.94	
9	3	8.82	
7	2	5.88	
5	1	2.94	
Total	34	100.00	

Relationship between adoption and selected socio-economic characteristics

Adoption scores when measured at the interval level could be regressed on similar variables. The relationship between adoption and education, cosmopolitan outlook, membership of cooperative society and farm size was tested by multiple regression (Table 6). An r^2 value (0.87) showed that level of education, cosmopolitan outlook, membership of cooperative society and farm size could be used to predict 87% of the variation in adoption behaviours of farmers. The significant variables were level of education, membership of cooperative society and farm size. In a similar study, Sezgin et al. (2011) found a significant relationship between adoption of artificial insemination and farmers' age, level of education, mass media use and participation in agricultural extension activities. However, in their data analysis they made use of logistic regression since they could not measure adoption at interval level.

Table 6. Multiple regression results of relationship between adoption and level of education, cosmopolitan outlook, membership of cooperative society and farm size

Variables	*B*	*Standard Error*	*Beta*	*t*	*P value*
Constant	-1.973	3.818	-	-0.517	0.621
Level of Education	0.180	0.076	0.630	2.358	0.051**
Cosmopolitan Outlook	-0.102	0.179	-0.155	-0.572	0.585
Membership of Cooperative	7.849	2.439	0.547	3.217	0.015 *
Farm Size	0.545	0.200	0.464	2.721	0.030**
		r^2 =	0.865		
		F =	11.185		0.004

Conclusion

The framework for measuring adoption consists of awareness, interest, evaluation, trial and adoption. Following the framework a scale to measure the adoption of the packaged TMS varieties of cassava was developed. The highest and lowest scores on the scale were 27 and 5 respectively. The scale made it possible to measure adoption at interval level and relates the scores to other variables, which were also measured at the interval level. Level of education, membership of cooperative society, and farm size were found to be good predictors of adoption of TMS cassava varieties. Researchers could follow the procedure outlined in this study to develop a scale for measurement of adoption instead of mere arbitrary assignment of figures to adoption stages.

References

Agbamu JU 2006, Essentials of agricultural communication in Nigeria, Malthouse, Lagos.

Agwu AE and Ayanwu AC 2000', Factors constraining farmers' use of improved cowpea technologies in Bauchi and Gombe states of Nigeria', *Agro Science Journal of Tropical Agriculture, Food, Environment and Extension*, 1(2): 30-41

Ekong EE 2003, *Introduction to rural sociology*, Dove Educational Publishers, Uyo, Nigeria.

Fishbein M 1980,'A theory of reasoned action: some applications and implications, in H Howe and M Page (Eds), *Nebraska Symposium on Motivation*, 27: 65-116, University of Nebraska Lincoin

Ghiasy FG and Mirakzadeh A 2012,'Analyzing of agricultural Wheat farmers behavior related to agricultural advisory services', *World Applied Sciences Journal*, 16(9):1321-1328.

Hill M and Linehan C 2011, 'Adoption of centre pivot irrigation in the irrigated dairy industry of south eastern Australia', *Extension Farming Systems Journal*, 7(1): 29-36

Imbur EN, Agwu AE, Akinnagbe OM 2008,' Adoption of citrus production technologies among farmers in Katsina-Ala Local Government Area of Benue State, Nigeria, *Journal of Agricultural Extension*, 1: 14-24

Ifejika PI, Akinbile LA, Ifejika LI and Oladeji JO 2008,' The socio-economic effects of adoption of aqua cultural technologies among fish farmers in Anambra State, Nigeria, Journal of Agricultural Extension, 11: 74-86

Iwueke CC 1990,' Adoption Behaviour of farmers toward yam minisset technique in Imo state, Nigeria, *Nigerian Agriculture Journal*, 25 (2): 16-17

Joe AI 1992, *Fundamental statistics for education and the behavioural sciences*, Kraft Books Limited, Ibadan

Oladele OI 2005,'A tobit analysis of propensity to discontinue adoption of agricultural technology among farmers in south western Nigeria', *Journal of Central European Agriculture*, 6(3): 250-254.

Ovwigho BO and Ifie PA 2007,'Socio-cultural factors affecting adoption of snailery in Delta central agricultural zone of Delta state, Nigeria, *Research Journal of Applied Sciences*, 2(1): 26-30

Ovwigho BO 2011,'Construction of a socio-economic status scale for heads of rural farm families in the north agricultural zone of Delta state, Nigeria', *Journal of Human Ecology*, 33 (2): 26-30.

Pannell D, Marshall G, Barr N, Curtis A, Vanclay F and Wilkinson RL 2006,'Understanding and promoting adoption of conservative practices by rural landholders', *Australian Journal of Experimental Agriculture*, 6(11): 1407-1424.

Parminter T 2011,'Pathways for innovations: influence of industry structures and producer social networks', *Extension Farming Systems Journal*, 7 (1): 1-10

Rogers EM 2003, *Diffusion of innovations*, Simon and Schuster, New York.

Swanson BE 2008, *Global review of good agricultural extension and advisory services*, FAO, Rome.

Sezgin A, Kaya TE, Kulekci M and Kumbasaroglu H 2011,'Factors affecting the adoption of agricultural innovations in Erzurum province Turkey', *African Journal of Business Management*, 6 (3): 777-782.

Technical Centre for Agricultural and Rural Cooperation, CTA 2011,'Three steps towards modernisation of agriculture'. *Spore Special Edition*, August, 2011, pp. 18-22

Thorndike RL and Hagen EP 1977, *Measurement and evaluation in psychology and education*, John Wiley and Sons inc. , New York

United States Agency for International Development, USAID 2011,*Rural extension and advisory services*, USAID Agriculture

Vijayabhjinandana B 2007,*Communication and diffusion of agricultural innovations*, National Institute of Agricultural Extension Management, Pradesh, India

Williams SKT, Fenley JM, and Williams, CE 1984,*A manual for agricultural extension workers in Nigeria*, Les Shyraden, Ibadan.