Pooled innovativeness and learning-pattern based adopter categorization

Chandre Gowda MJ[1], Shrishail Dolli[2], Durga Prasad MV[3], Saravanan D[4] & Sreenath Dixit[1]

[1] ICAR-Agricultural Technology Application Research Institute, Bengaluru 560024, Karnataka, India
[2]Agricultural Extension, University of Agricultural Sciences, Dharwad, Karnataka, India
[3] Institute of Rural Management (IRMA), Anand 388001, Gujarat, India
[4] Samuha NGO, Kanakagiri, Koppal District, Karnataka-583283
ICAR-Agricultural Technology Application Research Institute, Bengaluru, Karnataka, India
Email: maravalalu@yahoo.com

Abstract. Early studies on diffusion assumed that farmers adopt one innovation at a time, and hence adopter categorization was innovation specific. Since many innovations are being introduced by different agencies, pooled relative earliness for the multiple innovations adopted was computed, resulting in Innovators, Early Adopters and Late Adopters. This linear approach has limitations in explaining the complex innovation-adoption process, therefore, innovation learning pathways expressed as knowledge index, was used in further categorization. High-knowledge late adopters were sub-categorized as Informed Late Adopters. Similarly, low-knowledge innovators were sub-categorized as Ignorant Adopters. Profile analysis confirmed prevalence of categories ranging from Ignorant Adopters to Late Adopters and Informed Late Adopters to Innovators. Identification of Ignorant Adopters is critical for delivering targeted solutions by the extension system, demanding a shift in focus from innovators. Enhanced competencies among extension personnel are also required for adopting a techno-socio-psychological approach. Informed Late Adopters have a crucial role to play in promoting sustainable agriculture.

Keywords: Innovation learning pathway, Knowledge of innovations, adopter category, innovativeness, extension

Introduction

Agricultural innovations are crucial for the development of agrarian economies. Despite the long history of innovations in increased effectiveness on food production, the Diffusion of Innovations model proposed by Rogers (1983) has been criticised for its inability to respond to complex challenges and rapidly changing contexts including the shift to sustainable development (Roling 1988). In pursuit of alternate paradigms, the focus shifted to a systems approach (Byerlee, Harrington & Winkelmann 1982) and participatory approaches (Chambers 1994). In the search of new models of innovation systems, the Agriculture Knowledge and Innovation System (Roling & Engel 1991) was developed. It is a useful concept to describe a system of innovation, with emphasis on the organisations involved, the links and interactions between them, the institutional infrastructure with its incentives and budget mechanisms. Similarly, the Agricultural Innovation Systems (AIS) looked at the multiple conditions and relationships that promote innovation in agriculture (The World Bank 2012). In a pluralistic extension system, extension policies and strategies need to define effective division of labour between public and other providers (Alex et al. 2004). The comprehensive AKIS/RD (Rivera, Qamar & Mwandemere 2005) looks like a web of crisscrossing connections, and could be much more complicated for a country like India which has huge diversity of actors ad varying degrees of heterogeneity within each actor system.

The technical learning pathway, one of the three pathways that constitute the agricultural knowledge system in the network age (Lubell, Niles & Hoffman 2014), deals with the traditional means of knowledge transfer to farmers and other organizations involved in agriculture. Several stakeholders, including government and non-government sectors, are involved in this pathway. Agricultural knowledge is produced and distributed by a network of diverse types of actors, which are heterogeneous across contexts (Lubell, Niles & Hoffman 2014). Knowledge and innovations systems, knowledge networking and social networking are the emerging concepts related to technology diffusion, sharing and adoption. Interestingly, the Rogerian approach is still influencing diffusion research in many fields as evident by research conducted by Mahajan, Muller & Srivastava (1990); Eva, Yolanda & Carlos (1998); Diederen et al. (2003); Juhani & Marius (2003); Less (2003); Zayim, Yildirim & Saka (2006); Kauffman & Angsana (2009); Salah & Philippe (2010); Tucker (2011); John (2012); and Sara & Luis (2014). These efforts are presented in the ensuing review section in greater detail.

Adopter categorization – a review

Ryan & Gross (1943) were the first to use adopter categories although they did not use the five categories proposed by Rogers (Rogers, Singhal & Quinlan 2004). Many of the past efforts used innovativeness as the basis for adopter categorization. Mahajan, Muller & Srivastava (1990)

followed by Eva, Yolanda & Carlos (1998) used the Bass diffusion model and suggested five categories as did Rogers. Less (2003), Nithyashree & Siddaramaiah (2003) and John (2012) also classified respondents based on innovativeness, although the number of categories finally arrived at differed. In the study of faculty members, Less reported a higher proportion of respondents in the first three categories and fewer respondents in the last two categories. On the other hand, John reported more laggards and fewer in all other categories. Tucker (2011) categorized young people on the selection of mobile phones by asking a few forced choice questions, each of which directly correlated to one of the categories from Rogers' diffusions of innovations or Peter Zollo's teen/type categories (the Edge, Influencers, Conformers and Passives Teens). The categories from the two models were collapsed into four, in order of their place in the diffusion chain, as Innovators, Influencers, Majority and Laggards.

Anderson, Varnhagen & Campbell (1998) also followed the Rogers classification but dealt with two main groups 'earlier adopters' (innovators & early adopters together) and 'mainstream faculty' (early majority and late majority together). Zayim, Yildirim & Saka (2006) used the self-assessment of competency and use of information technologies as the basis for segregating Early Adopters (EA) from Mainstream Faculty. The assumption was that EAs have come to use the technologies earlier and thus have gained more skill and experience relative to a majority of the faculty. They classified adopters into two categories namely Early Adopters and Mainstream group. By using Rogers' adopter categories and innovativeness scores, 16 per cent of the respondents were assigned to the Early Adopter group (2.5 per cent Innovators+13.5 per cent Early Adopters), and 84 per cent of the respondents were assigned to the Mainstream group (34 per cent Early Majority+34 per cent Late Majority+ 16 per cent Laggards). Juhani & Marius (2003) used strategic/technological understanding of eCommerce and maturity of their websites as the basis for adopter categorization. At the first level, they suggested three major adopter categories: procrastinators (low understanding and low website maturity), followers (intermediate understanding and varying website maturity), and visionaries (high understanding and a mature website). As there was considerable variation among Followers, this group was divided further into opportunists (no clear-cut strategy), waverers (average understanding and maturity), and striders (externally induced).

Diederen et al. (2003) used nested logit model, to analyse the choice of a farmer to be an innovator, an early adopter or a laggard (an adopter of mature technologies or a non-adopter) in the adoption of innovations that are available on the market. It is a two-level choice making process. At the first level, a farmer chooses between being a frontrunner or a laggard. If he is a frontrunner then at the second level he has to choose between being an innovator or an early adopter. Kauffman & Angsana (2009) adopted a two-step analysis approach, first evaluating the distribution of adopters over time using various diffusion models and secondly using iterative survival analysis which suggested four adopter categories: innovators, early adopters, breakthrough adopters, and mainstream adopters. A new hybrid category named 'Leading-edge Opinion Leaders' was suggested by Salah & Philippe (2010) seen as emerging from the known innovators and early adopter categories. Sara & Luis (2014) identified late adopters through three dimensions - rate of adoption, resistance to innovation and scepticism.

Problem statement and the objective

A systems approach to understand agricultural networks could be better than linear approaches, but at the same time can pose problems for the extension system to use and adopt, in practical terms. For example, Leeuwis, Long & Villarreal (1990) expressed concern over the shift from "hard" to "soft" systems thinking, and the development of a more explicit and elaborated methodology, suggesting that there remains a number of important theoretical and practical problems. Studies have revealed constraints in the public extension system of India, including being overburdened with implementing state and centralized schemes, vacancies, insufficient funds for educational activities, and working in isolation due to weak linkages (Sulaiman, Hall & Suresh 2005).

This study is an attempt to facilitate a simpler understanding of the innovation learning pathway among Indian farmers. It was hypothesised that innovation learning patterns differ within the same category of innovativeness. It was also hypothesised that farmers adopt multiple innovations, and at different relative earliness for each innovation. Thus, based on a combination of relative earliness/innovativeness and learning patterns, through a two-stage process, new adopter categories were identified. Analysis of related parameters like domain-specific innovativeness, number of innovations adopted, time taken to complete adoption process and extension participation, besides the family profile in terms of socio-economic status, was expected to provide profiles of the new categories. The overall objective was to arrive at a new typology of

innovation learning that enables extension programs to target their efforts and limited resources towards enhanced effectiveness and reach.

Methodology

Farmers cultivating maize, paddy, groundnut, cotton and potato crops in ten villages of Gujarat state and eleven villages of Karnataka state in India, constituted the population for the study. Innovations adopted in the areas of seeds, irrigation method, micronutrients, pesticide and marketing were identified through focus group discussion. The time of introduction and year-wise spread in the community was also elicited through group discussion. Growers of the identified crop were randomly chosen for further observation and personal interviews. Data related to innovation learning pattern, knowledge of innovations and related parameters were elicited using structured schedule, checklist and scales. Data and observations from 736 farmers in 21 villages were collected during the cropping seasons of 2014-15 and 2015-16.

Pooled relative earliness was used as the criterion to categorize farmers in the first stage, as described below. For each innovation adopted in the village, farmers were listed and sorted chronologically based on the time of adoption of the innovation for the first time. Earliness of farmer "x" for innovation "I_1" in each village was worked out indicating the number of months farmer "x" is earlier than the last adopter for the same innovation in the village. The earliness score for the last adopter(s) for each innovation was zero. Earliness values were converted into unit scores (Zxi) by using the formula:

$$Zxi = \frac{Exi}{Efi} \quad (1)$$

Where:

Zxi is the unit score of farmer x on i^{th} innovation
Exi is the earliness value of farmer x
Efi is the earliness value of first adopter for i^{th} innovation
The Zxi values range from 0 (for the last adopter/s) and 1 (for the first adopter/s).

This process was repeated for "n" innovations for all the farmers in each village. Pooled innovativeness was worked out as the average of Z_{xi} scores for each farmer. Using the mean and standard deviation of pooled innovativeness for all the adopters in a village, farmers were categorized into innovators (>mean+½SD), early adopters (mean-½SD to mean+½SD), and late adopters (< mean-½SD).

In the second stage, farmers' innovation learning and knowledge acquisition process was studied using the number of sources, nature of the activities carried out and extent of knowledge acquired. Based on the type of sources of innovations (known/unknown, formal/informal), number of sources contacted (single/multiple) and activities carried out (passive, observation, discussion, verification) during innovation learning, each farmer was categorized in one of the four categories *viz*. "single unknown source/passive", "single informal source/active", "multiple sources/informal/active" and "multiple sources/formal & informal/ active", and the responses were scored 0, 1, 2, and 3 in that order. Knowledge of the innovations was scored using the three-point continuum of no knowledge, partial knowledge and complete knowledge with a score of 0, 1 and 2 respectively. The combination of the two resulted in the knowledge score for each innovation, which ranged from 0 to 5. This process was done for all of the innovations adopted by each farmer on the major crop of each village. The pooled knowledge score was converted into index values. Innovators with less than mean values of knowledge index were sub-categorized as "Ignorant Adopters". Similarly, Late Adopters with more than mean values of knowledge index were further segregated as "Informed Late Adopters". The two-stage classification can be seen in Table 1 and Table 2 for two villages, a peanut growing village in Junagadh district and a cotton growing village in Botad district of Gujarat state.

Mean knowledge index values of ignorant adopters and late adopters ranged between 10 and 50, confirming that these categories were on par with each other on knowledge of innovations. On the other hand, Innovator and Informed Late Adopters were on par with knowledge index values ranging between 40 and 100.

This two-stage adopter categorization process was done for farmers in 21 villages on five crops. The profile of the new adopter categories was studied in terms of domain specific innovativeness, socio-economic status and extension parameters. A farmer's domain specific innovativeness was measured using the five-statement scale proposed by Goldsmith & Hofacker (1991). The socio-economic status of a farmer's family was measured by using the 22 parameters scale with a

maximum value of 100 proposed by Aggarwal et al. (2005). These scales were translated to local language and were tested for reliability and validity before use.

Table 1. Two-stage adopter categorization of peanut farmers in a Gujarat village

Farmer	Zxi for Chemical	Zxi for Variety	Zxi for Sprinkler	Pooled Innovativeness	Innovativeness adopter category	Knowledge Index	Knowledge adopter category
1	0.29	1.00	0.87	0.72	I	86.7	I
2	0.71	0.50	0.80	0.67	I	86.7	I
3	0.14	0.75	1.00	0.63	I	86.7	I
4	0.71	1.00		0.86	I	80.0	I
5			0.73	0.73	I	80.0	I
6	0.57	1.00	0.33	0.63	I	80.0	I
7	0.43	1.00	0.47	0.63	I	80.0	I
8	0.57	1.00		0.79	I	60.0	IgA
9	0.57	1.00	0.47	0.68	I	60.0	IgA
10	0.71	1.00	0.33	0.68	I	40.0	IgA
11	0.29	1.00		0.64	I	33.3	IgA
12	0.71	1.00	0.13	0.62	EA	60.0	EA
13	0.71	1.00	0.07	0.59	EA	73.3	EA
14	0.71	0.75	0.27	0.58	EA	80.0	EA
15	0.57	0.50		0.54	EA	33.3	EA
16	0.29	0.75		0.52	EA	73.3	EA
17	0.71	0.50	0.33	0.52	EA	80.0	EA
18	0.43	0.50	0.60	0.51	EA	80.0	EA
19	0.57	0.25	0.67	0.50	EA	80.0	EA
20	0.29	0.50	0.60	0.46	EA	60.0	EA
21	0.14	0.75	0.47	0.45	EA	33.3	EA
22	0.43	0.25	0.47	0.38	LA	86.7	ILA
23	0.14	0.25		0.20	LA	86.7	ILA
24	1.00	0.00	0.07	0.36	LA	80.0	ILA
25	0.57	0.25	0.47	0.43	LA	60.0	LA
26	0.43	0.75	0.07	0.42	LA	60.0	LA
27	0.50	0.25	0.40	0.38	LA	60.0	LA
28	0.29	0.75	0.00	0.35	LA	60.0	LA
29	0.57	0.25		0.41	LA	33.3	LA
30	0.00	0.25	0.13	0.13	LA	26.7	LA
			Mean	0.53		66.00	
			SD	0.17			

I=Innovator, IgA=Ignorant Adopter, EA=Early Adopter, ILA=Informed Late Adopter, LA=Late Adopter

Other variables were measured using the schedule of questions related to extension participation, source of information and time taken to pass through the innovation decision process. Extension participation was measured by asking the respondent farmers about frequency of participation in extension activities on a three-point continuum *viz*. regularly, occasionally and never and given a score of 2, 1 and 0 respectively for each activity. Mean and standard deviation were used to categorize farmers into low, medium and high level on extension participation. Farmers' sources of information were categorized as institutional, community and private. Public extension departments, research institutions and mass media were considered as institutional sources of information. Community sources of information included progressive farmers, friends and relatives and neighbouring farmers. Input dealers, private company representatives, marketing agents, middlemen and traders were considered as private sources of information.

The adopter categorization data were subjected to decision tree analysis using the R software. Similarities and resemblance of farmers' categories in terms of personal and psychological characters were tested using discriminant function analysis. Significance of the differences in mean values among the five categories was estimated using F values of ANOVA. Chi-square was used for the test of association or independence of adopter categories on extension participation.

Table 2. Two-stage adopter categorization of cotton farmers in a Gujarat village

Farmer	Zxi for Variety	Zxi for Chemical	Zxi for Marketing	Pooled Innovativeness	Innovativeness adopter category	Knowledge Index	Knowledge adopter category
1	1.00	0.86	1.00	0.95	I	80.0	I
2	1.00	1.00	0.65	0.88	I	80.0	I
3	0.67	0.71	0.90	0.76	I	73.3	I
4	0.67	0.86	0.70	0.74	I	73.3	I
5		0.71	0.65	0.68	I	66.7	I
6	0.67	0.57	0.70	0.65	I	66.7	I
7	1.00	0.71	0.80	0.84	I	46.7	IgA
8		0.71	0.95	0.83	I	46.7	IgA
9	1.00	0.71	0.75	0.82	I	46.7	IgA
10	1.00	0.86	0.55	0.80	I	46.7	IgA
11		1.00	0.55	0.78	I	46.7	IgA
12		0.71	0.95	0.83	I	33.3	IgA
13	1.00	0.86	0.70	0.85	I	20.0	IgA
14		0.86	0.25	0.55	EA	80.0	EA
15	0.67	0.43	0.55	0.55	EA	53.3	EA
16	0.33	0.71		0.52	EA	73.3	EA
17	0.67	0.29	0.50	0.48	EA	53.3	EA
18	0.67	0.43	0.35	0.48	EA	53.3	EA
19	0.33	0.71	0.35	0.47	EA	53.3	EA
20		0.86	0.05	0.45	EA	53.3	EA
21	1.00	0.29	0.05	0.45	EA	73.3	EA
22	0.00	0.57	0.75	0.44	EA	53.3	EA
23		0.57	0.30	0.44	EA	33.3	EA
24		0.43	0.30	0.36	EA	20.0	LA
25		0.43	0.30	0.36	EA	33.3	EA
26		0.29	0.35	0.32	LA	73.3	ILA
27	0.33	0.14	0.25	0.24	LA	73.3	ILA
28	0.33	0.29	0.10	0.24	LA	73.3	ILA
29		0.29	0.10	0.19	LA	73.3	ILA
30		0.14	0.10	0.12	LA	46.7	LA
31	0.00	0.14	0.05	0.06	LA	46.7	LA
32	0.00	0.14	0.45	0.20	LA	26.7	LA
33	0.00	0.14	0.35	0.16	LA	26.7	LA
34	0.33	0.14	0.00	0.16	LA	26.7	LA
35		0.14	0.00	0.07	LA	26.7	LA
36	0.00	0.00	0.05	0.02	LA	26.7	LA
37	0.00	0.14	0.10	0.08	LA	20.0	LA
			Mean	0.48		51.35	
			SD	0.28			

I=Innovator, IgA=Ignorant Adopter, EA=Early Adopter, ILA=Informed Late Adopter, LA=Late Adopter

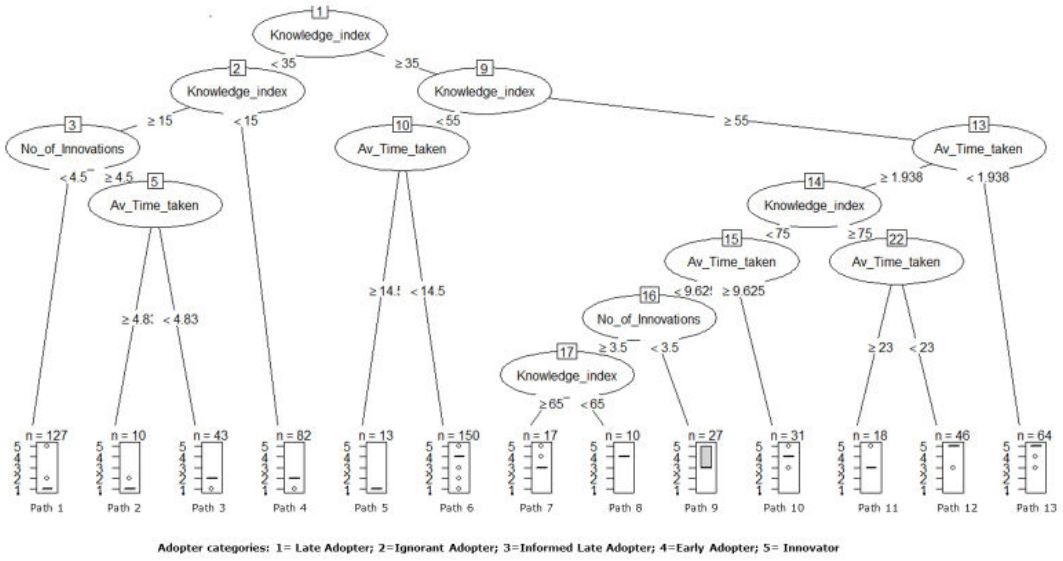
Results

In the final analysis of 736 respondent farmers, there were 634 adopters, and the remaining were non-adopters (13.9 per cent). Adopters were categorized as Innovators (17.1 per cent), Ignorant Adopters (18.8 per cent), Early Adopters (23.2 per cent), Late Adopters (18.6 per cent) and Informed Late Adopters (8.4 per cent). The mean knowledge index values of ignorant adopters ranged between 10 and 40, whereas the late adopters' knowledge level ranged between 10 and 50, confirming that these categories were on par with each other on knowledge of innovations. On the other extreme was the Innovator category whose knowledge index values ranged up to 100, indicating that some of the Innovators were completely knowledgeable regarding all of the innovations that they had adopted. Knowledge values of Informed Late Adopters ranged between 40 and 80, indicating that they were on par with innovators on knowledge of innovations.

Decision tree analysis of the data revealed the decisive importance of knowledge in identifying the adopter categories (Figure 1). The five adopter categories depicted in the decision tree are 1= Late Adopter, 2=Ignorant Adopter, 3=Informed Late Adopter, 4=Early Adopter and

5=Innovator. The first branching of the decision tree is based on the Knowledge index with a cut-off value of 35. A knowledge index of less than 35 had two sub-branches *viz.* "very low knowledge" (less than 15) and "low knowledge" (15 to 35). Very low knowledge was an exclusive predictor of Ignorant and Late Adopters (path 4). Low knowledge in combination with fewer innovations (path 1) and in combination with more innovations and more time (path 2) also featured Late Adopters. More innovations and less time differentiated Ignorant Adopters (path 3) from Late Adopters. A few late adopters also had medium knowledge (35 to 55), but took more time, as indicated in path 5. Medium knowledge (Path 6) and less time represent a combination of all adopter categories, a majority being Early Adopters (category 4). Farmers with very high knowledge (more than 75) who took more time were the Informed Late Adopters (path 11). High knowledge (more than 55) and very high knowledge (more than 75) with less time was evident among Innovators (path 12 and 13). Paths 7 to 10 represent high knowledge in combination with different amounts of time and number of innovations, mostly involving Early Adopters and Informed Late Adopters.

Figure 1. Knowledge-based segregation of adopter categories



Farmers in India normally visit known retail outlets for purchase of inputs out of trust that they have developed over time or for the sake of the availability of inputs on credit. This situation is being exploited by the input agencies to sell new products (innovations), particularly to those in the Ignorant Adopter category. Farmers with knowledge and resources fall in the category of Innovators and Early Adopters and they do not come under the influences of input dealers. Knowledgeable farmers who took more time were the Informed Late Adopters. In fact, an individual may have all the necessary knowledge, but this does not mean that the individual will adopt the innovation because the individual's attitudes also shape the adoption or rejection of the innovation (Ismail 2006). Literature indicates that late adopters are not only resistant to change, they are also suspicious of agents of change; that is, people who promote change.

Profile of the new adopter categories

The results in respect to the number of innovations adopted, average time taken to pass through the innovation decision process, domain specific innovativeness and socio-economic status are given in Table 3.

Informed Late Adopters differed in time taken, despite having innovativeness and better socio-economic status. This makes the researchers strongly believe that the Informed Late adopters were deliberately delaying. Deliberate delay could be for various reasons that are related to resistance to adoption. The causes of innovation resistance stem from one or more of the adoption barriers (Ram & Sheth 1989; Arnould, Price & Zinkhon 2004).

Table 3. Innovations adopted, innovativeness, time taken and socio-economic status of adopter categories

Adopter category	Innovations (no.)	Time taken (months)	Innovativeness	Socio-economic status
Late Adopters	3.1	14.1	2.24	38.85
Ignorant Adopters	4.3	4.1	2.06	39.47
Early Adopters	3.6	5.1	2.34	39.16
Informed Late Adopters	3.7	13.4	3.40	40.97
Innovators	4.7	6.6	3.37	43.34
F value	17.82**	18.59**	15.84**	17.19**

**significant at 0.01 level

Ignorant Adopters were found to have no or low extension participation (Table 4). The emphasis of the extension system must be different with different adopter categories to encourage their extension participation. Informed Late Adopters and Ignorant Adopters need education on innovations and emerging technologies with a different focus. Profitability and cost reduction should be the focus for Ignorant Adopters as they are more prone to impulsive adoption. Environmental concerns may be more important for Informed Late Adopters as they tend to adopt only after getting convinced of the innovations' long-term benefits.

Table 4. Extension participation of different adopter category farmers

Adopter category	No participation	Low	Medium	High	Chi-square
Late Adopters	23	61	33	20	2.26
Informed Late Adopters	6	30	14	12	
Innovators	3	36	42	45	19.41**
Ignorant Adopters	16	51	49	22	

**significant at 0.01 level

Private sources like input dealers, company agents and the traders were the primary sources of information on innovations for the Ignorant Adopters (Table 5). Ignorant Adopters' poor knowledge of innovations could be attributed to their source of information itself. Private dealers and agents most of who are primarily driven by the motive of increasing sales volume have failed to sufficiently educate the ignorant adopters as they may be inadequately trained themselves on the innovations. To create new knowledge, technology education and practice should provide not only a "how-to" experience but also a "know-why" experience (Seemann 2003).

Table 5. Primary sources of information for farmers belonging to different adopter categories (%)

Adopter category	Private	Community	Institutional	Mix of all
Late Adopters	20.6	57.4	11.8	10.3
Ignorant Adopters	43.3	36.6	8.2	11.9
Early Adopters	4.3	51.5	26.4	17.8
Informed Late Adopters	4.9	18.0	49.2	27.9
Innovators	1.6	11.2	50.4	36.8
Overall	15.8	38.1	26.3	19.7

Discussion

The innovativeness data presented in Tables 1 and 2 confirms that each farmer had different relative earliness for different innovations. The same farmer was not the first adopter for all the innovations and similarly an individual was not the last adopter for all the innovations that he adopted. However, the tendency of being early or late was visible when compared across the innovations. The pooled innovativeness of Innovators was 0.70, whereas that of Late Adopters was 0.34 for peanut farmers (Table 1) and the corresponding values for cotton farmers (Table 2) was 0.80 and 0.16 respectively, indicating that converting the relative earliness to unit values and then pooling provides a generic view of who are likely to be Innovators and who are likely to be Late Adopters. This farmer-centric categorization enables the extension system to better target

its activities. There was also difference in the proportion of Ignorant Adopters in the two cases presented. More Ignorant Adopters were observed among cotton farmers (7 out of 37) compared to peanut farmers (3 out of 30). This could be due to the increased dependency of cotton farmers on input dealers for information on varieties (many private companies compete with one another to introduce new varieties every year), micro-nutrients and pest management, as compared to peanut farming which is relatively less input-demanding. Farmers in India tend to visit known retail outlets for the sake of procuring inputs on credit. This situation is being exploited by the input agencies to introduce new products. These crop-specific differences in adoption tendency, and thereby typology of adopters, has the potential to help the extension system concentrate on the learning pattern of farmers.

OECD defines innovation as 'the implementation of a new or significantly improved product, process, a new marketing method' (OECD 2005; as quoted in European Commission 2015, p. 12). This implies that innovation activities are all scientific, technological, organisational, financial and commercial steps, which are, or are intended to lead to the implementation of innovations. Domain-specific innovativeness and knowledge of innovations are crucial for successful uptake and the achievement of benefits from innovation adoption.

The following discussion on profile analysis of adopter categories is focused on Ignorant Adopters and Informed Late Adopters, the two new adopter categories. Ignorant Adopters had adopted a greater number of innovations although the psychological predisposition to adopt innovations early, as measured by domain-specific innovativeness, was very low indicating the possibilities of forced early adoption. Induced adoption could be a lot quicker as is evident by the less time taken by Ignorant Adopters to pass through the innovation decision process. Forced earliness without adequate education about the innovations make them the ignorant innovators. Since "Innovator" is a misnomer to them as they are in no-way possessing any of the characteristic features that the extension systems look among Innovators, they are labelled as 'Ignorant Adopters'. The Theory of Reasoned Action (TRA) states that individuals do not act independently of cultural/social influences but are continually referring their behaviour back to some important reference groups (Burton 2004). The reference groups for 'Ignorant Adopters' in this case could be the input dealers who might be providing the inputs on credit basis or whose advice on earlier occasions would have helped them achieve good harvests. The 'truncated outdegree' pattern of learning proposed by Matous & Todo (2015) is applicable to the Ignorant Adopters, as they are the less connected individuals.

Contrary to this group are the Informed Late Adopters who possess high domain-specific innovativeness and an indicator of willingness to adopt innovations but took more time to adopt. Learning is an active knowledge construction process rather than the (passive) absorption and reception of knowledge (Koutsouris 2012). Often, general regional advice does not match individual farm conditions and the socio-economic context of the farmers (Chambers & Jiggins 1986). Informed Late Adopters were found to be deliberately delaying and exhibited resistance to adoption. The causes of innovation resistance stem from one or more of the adoption barriers. These barriers are usage, value, risk, image and traditional barriers. The *usage barrier* comes when the innovation is not compatible with consumers' existing workflow, practices, or habits. The *value barrier* is based on the economic value of an innovation that the innovation does not offer strong performance-to-price compared to its alternative products. *Risk barrier* is the degree of potential risks an innovation may entail. *Traditional barrier* generally involves the changes an innovation may cause in daily routines, also it 'a preference for existing, familiar products and behaviours over novel ones' (Arnould, Price & Zinkhon 2004, p. 722, as quoted in Khan & Hyunwoo 2009, p. 14). The *image barrier* is associated with the innovation's identity (from its origin) like the product category, brand, or the country of origin (Ram & Sheth 1989). Extension participation of Informed Late Adopters was low and on par with that of Late Adopters. The Informed Late Adopters may follow the "reciprocity" kind of information sharing (Matous & Todo 2015), thereby indicating mutual information exchange among the members of the same group and thus having limited contact with the extension system. Better socio-economic status of Informed Late Adopters and their social networks could be harnessed by the extension system to promote sustainable agriculture practices.

The National Sample Survey Organization (NSSO) of India data reveals that only about 41 per cent of farmers during *kharif* (wet or monsoon) and about 35 per cent during *rabi* (dry) season had access to technical information (NSSO 2014). The public extension system, working under pressure to deliver government's welfare schemes and subsidies, has been reduced to a "subsidy shop" (Balamatti 2017). The study conducted by the State Department of Agriculture, Government of Karnataka, India during 2014 revealed that the extension personnel spend only about 15 per cent of their time with farmers for providing advisory and educational services (UASB 2013). In addition to needing different types of information and using different information

sources, different farmers will have different search behaviours. Since the inadequacies being faced by public extension may not be overcome immediately, the available time and resources of the public extension system could be strategically and effectively directed towards the Ignorant Adopters. As the factors such as literacy or access to resources will have a large impact on information needs, searching behaviour, access, and use (Glendenning, Babu & Asenso-Okyere 2010), the new adopter categories provide a scope for enhancing the extension efficiency and effectiveness. Weaning the Ignorant Adopters away from private agents is essential and possible by focusing the educational activities on them. They are willing to adopt more innovations and hence could be linked to Innovators and thus enhance technology uptake and spread.

Conclusions

Innovativeness is generally considered as a positive trait and this holds true in agriculture as well. However, forced earliness could be disastrous as inappropriate innovations could fail the adopters in many ways. In this study, a novel attempt was made to categorize the adopters through a two-stage approach. Ignorant Adopters were early in adoption and took less time to pass through the innovation learning process despite possessing less knowledge and no or a low level of extension participation. This was attributable to the private agents who were their major source of information and must have induced the Ignorant Adopters to adopt new technologies under the pretext of giving inputs on credit. Informed Late Adopters resembled the Innovators in their profile but exhibited deliberate delay in adoption which explains the innovation resistance that has been referred to in the recent literature. This also emphasizes the need for stratification of farmers for different types of knowledge and information support. The results have broader implications to the way extension is organized or should be organized. The limited manpower and time resources available within the development departments can be effectively invested on educating Ignorant Adopters who have a tendency to adopt more innovations. There is also a need to simultaneously work towards educating the input dealers who are mostly contacted by the Ignorant Adopters for inputs and advise. The ongoing programme of Diploma in Agricultural Extension Services for Input Dealers (DAESI) of Government of India needs to be intensified. The programmes organized should necessarily give priority to Ignorant Adopters and Late Adopters. The Informed Late Adopters could well be the potential group for promoting conservation and sustainability practices.

Acknowledgements

Thanks to the National Agricultural Science Fund (NASF) of Indian Council of Agricultural Research (ICAR) for funding the research project entitled "Behavioural Analysis of Farmers Decision Making on Agricultural Innovations". Advisory/Expert Committees, the field staff and all the respondent farmers are profusely thanked.

References

Aggarwal, OP, Bhasin, SK, Sharma, AK, Chabra, P, Aggarwal, K & Rajoura, OP 2005, 'A new instrument (scale) for measuring the socioeconomic status of family: Preliminary study', *Indian Journal of Community Medicine*, vol. 30, no. 4, pp. 111-114.

Alex, G, Byerlee, D, Helene-Collin, M & Rivera, W 2004, 'Extension and rural development: converging views on institutional approaches?', Agriculture and rural development discussion paper 4, p 23.

Anderson, T, Varnhagen, S & Campbell, K 1998, 'Faculty adoption of teaching and learning technologies: Contrasting earlier adopters and mainstream faculty', *The Canadian Journal of Higher Education*, vol. 28, no. 23, pp. 71-78.

Arnould, EJ, Price, L & Zinkhon, G 2004, Consumers, 2nd edn, New York: Mc Graw Hill/Irwin.

Babu, SC, Joshi, PK, Glandenning, JC, Asenso-Okyere, K & Sulaiman, RV 2013, 'The state of agricultural extension reforms in India: Strategic priorities and policy options', *Agricultural Economics Research Review,* vol. 26, no. 2, pp. 159-172.

Balamatti, A, 2017, Demand-driven extension: Need for public extension to turnaround, AESA Blog 65, Available from: http://www.aesa-gfras.net/, [24 February 2017].

Burton, JFR 2004, 'Reconceptualizing the behavioural approach in agricultural studies: a socio-psychological perspective', *Journal of Rural Studies,* vol. 20, pp. 359-371.

Byerlee, D, Harrington, L & Winkelmann, DL 1982, 'Farming systems research: issues in research strategy and technology design', *American Journal of Agricultural Economics*, vol. 64, pp. 897-904.

Chambers, R 1994, 'The origins and practice of participatory rural appraisal', *World Development*, vol. 22, pp. 953-969.

Chambers, T & Jiggins, J 1986, Agricultural research for resource poor farmers, IDS Discussion Paper 220, Brighton, University of Sussex.

Diederen, P, Meijl, HV, Wuolters, A & Bijak, K 2003, Innovation adoption in agriculture: Innovators, early adopters and laggards, Wageningen University and Research Centre, Agricultural Economics Research Institute, The Netherlands, Available from: http://ageconsearch.umn.edu/ , [2 February 2017].

European Commission 2015, Agricultural knowledge and innovation systems towards the future: a foresight paper, Standing Committee on Agricultural Research (SCAR) Strategic Working Group AKIS, Brussels. Available from: https://ec.europa.eu/, [03 July 2017].

Eva, M, Yolanda, P & Carlos, F 1998, 'The acceptance and diffusion of new consumer durables: differences between first and last adopters', *Journal of Consumer Marketing*, vol. 15, no. 4, pp. 323 – 342.
Glendenning, JC, Babu, S & Asenso-Okyere, K 2010, Review of agricultural extension in India: Are farmers' information needs being met? Discussion paper 01048. International Food Policy Research Institute (IFPRI), Washington DC. Available from: http://www.ifpri.org/, [24 January 2017].
Goldsmith, ER & Hofacker, FC 1991, 'Measuring consumer innovativeness', *Journal of Academy of Marketing Science*, vol. 19, no. 3, pp. 209-221.
Ismail, S 2006, 'Detailed review of Rogers diffusion of innovations theory and educational technology-related studies based on Rogers' theory', *The Turkish Online Journal of Educational Technology*, vol. 5, no. 2, pp. 14-23.
John, M 2012, A study of early adopters of innovation. Dissertation submitted to the graduate faculty of the University of Alabama at Birmingham in partial fulfilment of the requirements for the degree of Doctor of Science in Health Services Administration, Birmingham, Alabama, 2012.
Juhani, I & Marius, J 2003, 'Analysis of electronic commerce adopter categories in retailing: The case of automobile dealerships', *Journal of Organizational Computing and Electronic Commerce*, vol. 13, no. 1, pp. 25–55.
Kauffman, RJ & Angsana, AT 2009, 'Understanding early diffusion of digital wireless phones', Telecommunications *Policy*, vol. 33, no. 8, pp. 432-450.
Khan, K & Hyunwoo, K 2009, Factors affecting consumer resistance to innovation -A study of smart phones, Mater thesis within Business Administration, Jankoping International Business School, Jankoping University, p 69.
Koutsouris, A 2012, 'Facilitating Agricultural Innovation Systems: a critical realist approach', *Studies in Agricultural Economics*, vol. 114, pp. 64-70.
Leeuwis, C, Long, N & Villarreal, M 1990, 'Equivocations on Knowledge Systems Theory: an actor-oriented critique', *Knowledge in Society: The International Journal of Knowledge Transfer*, vol. 3, no. 3, pp. 19-27.
Less, KH 2003, Faculty adoption of computer technology for instruction in the North Carolina Community College System, Electronic Theses and Dissertations, Paper 782. http://dc.etsu.edu/etd/782. [25 January 2017]
Lubell, M, Niles, MT & Hoffman, M 2014, 'Agricultural education and outreach in the age of connectivity', *Journal of Society and Natural Resources*, vol. 27, pp. 1089-1103.
Mahajan, V, Muller, E & Srivastava, RK 1990, 'Determination of adopter categories by using innovation diffusion models', *Journal of Marketing Research*, vol. 27, no. 1, pp. 37-50.
Matous, P & Todo, Y 2015, 'Exploring dynamic mechanisms of learning networks for resource conservation', *Ecology and Society*, vol. 20, no. 2, pp. 36. http://dx.doi.org/10.5751/ES-07602-200236 [03 July 2017]
National Sample Survey of India (NSSO) 2014, Key indicators of situation of agricultural households in India. Ministry of Statistics and Programme Implementation, New Delhi, Available from: http://mospi.nic.in/, [08 January 2017]
Nithyashree, DA & Siddaramaiah, BS 2003, 'A new method of adopter categorization: PRIM(E) model', Proceedings of the international conference on communication for development in the information age: extending the benefits of technology for all, Jan. 07-09 2003, ed. B.Jirli, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, India.
OECD 2005, Fostering green growth in agriculture: The role of training, advisory services and extension initiatives. OECD Green Growth Studies, OECD Publishing, Paris.
Ram, S & Sheth, NJ 1989, 'Consumer resistance to innovation: The marketing problems and its solutions', *The Journal of Consumer Marketing*, vol. 6, no. 2, pp. 5-14.
Rivera, WM, Qamar, MK & Mwandemere, HK 2005, Enhancing coordination among AKIS/Rd actors: an analytical and comparative review of country studies on agricultural knowledge and information systems for rural development (AKIS/RD), Food and Agriculture Organization of the United Nations, Rome, PP115.
Ryan, B & Gross, CN 1943, 'The diffusion of hybrid seed corn in two Iowa communities', *Rural Sociology*, vol. 8, pp.15-24.
Rogers EM, 1983, Diffusion of Innovations. Third edition. The Free Press, New York, USA.
Rogers, EM, Singhal, A & Quinlan, MM 2004, 'Diffusion of innovations', in An integrated approach to communication theory and research, eds, S Don and S Michael, New York: Routledge.
Roling, N 1988, *Extension science,* Cambridge, Cambridge University Press.
Roling, N & Engel, P 1991, The development of the concept of agricultural knowledge and information systems (AKIS): implications for extension, in Agricultural extension: Worldwide institutional evolution and forces for change, eds, W Rivera and D Gaustafson, Amsterdam, Elsevier, pp. 125-139.
Sara, FJ & Luis, FL 2014, The late adopter scale: A measure of late adopters of technological innovations, Working Paper # 584, Nova School of Business Economics.
Salah, H & Philippe, D 2010, 'How do 'leading-edge' opinion leaders bridge the innovation gap? advancing a new adopter category', in: NA - Advances in Consumer Research Volume 37, eds, MC Campbell, J Inman, and R Pieters, Duluth, MN: Association for Consumer Research, pp. 668-669. Available from: http://www.acrwebsite.org/, [24 February 2017]
Seemann, K 2003, 'Basic principles in holistic technology education', *Journal of Technology Education*, vol. 14, no. 2, pp. 28-39.
Sulaiman, R, Hall, A & Suresh, N 2005, Effectiveness of private sector extension in India and lessons for the new extension policy agenda, Network Paper 141, London: Agricultural Research & Extension Network. Available from: https://www.odi.org/sites/, [03 February 2017]

The World Bank 2012, *Agricultural innovation systems: an investment sourcebook,* The World Bank, Washington DC.
Tucker, T 2011, 'What influences young adults' decision to adopt new technology?', *The Elon Journal of Undergraduate Research in Communications*, vol. 2, no. 2, pp. 147-157.
UASB 2013, *Agricultural extension reforms in Karnataka: a survey report*, Government of Karnataka, India, An unpublished report submitted by Agricultural Universities in Karnataka, August 2013.
Zayim, N, Yildirim, S & Saka, O 2006, 'Technology adoption of medical faculty in teaching: Differentiating factors in adopter categories', *Educational Technology & Society*, vol. 9, no. 2, pp. 213-222.