Influence of Information Networks on Farmer's Decision-Making in West Bengal

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ABSTRACT

Adoption research for many years has considered individual farmer as the basis of analysis, whereas the effect of information networks on farmer's decision-making has received limited attention. Hence, understanding the relation between farmers' position within their agricultural information networks and their adoption decision is of practical importance. The present study was conducted at Purulia District in West Bengal, India, to study the spread of chilli (Capsicum annum) and wheat (Triticum aestivum) cultivation among the farmers of selected village. Focus group discussion was used to track this spread of new crops over different generations of adopter. Data collected through structured questionnaire was analyzed by sociometric technique and the fractional ranking of network scores of farmers was compared with their relative earliness in adopting chilli and wheat cultivation. It was found that most of the farmers having higher network scores were earlier adopters of chilli and wheat cultivation, but the reverse was not true. A string of other factors were found to be operating at the community level. Understanding these information networks may help understanding diffusion process of agricultural innovations at the micro-level.

Key words: *Adoption-decision; Information network; Social network analysis; Technology transfer;*

The pattern of communication and information exchange among farmers constitutes an integral part of their farming system (*Ramirez, 1997*). Understanding this information system is important to explore the context of innovation and its spread and utilization. The question of practical concern has been – 'Why do some farmers accept new practices more than their fellow farmers?' Studies on diffusion of innovations have emphasized the effects of socio-structural factors; and diffusion has been explained not only on the basis of individual attributes of farmers but also according to the relationships among the various actors involved in the process (*Monge et al. 2008*). At the micro level, analysis of farmers' communication networks is, thus, a valid point of contemplation.

Adoption research has considered individual farmer as the basis of analysis. However, the importance of interpersonal networks for coping with uncertainties associated with new ideas and its adoption has received attention much later. *Rogers and Kincaid (1981)* studied several family planning innovations in Korean villages. This work was a departure from individual-oriented diffusion research tradition, proposing network consideration in diffusion studies *(Rogers,1995).* As network consideration became popular, a distinct area of social science research – social structure analysis – gained momentum among the sociologists (structuralists) of 'Rural Sociology' (*Skinner and Steiger,2005*). Social Network Analysis has also become powerful with the development of research on social capital vis-à-vis social networks (*Putnam 1993, 2000*). The present study can be understood as a part of this research paradigm.

Network analysis is the study of how the social structure of relationships around a person, group, or organization affects beliefs or behaviors. The axiom of every network approach is that reality should be primarily conceived and investigated from the view of the properties of relations between and within units instead of the properties of these units themselves. It is a relational approach. In social and communication science, these units are social units: individuals, groups/

organizations and societies (*University of Twente 2004*). *Rogers (1986)* characterized a communication network as consisting of interconnected individuals who are linked by patte rned communication flows. A communication network analysis studies the interpersonal linkages created by the sharing of information in the interpersonal communication structure (*ibid*). Also, there is a substantial amount of literature available on how network data gathered within formal and informal organizations can be analyzed (*Rice and Richards 1985; Freeman et al. 1992; Wasserman and Faust 1994; Scott 2000*).

Motivated by the research tradition in social learning (*Bandura 1977)* adoption behaviour of farmers within such networks are being studied (*Foster and Rosenzweig 1995; Bandiera and Rasul 2003; Udry and Conley 2004*), health and drug being the most empirically tested areas (*Valente, 2003*). Most of the studies in the field of agricultural adoption have shown the importance of agricultural social networks on adoption and adaptation of agricultural technologies (*Mazur and Onzere 2009*). However, direct applications of social network analysis to study the diffusion of innovations in agriculture have been limited (*Monge et al. 2008*). Parallel research tradition is also scarce in India in general, and among extension researchers in particular. In many of the third world communities these networks are formal embodiment of social bondage developed over ages and its analysis can prove to be critical input to formal extension agencies (*Valente, 2006*) and the social and farming system niches regarding new crops may be understood (*Monge et al. 2008*).

With this background, the present study was undertaken to understand the relationship between adoption of newer crops and the communication network of the adopters.

METHODOLOGY

The study was conducted in Sardarpara village of Purulia-I Block in Purulia district, West Bengal, India during the period 2006-07. Purulia is the extreme western district of West Bengal (23°20'N 86°22'?E' / 23.33°N 86.37°E/23.33; 86.37) with an area of 6255.51 sq. km. It has an average elevation of 228 metres (748 feet). Summers are extremely hot and dry with temperatures ranging from lows of 23°C to highs above 45°C. Winters are very dry and cool with daily temperatures ranging from 3°C to 20°C. Most of the rainfall occurs during the wet monsoons. As per the 2001 census, total population of the district was 2535516, out of which 89.93% are residing in rural areas. About 51.18% of the populations are males and 48.82% are female. The percentage of Scheduled Caste and Scheduled Tribes are 18.29% and 18.27% respectively. Total number of families below poverty line in rural areas of this district is 197381 (43.65 %), which is well above the national (27%) and sate (26%) figure (*Govt. of West Bengal 2001*).

Cultivation in this district is predominantly monocropped. About 60% of the total cultivated land is upland. Out of the total agricultural holding, about 73% belong to small and marginal farmers having scattered and fragmented smallholdings. Paddy is the primary crop of the district. Almost 50% of the total land is under net-cropped area and only 17% of the net cropped area is under multi crop cultivation, 77% of the net-cropped area being under Aman paddy cultivation. The crops are grown mostly under rainfed condition, generally with low fertilizer consumption per unit area. Thus productivity is very low as compared to other districts of West Bengal (*ibid*).

The boundaries of a social network can be interactional, spatial or temporal (*Scott 1986*). The isolated settlement for the study was purposively selected for controlling the effects of space on communication pattern of the villagers. However, multi-stage random sampling was employed for the selection of district, block and gram panchayat (local democratically elected self-governing body) within which the study area was situated. Total enumeration technique was followed for the selection of respondents. Focus group discussion was used to track the spread of chilli and wheat cultivation over different generation of adopters. Information generated for describing this spread was drawn in the form of a diagram with distinction of generations of adopters (the first farmer cultivating chilli/ wheat has been conceptualized as a farmer of 1st generation; the farmers following him in the next season was considered as members of the 2nd generation),

mode of transfer [material (seed)/method (cultivation practice)/capacity (special human capital)] and household number. A similar method may be observed in *Van Mele and Zakaria's (2002)* study in Bangladesh that described the spread of innovations among the villagers in a participatory manner. Households were demarcated with separate colours in the diagram, showing their respective well-being groups identified through *Grandin's (1988)* card sorting method.

Network Analysis (Sociometry) was employed to elicit information regarding the farmers' agricultural information network (*Wasserman and Faust, 1994*). A thoroughly pre-tested structured interview schedule (with respondents of a non-sample village in the area) was developed for personal interviews with 44 farmers of the study area. Both visual and statistical methods have been used. Network diagram (Sociogram) is used for visual representation (*Figure 1*), whereas distance matrix was constructed for the measurement of network scores (*Lindzey and Byrne 1968*). Prestige score i.e., an index that takes into account both his influence domain and centrality within the network, was calculated. *Lin (1976)* defines prestige of a person as the extent to which he enjoys a large following (high influence-domain) and is centrally located in the group (high centrality). The fractional ranking of prestige scores of farmers within the network was then tabulated for the individual farmers who featured in the diagram of spread of chilli and wheat cultivation *(Fig. 2 and Fig. 3).* A scrutiny was then made to check whether the farmers appearing in the earlier generations of technology spread had relatively higher prestige scores or not. Kruskal Wallis Test was employed for this purpose.

RESULTS AND DISCUSSION

The Agricultural Information Network : A visual check of the visual diagram shows sparsely situated small, weakly integrated groups of interaction between farmers with few interconnections among them. The small separated sections within the network were formed due to the physical proximity of settlement and nearness of farmers' farming fields. Few important, less conspicuous dominant groups within the network could also be noticed. There were some satellite-like structures around '32', '115' and '7' with several cleavages spread across the information network. There

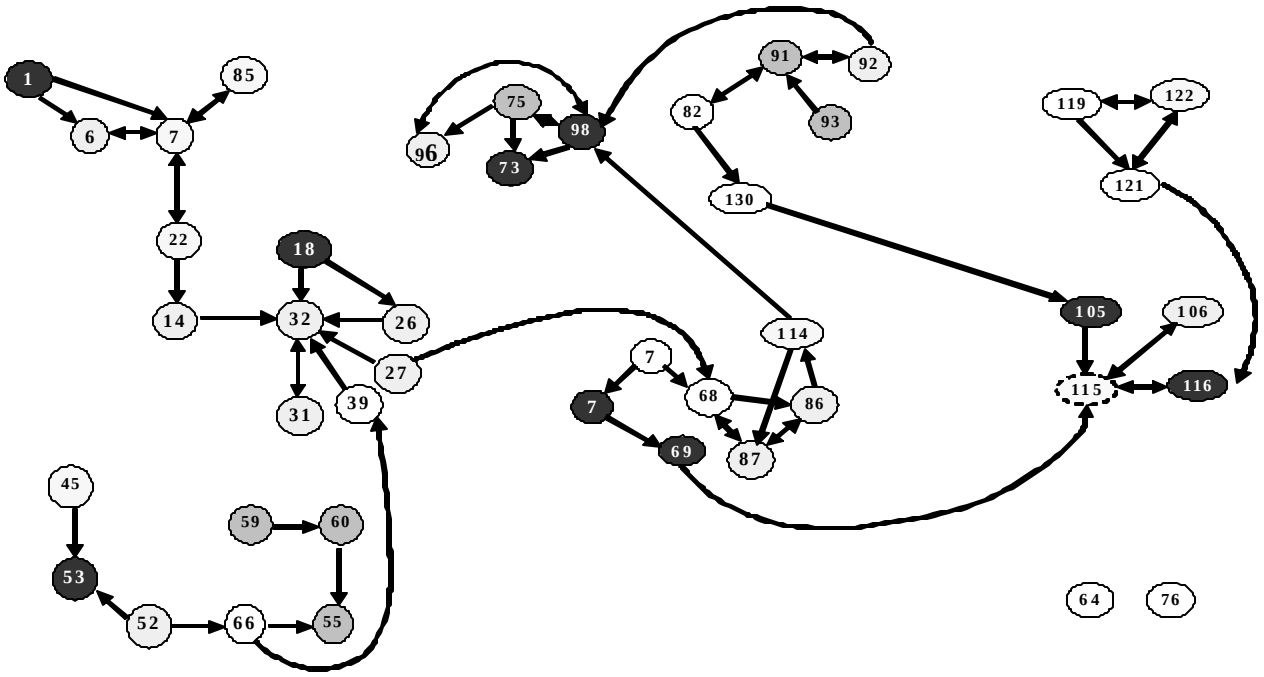

Fig. 1. Network diagram of 'agriculture and allied' information domain in Sardarpara village. Different circles indicate households belonging to different well-being groups.

- Well-off
- Moderately Well-off
- Moderate
- Moderately Poor
- Poor
- Very poor

was overwhelming dependence on primary and secondary liaisons as there were few connections between the sub-groups. Few important chains emerged throughout the network ('7'-'22'-'14'-'32'; '52'-'66'-'39'-'32'; '27'-'68'-'86'/'87'-'114'-'98'-'75'/'73'-'96'; '91'-'82'-'130'-'105'-'115'-'116'), which indicated the principal routes of information flow.

There were two isolates ('64' & '76'), 8 neglectee ('27', '52', '59', '18', '93', '45', '71', '1'), and 4 opinion leaders ('115', '32', '98' & '7') in the group accounting for 4.55%, 18.18%, and 9.09% of the group members respectively. There were 14 liaisons ('22', '14', '66', '39', '32', '27', '68', '86', '114', '98', '116', '115', '105', '130') in the network; this high number might be due to the sparse spatial distribution of the households.

Group cohesiveness of the network was 0.0148 with 14 mutual choices, while the social compatibility index was calculated to be 0.3256. Mutual choice was found to be low due to the fact that very few of the farmers were knowledgeable regarding modern agricultural practices and intense information seeking took place around the few knowledgeable farmers. The localized interaction pattern had also lessened the probability of mutual interaction to certain extent. Moreover, less profitability of the agricultural enterprise had affected farmers' information seeking behaviour greatly. Most of the mutual choices were due to the physical proximity and family relations.

The Spread of Chilli and Wheat Cultivation : In *Figure 2* the spread of cultivation of chilli among the farmers has been shown. The horizontal lines separate generations of adopter. The circles represent the individual decision making units, i.e. the farm family. Up to the 4th generation, the spread could be identified and diagrammed by the villagers. The circle with letter 'O' at the upper left corner shows the external source

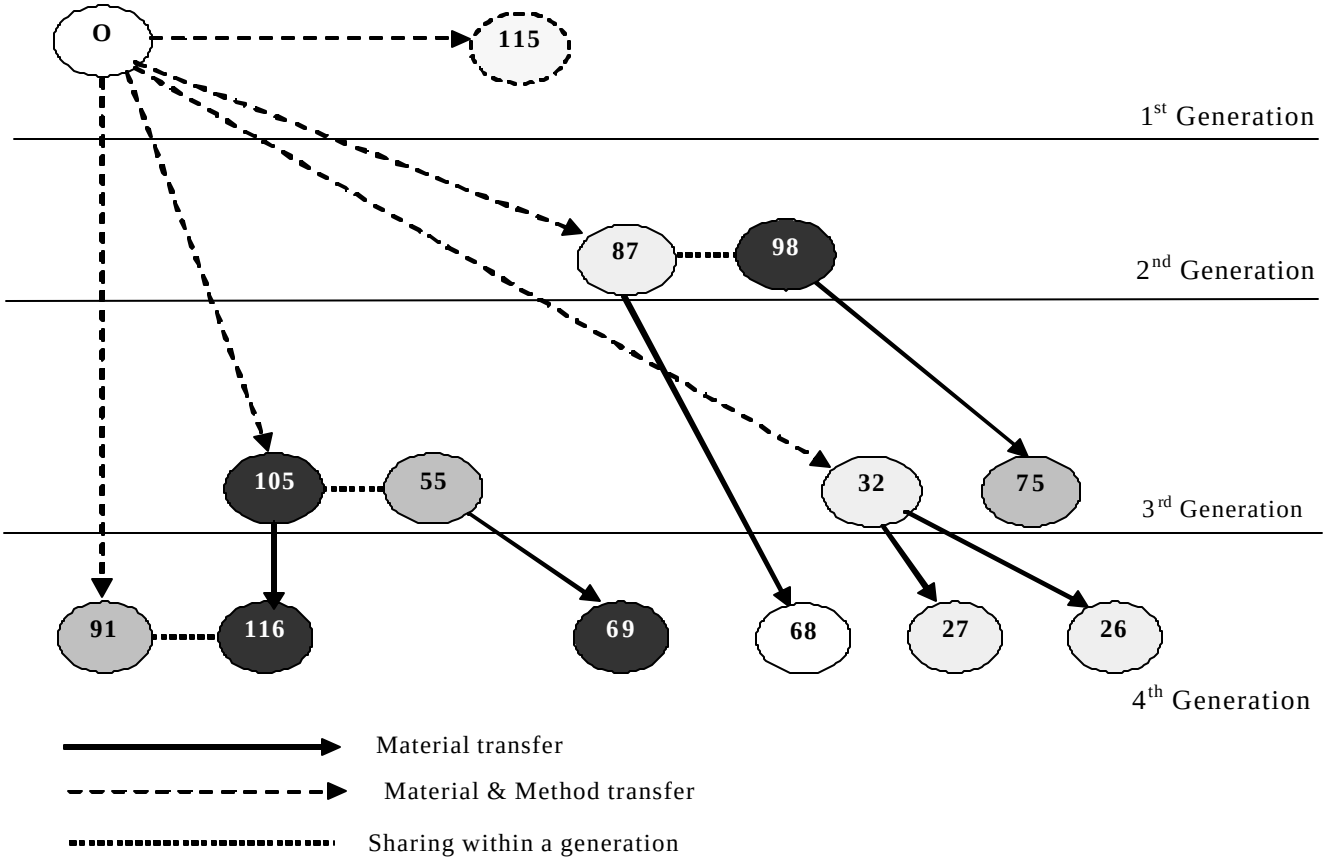

Fig. 2. Spread of chili cultivation among the farmers of Sardarpara village. The circle with letter 'O' in the 1st generation connected to '115' indicates external source. Different colours of circles indicate households belonging to different well-being groups.

- Well-off
- Moderately Well-off
- Moderate
- Moderately Poor
- Poor
- Very poor

of seed (seed shop in the market) and the dotted lines with arrow shows its material transfer coupled with method transfer.

Household no. '115' started growing chilli, which was requested and provided by the local seed shop owner of the nearby market. The seed shop owner transferred the method of cultivation along with seed material. Noticeably, farmers shared only seed material among themselves. In most of the cases the crop was grown in small scale (even on homestead lands) for family consumption and sale within the village. For the earlier generations the farmers depended on external sources for seed material. In the later generations, they became self-sufficient in seed material. Farmers growing the crop in large areas used to share the seeds they stored with fellow farmers. With the increasing market price of seed, small farmers sought seeds from the fellow large farmers. Few farmers also exchanged chilli seeds with other vegetable seeds. Thus the whole process was farmer-driven and similar to the findings from other parts of the West Bengal state (*Basu et al. 2009*). The number of chilli growers and the area under chilli cultivation over years is given in Table 1.

Table 1. Diffusion of chilli cultivation in Sardarpara village

Year	Cumulative number of adopters	Cumulative area (acre) under cultivation
2002-03	1	0.5
2003-04	3	1.5
2005-06	7	3.0
2006-07	13	6.0

The number of adopters increased from generation to generation in the following way (with well-being groups (WBG) in parenthesis) –

1 (A) $\rightarrow$ 2 (E, C) $\rightarrow$ 4 (2B, C, E) $\rightarrow$ 6 (B, 2C, 2E, F)

Generation wise distribution of farmers on the basis of their well-being could not give any generalizable and conclusive information. Because, firstly, the farmers mostly belonged to moderate to lower well-being groups (C, E and F) in the study area, resulting in their overrepresentation in Figure 2. Secondly, well-being did not have sole effect on the process of spread. Other factors like family relationship, neighbourhood, friendship, adjacent cultivable lands etc. were also important. The spread of wheat cultivation among the farmers of the village is shown in *Figure 3*. The salient observations are described below –

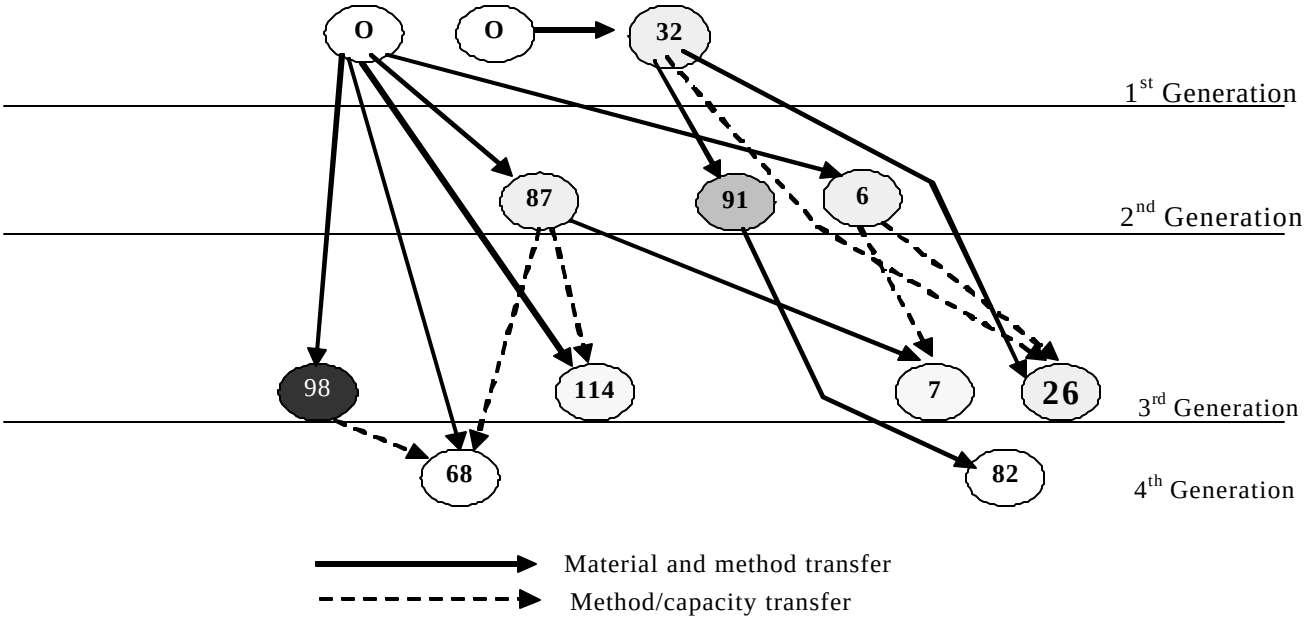

Fig. 3. Spread of wheat cultivation among the farmers of Sardarpara village. The circles with letter 'O' in the 1st generation indicate external sources. Different colour of circles indicate households belonging to different well-being groups.

- Well-off
- Moderately Well-off
- Moderate
- Moderately Poor
- Poor
- Very poor

Farmer '32' started wheat cultivation in the *rabi* (winter) season after securing seed from one of his friends of the neighbouring village. He grew it on a trial basis in his nearest piece of land where he could provide assured irrigation. Although he had a piece of land near the local irrigation canal with assured irrigation, he did not sow seed there as the crop will be damaged by the grazing animal and the land was also away from his home rendering monitoring of the crop difficult. Both material transfer and method transfer could be found among different generation of adopters. This was more among the farmers having adjacent pieces of land in the field. For the next generation, the earliest cultivator of the village became the source of material and method, although farmers sought counsel from farmers of previous generation regarding crop management. That is, in most cases, a two way communication could be observed between two generations. Farmers also adapted the practices according to their own situation, which have been observed in other parts of the West Bengal state (*Basu et al. 2009*). Farmers of the previous generations requested others to cultivate wheat so that the field could be covered with crops in the *rabi* season and grazing problem could be overcome. It was expected that the crop will spread quickly as there was little scope of irrigation in the winter and only crops of low water requirement could be grown in limited lands near the canal (where water was being supplied regularly for last few years).

The number of adopters increased from generation to generation in the following manner (with well-being groups in parenthesis) –

1 (E) $\rightarrow$ 3 (B, 2E) $\rightarrow$ 4 (C, 2D, E) $\rightarrow$ 2 (2F)

Unlike the spread of chilli cultivation, the spread of wheat cultivation revealed a new factor influencing crop spread among the farmers of a community, that is - dependence on scale of adoption (by fellow farmers). The theoretical support may be availed from *Rogers'* (1995: 313-330) concept of critical mass (although in a different context). Unless and until some definite proportion of the farmers adopted a new practice (here coverage of a large portion of the field that hinders grazing of animals in open field) the adoption decision of others became subject to risk/non-viability. That is why the spread of wheat cultivation had been relatively slower, restricted and subsequently decreased. Moreover, well-being did not show any effect on the process. Because only the farmers having land near the canal could secure water that seeped from the bund and this was not dependent on farmers' well-being. The number of wheat growers and the area under chilli cultivation over years is given in Table 2 –

Table 2. Diffusion of wheat cultivation in Sardarpara village

Year	Cumulative number of adopters	Cumulative area (acre) under cultivation
2002-03	1	0.33
2003-04	4	1.5
2005-06	8	3.0
2006-07	10	4.5

There were some important factors that could be identified from these two cases to understand the niches for the new crops. These were –

Initial source of innovation– internal/external, scale of operation – small-scale or large scale, subsequent source of innovation – internal/external; mode of learning – seeing/doing/formal training, mode of transfer – material/method/capacity, nature of transfer – sporadic/ contiguous, generation wise increase in number of farmers – patterned/not patterned, well-being, nature of the innovation – capital intensive/technical complexity/ marketing/dependence on external source for material and method, family relationship – friendship/ neighbourhood, constraint of spread – type of land/ nature of innovation/competition with other crops etc., advantage of one farmer over another – type of land/ irrigation facility/excess of family labour/nature of farming, collective decision making, constraint of spread - type of land/nature of innovation/irrigation/grazing problem etc.

Comparison of Prestige Scores among different generation of adopters: Now, the task was to examine whether the earlier adopters of the 'chilli' and 'wheat' cultivation had higher network scores computed by network analysis.

From Table 3, it can be observed that one farmer's fractional rank of prestige scores in generation 1 (for the individuals involved in the spread of chilli cultivation) were from first quartile, while for the generation 2, all the farmers were from upper quartile. For generation-3, one out of four farmers was from fourth quartile while

for generation-4 one of six farmers was from the fourth quartile. No significant relationship (p=0.261) was observed among the prestige scores and generation of adopters. This was because of the fact that, farmers having higher prestige scores were often large farmers having good external contacts and capacity to procure costly inputs; but the farmers having little prestige score in the network could also avail seed material from immediate neighbours.

Table 3. Prestige score and ranking of the farmers involved in the spread of chilli (*Capsicum annum*) cultivation in Sardarpara village

	No.	Ranking of prestige score (fractional rank as %)	Mean Rank
Gen-1	115	01.00 (2.38)	1.00
Gen-2	87	03.00 (7.14)	5.00
	98	08.00 (19.05)	
Gen-3	105	26.00 (61.90)	9.00
	55	40.00 (95.24)	
	32	05.00 (11.90)	
	75	18.00 (42.86)	
Gen-4	91	06.00 (14.29)	7.33
	116	07.00 (16.67)	
	69	23.00 (54.76)	
	68	02.00 (4.76)	
	27	19.00 (45.24)	
	26	30.50 (72.62)	

χ^2 = 4.00; Kruskal Wallis Sig. - 0.261
No.= Number of Respondents

This finding is not similar to several other works in the related fields (*Faust 1997; Borgatti 2005; Goswami and Basu, 2010*). However, the findings were in line with study carried out in another district of West Bengal (*Goswami 2007*). The mean rank for individual generations also showed that for the first three generations mean rank increased consistently but decreased for the fourth generation. That means, the later adopters may not necessarily the excluded ones in the information network.

From Table 4 it can be observed that one farmer's fractional rank of prestige scores in generation 1 (for the individuals involved in the spread of wheat cultivation) were from first quartile, while for the generation 2, two out of three farmers were from upper quartile. For gemeration-3, one out of four farmers was from fourth quartile while for generation-4 no farmer was from the fourth quartile. No significant relationship (p=0.584) was observed among the prestige scores and generation of adopters. This was because of the fact that adoption of wheat was more dependent on the location of cultivable land in the field (near irrigation source) and little effect of information network could be found. This finding also does not conform to several other works in the related fields (*Faust 1997, Borgatti 2005*) but were in line with study carried out in another district of West Bengal (*Goswami 2007*). The mean rank for individual generations also showed that for the first three generations mean rank increased consistently but decreased for the fourth generation. That means, the later adopters may not necessarily the excluded ones in the information network.

Table 4. Prestige score and ranking of the farmers involved in the spread of wheat (*Triticum aestivam*) cultivation in Sardarpara

	No.	Ranking of prestige score (fractional rank as %)	Mean Rank
Gen-1	32	05.00 (11.90)	3.00
Gen-2	87	03.00 (7.14)	4.67
	91	06.00 (14.29)	
	6	15.00 (35.71)	
Gen-3	98	08.00 (19.05)	7.00
	114	10.00 (23.81)	
	7	09.00 (21.43)	
	26	30.50 (72.62)	
Gen-4	68	02.00 (4.76)	5.00
	82	17.00 (40.48)	

χ^2 =1.95; Kruskal Wallis Sig. – 0.584
No.= Number of Respondents

CONCLUSION

The implication of the present study is more important for academicians than practitioners. However, academic implications have far reaching impact on practice. The study has demonstrated the influence of individuals' position within agricultural information networks on their acceptance of new crops. It has provided some basic propositions in the given area and identified the factors that affect the adoption decision of farmers regarding the adoption of new crops. While the early generation adopters mostly had higher prestige scores within the network, the late generations were not necessarily the excluded ones of the network. This will focus more on the associated factors of technology adoption, many of which are location-specific, in the

empirical studies on network analysis. The present study has also elicited a string of such factors. That means such location specific factors are to be appreciated by the social network analysts – working in the field of technology transfer – before going for large scale research. This will either be included in a formal model or be controlled during the study.

As far as the practical implications are concerned, these information networks at the grassroots, if plotted carefully, can act as an important input to extension agencies in reaching client system more efficiently. Extension professionals may have ideas on how agricultural information flows in a network, may understand the critical roles of important network nodes/ actors, may get sensitized regarding the important role of small and resource-poor farmers in diffusion process. Some modifications of the methodology followed in this paper may help extension workers to understand diffusion of innovations at the community level. Similar studies linking micro with macro situations (that conceptualizes different stakeholders of an agricultural knowledge and information system as network node/ actor) with suitable modeling can also prove useful for analysing agricultural knowledge and information systems for specific crops. Moreover, the identified social networks can be used to support broader livelihood related information like health, information of development programmes etc. needed by the farming community, which is a challenge for broad based and diversified extension services in the third world countries.

Paper received on : January 19, 2011
Accepted on : March 23, 2011

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