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2006

Does Information Network Affect Spread of New Crops? A Study on the Spread of Bitter Gourd and Sunflower Cultivation among the Farmers of a Sunderbans Island in West Bengal, India

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ABSTRACT

Adoption research for many years has considered individual farmer as the basis of analysis, whereas the effect of networks governing a farmer's decision-making has received limited attention. Moreover, the spread of technology over different generation of adopters has not been addressed adequately. Hence, farmers' position within the agricultural information networks and their adoption decision, may be studied to formulate some lower order propositions regarding the diffusion of agricultural innovations within information networks. The present study was conducted at Konkondighi Island in Sunderbans region, West Bengal, India, to study the spread of bitter gourd (*Momordica Charantia* L.) and sunflower (*Helianthus annuus* L.) cultivation among the farmers of selected villages. Case study method and focused group discussion were used to track this spread of new crop over different generation of cultivators. Data collected through survey method was analysed by sociometric technique and network score of the farmers in the agricultural information network was computed. The fractional ranking of network scores of farmers was compared with their relative earliness in starting bitter gourd and sunflower cultivation. It was observed that in the process of the spread of bitter gourd and sunflower cultivation, most of the farmers who had higher network scores were earlier adopters of bitter gourd and sunflower cultivation practices; but the opposite was not the same. This indicated relations between farmers' positions in information networks and their adoption-decision regarding the adoption of new crops.

Key words: technology transfer, agricultural information network, social network analysis, adoption-decision, India

INTRODUCTION

Farmers and farmer groups are stakeholders in a rural community, just as much as many other 'players' affecting farming communities, who interact constantly, seeking to negotiate and create opportunities to fulfill their needs and pursue their interests. In these negotiations information is exchanged on prices, market opportunities, technology and practices, policy changes and politics. These patterns of communication and information exchange constitute an integral part of a farming system. Röling (1988 in Ramirez, 1997) argues that they constitute part of a broader system – an agricultural knowledge and information system. In terms of agricultural development, the different stakeholders can together be perceived as a social organization, and their joint action enhances or limits the development of innovation (Engel, 1995). Understanding this information system is important to explore the context of innovation, its spread and utilization. Studies on diffusion of innovations also tend to emphasize the effects of socio-structural factors, explaining diffusion not only on the basis of individual attributes 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 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 patterned 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 & Richards, 1985; Freeman, White and Romney, 1992; Wasserman and Faust, 1994; Scott, 2000).

Motivated by the research tradition in Social Learning (Bandura, 1977; Ellison and Fundenberg, 1995), 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 agriculture 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 more 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).

MATERIAL AND METHODS

The study was conducted in Purba Musalmanpara settlement of Konkandighi Island in South 24 Parganas district, West Bengal, India. South 24 Parganas is the extreme southern district of West Bengal, India (22°32′N 88°20′E / 22.53°N 88.33°E) and with an area of 8165.05 km^2. The population of the district is nearly 7 million, of which 84.23% stays in rural areas. Percentage of households below the poverty line is 37.21, much higher than the state and country average (26% and 29%). The district is one of the poor districts of West Bengal having large number of resource poor farmers and falls under the coastal saline agricultural production system of the state (Government of West Bengal, 2001). Natural resource is fragile and highly prone to degradation. The district receives 1750-1770 mm annual rainfall and the temperature and relative humidity ranges from 13.6^0C-36.3^0C and 71%-85% respectively. Percentage of cropped area and irrigated area of this district was 393.47 thousand ha and 98.31 thousand ha in 2006-07. Sunderbans region is situated in this district and covers a vast tract of forest and saltwater swamp forming the lower part of the Ganges Delta. It extends about 260 km along the Bay of Bengal from the Hooghly River estuary (India) to the Meghna River estuary in Bangladesh. Konkandighi is a small Island (13 km^2) with a population of 5600 that falls within this region. The island is isolated from the mainland and depends highly on local resources for natural resource management. Rainfed rice is the main cultivated crop, although limited vegetables are

grown in upland situation. The soil becomes highly saline in winter months barring farmers from growing vegetables in large areas.

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. Case study method and focused group discussion was used to track the spread of bitter gourd and sunflower cultivation over different generation of adopters. Information generated for describing this spread was drawn in form of a diagram with distinction of generations of adopters (the first farmer cultivating bitter gourd/sunflower has been conceptualized as a farmer of 1st generation; the farmers following him in the next season have been 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. 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 island) was developed for personal interviews with 50 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 bitter gourd and sunflower 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.

RESULTS AND DISCUSSION

The Agricultural Information Network

A visual check of the network diagram shows disperse pattern of interactions among the farmers. No dominant group within the network could be observed. There were some star-shaped structures around farmer '40' and '107'. One closely associated, compact wired wheel-like structure could be noticed within the network. There were distinct cleavages separating subgroups with overwhelming dependence on primary and secondary liaisons. A long chain emerged throughout the network ('77' – '96' – '35' – '40' – '55' – '88' – '90' – '94' – '122' – '107' – '3' – '21') indicating the principal route of information flow.

Five isolates ('82', '46', '76', '64', '11'), 12 neglectees ('70', '6', '65', '4', '8', '81', '14', '15', '83', '108', '5', '2'), 1 clique consisting of 4 individuals ('6', '7', '9', '98') and 2 opinion leaders ('40', '107') in the information network that accounts for 10%, 24%, 8% and 4% of the network members respectively.

There had been 11 liaisons ('77', '96', '40', '88', '90', '94', '122', '3', '55', '35', '38') in the network. This high number might be due to the nature of spatial distribution of the households which was very sparse.

Group cohesiveness of the network was 0.0114 with 14 mutual choices while the social compatibility index was found to be 0.2857. Mutual choice was found to be low due to the fact that very few of the farmers were knowledgeable enough regarding modern agricultural practices and intense information seeking centered around only a few knowledgeable farmers. Moreover, less profitability of the enterprise had affected farmers' information seeking behaviuor. Most of the mutual choices were contributed by the physical proximity of farmers and their family relations.

Figure 1

Figure 2 shows the spread of cultivation of bitter gourd on bund (locally known as *ail*) among the farmers of the area. To overcome the problem of soil salinity, cultivation of vegetables on bund is practiced widely by the farmers of this agricultural production system (Basu et al, 2009). The horizontal lines separate generations of adopter. The circles represent the individual decision making units, i.e. the farm family. Upto the 4^{th} generation the spread could be identified and diagrammed by the villagers. White circles represent the outside source of the technology either in the form of material or method/capacity.

Figure 2

Salient observations from Fig. 2 are described below –

Household no. 7 started growing bitter gourd in his farm which he saw in his relative's farm at Raidighi, the nearest main land. His observation was reinforced by seeing the same practice in a neighbouring village, which had a high degree of soil salinity. Method transfer was found to be the only mode of technology spread as the nature of the innovation was such that method was considered to be the most important input. Material was available in the local market and capacity to grow the crop was with the farmers. Interestingly, even after the practice started spreading within the village, farmers continued to depend on external sources to reinforce their

learning. It was only after the third generation that they were confident to continue on the basis of their own experience. The spread was also faster than that of the other cases studied in other agricultural production systems of West Bengal. This observation was different from similar studies conducted in other districts of West Bengal (Goswami, 2007). The reason may be that the nature of the practice was not complex. Moreover, there were no other crops/alternatives to replace the practice. Dependence on single or few farmers was not fund; learning by seeing others' practices was enough for reinforcement. The number of adopters increased from generation to generation in the following way (with well-being groups (WBG) in parenthesis) –

1 (B) → **4** (A, B, 2E) → **6** (2B, 4E) → **10** (C, 2D, 6E, 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 the lower well-being groups (D, E and F) in the study area, especially farmers from WBG-E was in overwhelming proportion, resulting in their overrepresentation (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.

Figure 3

The spread of sunflower cultivation among the farmers of the village is shown in Figure 3. The salient observations are described below –

Household no. 107 started growing sunflower on a piece of 5 *katha* land (0.03 ha). He collected sunflower seed from one of his friends in the neighbouring village. The seed was distributed by the local Panchayat and Department of Agriculture as minikit (by the Department of Agriculture). In most of the cases, when material was provided by the Panchayat, instructions regarding the package of practices) were also

provided. Thus, material transfer accompanied method transfer. Moreover, it was a new crop to the farmers and they had little experience in growing sunflower. Although, there were cases of method transfer taking place alone when farmers sought counsel from fellow farmers. For all the generations, Panchayat was the sole provider of seed (and method) except of few cases where excess seed of previous season was shared among farmers. The interesting feature of this case of sunflower cultivation was the sharing of seed within generations. In most of the cases farmers did not sow all the seeds provided with the minikit and shared some seed with fellow farmers who could not secure seeds from the local Panchayat (or decided to grow the crop lately). Farmers 107, 37 and 21 got training from Farmer Science Centre and were consulted by their fellow farmers frequently. The number of adopters increased from generation to generation in the following manner (with well-being groups in parenthesis) –

1 (E) → **3** (A, B, E) → **5** (B, 4E) → **7** (2D, 4E, F)

Generation wise distribution of farmers on the basis of their well-being could not give any generalizable and conclusive information in this case also. The reason is same as mentioned during the discussion of Figure 2. Apart from that, sunflower is not highly capital intensive crop and local Panchayat provided the *minikit* support with it. Moreover, well-being did not have sole effect on the process; other factors like family relationship, neighbourhood, friendship, adjacent cultivable lands etc. were also important factors. Overall, the spread was slower than that of bitter gourd as because the farmers had less prior experience of growing this oil seed and the market was also not very secured and lucrative in comparison to alternative crops which could be consumed by the farm family.

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.

Comparison of Prestige Scores among Different Generation of Adopters

Now, the task was to examine whether the earlier adopters of the 'bitter gourd cultivation on bund' and sunflower cultivation had higher network scores computed by network analysis.

Table 1

From Table 1 it can be observed that one farmer's fractional rank of prestige scores in generation 1 (for the individuals involved in the spread of bitter gourd cultivation on ail) were from first quartile, while for the generation 2, two out of five farmers were from upper quartile. For gemeration-3 four out of nine farmers were from fourth quartile while for generation-4 no farmer was from the fourth quartile. This finding is not similar to several other works in the related fields (Faust 1997, Borgatti 2005). However the findings were in line with study carried out in another district of West Bengal (Goswami, 2007). This was because the innovation was simple and labour intensive that could be adopted by farmers who had excess of family labour. Also, most of the well-off farmers cultivating twice a year (higher prestige score in the agriculture related information network) had non-saline uplands

and they were not in immediate need to adopt such innovation to overcome soil salinity. For this reason many individuals with prestige scores from upper quartile could be found in the 3rd and 4th generation.

Table 2

It can be observed that both the fractional rank of prestige scores for all the farmers in generation 1 and 2 (for the individuals involved in the spread of bitter gourd cultivation on ail) were from first quartile. For gemeration-3 four out of nine farmers were from fourth quartile while for generation-4 no farmer was from the fourth quartile (Table 2). Like the case of bitter gourd cultivation, this finding is also not similar to several other works in the related fields (Faust 1997, Borgatti 2005) but in line with study carried out in another district of West Bengal (Goswami, 2007).

This was because local Panchayat supported the poor farmers (who had moderate to low prestige score in the information network) and some of the progressive farmers (who had high prestige score in the information network) did not adopt sunflower for processing and marketing related problems.

CONCLUSION

The present 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. This information network at the grassroots, if plotted carefully, can act as an important input to extension agencies in reaching client system more efficiently. Similar studies linking micro with macro situations 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 needed by the farming community which is a challenge of extension profession services in the third world (Chamala and Shingi, 1997).

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Table 1 Ranking of prestige score of the farmers involved in the spread of bitter gourd cultivation on bund in Purba Musalmanpara.

	Farmer Id. No. as shown in Fig. 2	**Ranking of prestige score (fractional rank as %)**
Gen-1	7	22.50 (45)
	21	12 (24)
Gen-2	15	37.50 (75)
	6	22.50 (45)
	107	2 (4)
	40	3 (6)
	35	31.50 (63)
Gen-3	12	25 (50)
	64	48 (96)
	42	5 (10)
	108	37.50 (75)
	48	1 (2)
	38	31.50 (63)
	122	29 (58)
	85	11 (22)
	59	13 (26)
Gen-4	73	9 (18)
	121	20 (40)
	88	21 (42)
	55	6 (12)
	77	4 (8)

Table 2 Ranking of prestige score of the farmers involved in the spread of sunflower cultivation in Purba Musalmanpara.

	Farmer Id. No. as shown in Fig. 3	**Ranking of prestige score (fractional rank as %)**
Gen-1	107	2 (4)
	37	7 (14)
Gen-2	21	12 (24)
	42	5 (10)
	40	3 (6)
	48	1 (2)
Gen-3	7	22.50 (45)
	88	21 (42)
	121	20 (40)
	59	13 (26)
	90	19 (38)
	64	48 (96)
Gen-4	12	25 (50)
	38	31.50 (63)
	55	6 (12)
	122	29 (58)

FIGURES

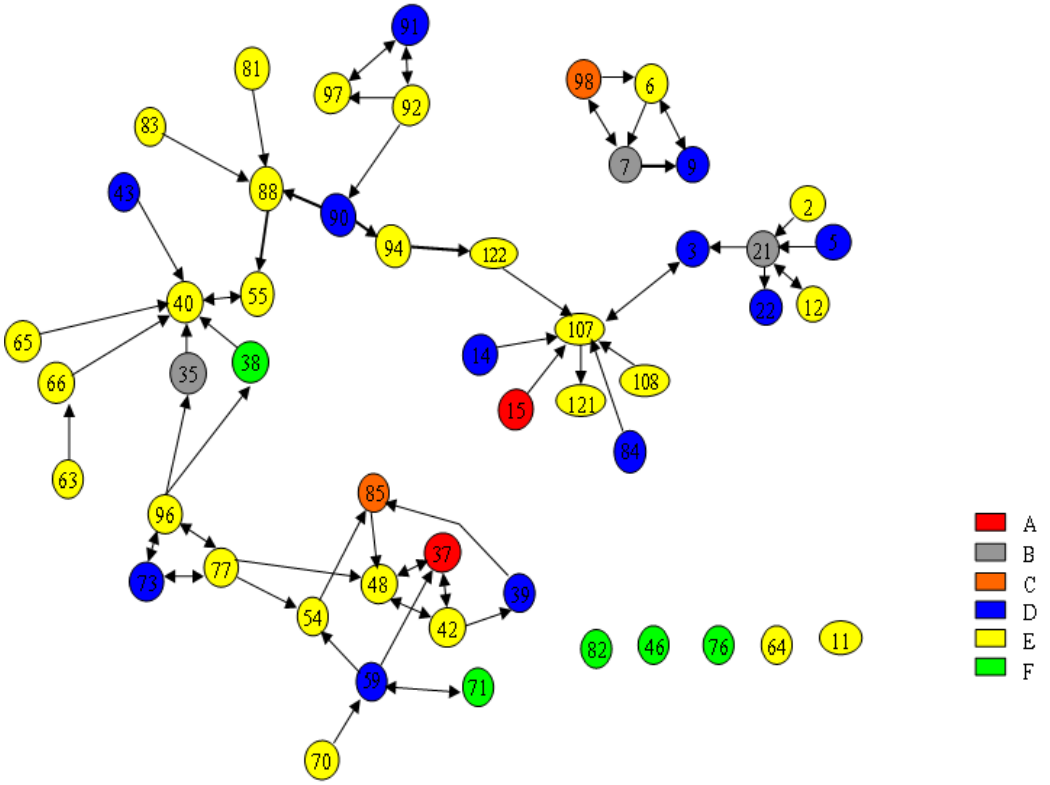

Figure 1: Network Diagram of 'agriculture and allied' information domain in Purba Musalmanpara. Different colours of circles indicate households belonging to different well-being groups (Red-Well-off; Yellow-Moderately well-off; Blue-Moderate; Green-Moderately poor; Orange-Poor; Grey-Very Poor).

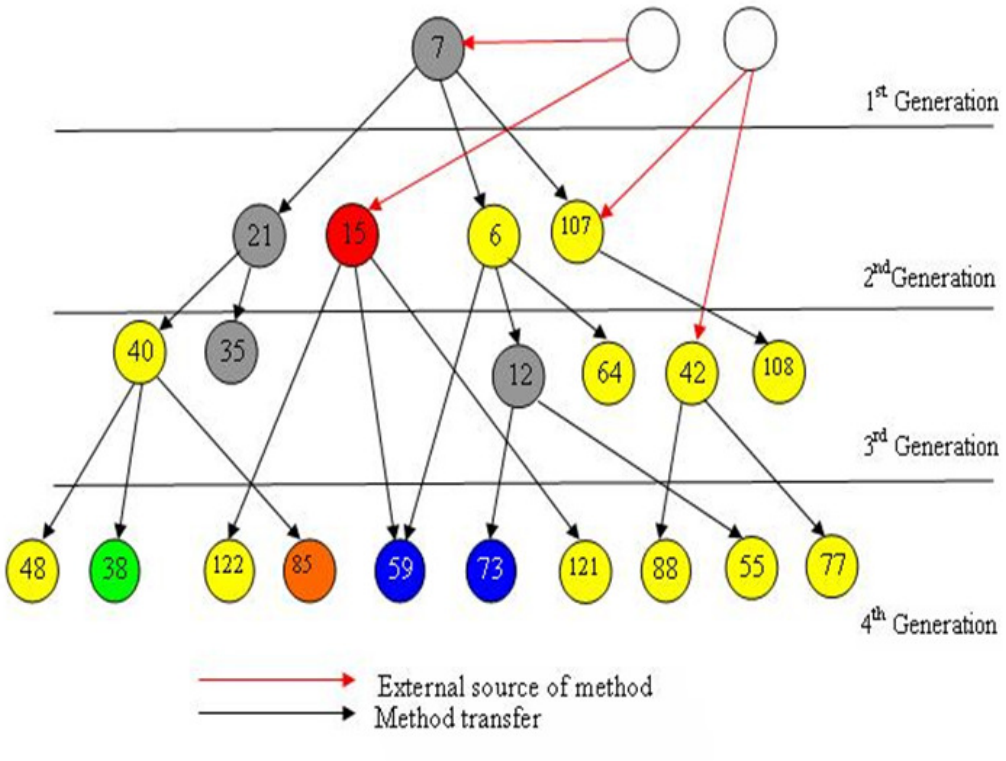

Figure 2: Spread of bitter gourd cultivation among the farmers of Purba Musalmanpara. Different colours of circles indicate households belonging to different well-being groups (Red-Well-off; Yellow-Moderately well-off; Blue-Moderate; Green-Moderately poor; Orange-Poor; Grey-Very Poor). White circles represent the outside source of the technology either in the form of material or method/capacity.

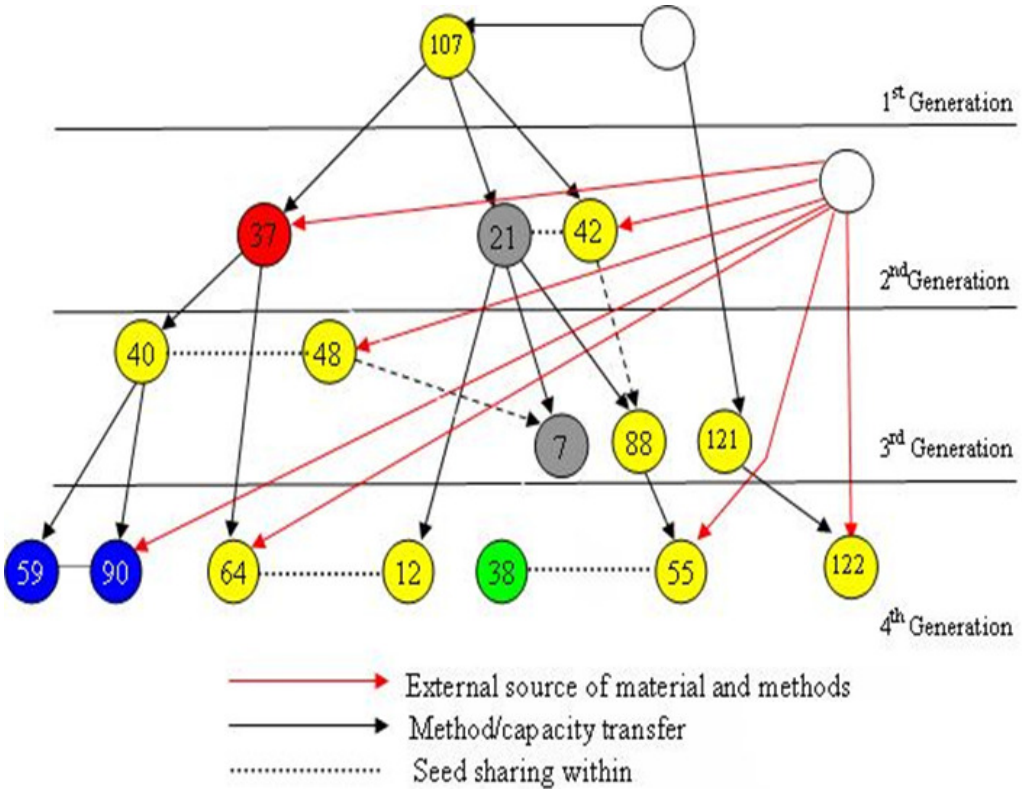

Figure 3: Spread of sunflower cultivation among the farmers of Purba Musalmanpara. Different colour of circles indicate households belonging to different well-being groups (Red-Well-off; Yellow-Moderately well-off; Blue-Moderate; Green-Moderately poor; Orange-Poor; Grey-Very Poor). White circles represent the outside source of the technology either in the form of material or method/capacity. Different positions of circles within a generation denote the commencement of cultivation in different times within one agricultural season.