Research Journal of Agriculture and Biological Sciences, 6(6): 701-707, 2010

Does Information Network Affect Technology Diffusion? A Study on the Spread of Banana and Guava Cultivation Among Farmers of Nadia District, West Bengal, India

[1]Rupak Goswami, [2]Debabrata Basu

[1]Lecturer, Integrated Rural Development and Management (IRDM) Faculty Centre, Ramakrishna Mission Vivekananda University, Narendrapur, Kolkata-103, INDIA
[1]Reader, Department of Agricultural Extension, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, INDIA

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 social networks. The present study was conducted at Nadia District of West Bengal, India to study the spread of banana (*Musa paradisiacal* L.) and guava (*Psidium guajava* L.) cultivation among the farmers of selected villages. Case study method and focused group discussion was used to track this spread over different generations of adopters. Sociometric technique was employed to find out the network score of farmers in the agricultural information network. The fractional ranking of network scores of farmers was then compared with their relative earliness in the spread of banana and guava cultivation. It was found that both in the spread of banana and guava cultivation, most of the farmers who had higher network scores were earlier adopters of banana and guava cultivation practices and *vice versa*. This indicates the possible relations between farmers' adoption-decision regarding new crops and their position in social networks.

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. These stakeholders 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 seemingly invisible patterns of communication and information exchange constitute an integral part of a farming system. Some argue that they constitute part of a broader system – an agricultural knowledge and information system[21,16]. In terms of agricultural development, the different stakeholders can together be perceived as a social organisation; and it is their joint action that enhances or limits the development of innovation[16]. Understanding this information system is of paramount importance to explore the context of innovation, its spread and ultimate utilization. At the micro level, analysis of farmers' communication network is, hence, a valid point of contemplation.

Adoption research for long has considered individual farmer as the basis of analysis. However, the importance of interpersonal network on individuals for (a) coping with uncertainties of new ideas and (b) convincing them to adopt innovations has received attention much later. One of such important and pioneering works came with Rogers and Kincaid's[20] study of several family planning innovations in Korean villages. This study embodied a departure from individual-oriented diffusion research tradition with the proposal of network consideration in diffusion study[19]. By the time network consideration gained popularity among diffusion researchers, a distinct area of social

Corresponding Author: Rupak Goswami, Lecturer, Integrated Rural Development and Management (IRDM) Faculty Centre, Ramakrishna Mission Vivekananda University, Narendrapur, Kolkata-700103, INDIA
Phone: 91-9433246593
E-mail: goswamirupak@rediffmail.com

science research – social structure analysis – gained momentum among the sociologists (structuralists) of '*Rural Sociology*'[23]. Social Network Analysis has also become powerful with the development of social capital *vis-à-vis* social networks[15]. The present study can be understood as a part of both these 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[24]. Rogers[18] 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 that is the network. Also, there is a substantial amount of literature available on how network data gathers within formal and informal organizations that can be analyzed[17,9,22,29]

Motivated by the research tradition in Social Learning[2,5], the adoption behaviour of farmers within such networks are recently being studied[8,1,25], health and drug being the most empirically tested areas[26]. 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[12]. However, direct applications of social network analysis to study the diffusion of innovations in agriculture have been more limited[13]. 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[27] and the social and farming system niches regarding new crops may be understood[13].

MATERIALS AND METHODS

The study was conducted in Basantapur village of Chakdah block in district Nadia of West Bengal, India. Multi-stage random sampling was employed for the selection of district, block, gram panchayat (local democratically elected self-governing body) and social village. Total enumeration technique was followed for the selection of respondents. A thoroughly pre-tested structured interview schedule (on respondents of a non-sample village of the block) was developed for personal interview with the respondents. Case study method and focused group discussion was used to track the spread of banana and guava cultivation over different generation of adopters. Generated information for describing such spread was drawn in a form of diagram with distinction of generations of adopters (the first farmer cultivating banana/guava has been conceptualized as a farmer of 1st generation; the farmers following him in the next season have been considered as the member of the 2nd generation), mode of transfer [material (planning material)/method (method of doing things)/capacity (special human capital)] and household number (similar method may be observed from Van Mele and Zakaria[28]). Households were demarcated with separate shades/textures in the diagram showing their respective well-being groups identified through Grandin's[10] card sorting method. Then qualitative description of the process was made.

Network Analysis (Sociometry) was employed to elicit information regarding agricultural information network of the farmers. Both visual and statistical methods have been used. Network diagram (Sociogram) has been used for visual representation, whereas distance matrix was constructed for the measurement of network scores. Prestige score i.e., an index taking into account both his influence domain and centrality in the group, was then calculated. The *prestige* of a person is defined as the extent to which he enjoys a large following (high influence-domain) and is centrally located in the group (high centrality)[11]. The fractional ranking of prestige scores of farmers within the network was then tabulated against the individual farmers featuring in the diagram of spread of banana and guava cultivation (Fig. 2 and Fig. 3). A scrutiny was then made to see whether the farmers appearing in the earlier generations of technology spread were also having relatively higher prestige scores or not.

RESULTS AND DISCUSSION

The graphical presentation of network analysis is presented by Fig. 1. From the visual check of the figure a wired wheel structure could be noticed with more or less conspicuous dominant subgroups interlinked among them. Household number 60, 8 and 78 are at the central position of the network with some dense interaction around household number 9, 81 and 59 at the periphery. There was no apparent cleavage in the network and few important chains indicated the most important paths of information flow through the network (59→8→78→61; 74→60→78→9→81; 74→60→8→29→1→81).

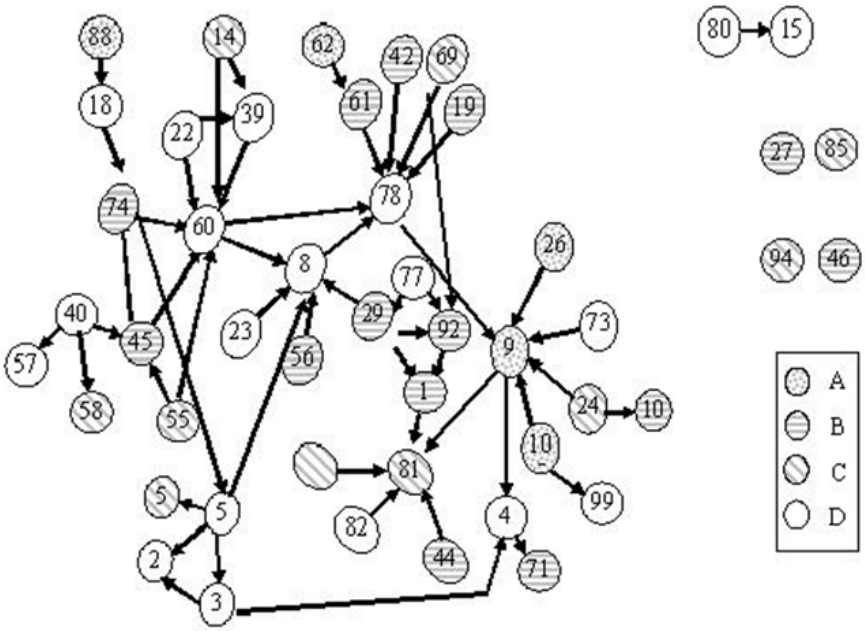

Fig. 1: Network Diagram of 'agriculture and allied' information domain in Basantapur village. Different shades of circles indicate households belonging to different well-being groups (A-Rich; B-Moderately rich; C-Poor & D-Very poor) identified before data collection.

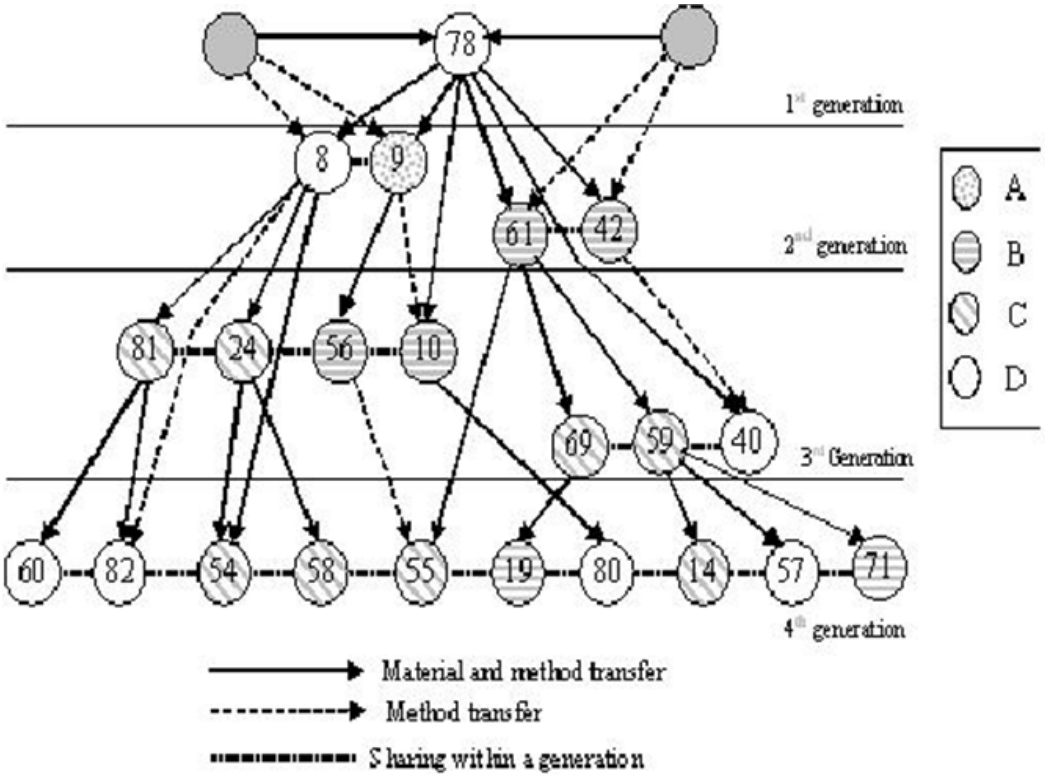

Fig. 2: Spread of banana cultivation among the farmers of Basantapur village. The grey circles in the 1st generation connected to '78', indicate external sources. Different shades of circles indicate households belonging to different well-being groups (A-Rich; B-Moderately rich; C-Poor & D-Very poor) identified before data collection.

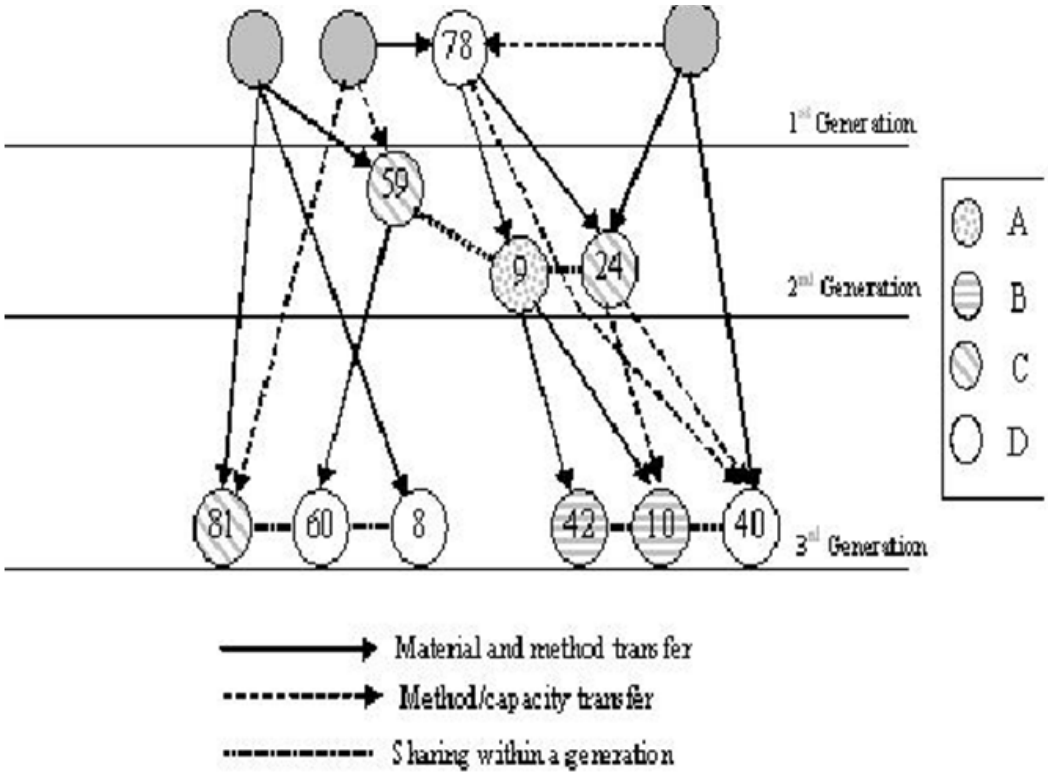

Fig. 3: Spread of guava cultivation among the farmers of Basantapur village. The grey circles in the 1st generation connected to '78', indicate external sources. Different shades of circles indicate households belonging to different well-being groups (A-Rich; B-Moderately rich; C-Poor & D-Very poor) identified before data collection.

There were 4 isolates (27, 46, 85, 94), 16 neglectees (57, 58, 55, 54, 34, 14, 23, 56, 42, 69, 19, 3, 82, 44, 71, 73), 1 clique consisting of 2 individuals (80, 15), 6 opinion leaders (60, 78, 8, 9, 81, 59) and 5 liaisons (45, 60, 9, 1, 78) in the network. Group cohesiveness of the network was 0.0151 with 17 mutual choices and social compatibility index was calculated to be 0.3617. Mutual choice has been moderate due to the fact that most of the farmers were dependent on agricultural input supplier's shop (fertilizer and pesticide shop owner) for technical information regarding the agricultural enterprises and intense information seeking centered on only few knowledgeable farmers.

Figure 2 shows the spread (flow) of Banana cultivation among the farmers of the study village. The spread could be identified and drawn up to the 4th generation. The horizontal lines separate generations, while the circles represent the individual farm family. The texture of the circles represents households' respective well-being groups. Grey circles represent the external source of the technology either in the form of material or method/capacity. Different positions of households within a generation of adopters denote the commencement of cultivation in different agricultural seasons within a year. Here it is for two cultivars of banana planted during different times of the year (local name *Martaman* and *Singapuri*). The salient observations evident from the diagram with the underlying logic are described below:

1. One farmer (household no. 78) started banana cultivation with planting materials from two different sources of the neighbouring village. This was to cross-check the information sources and to minimize the risk of getting defective planting materials.
2. In most of the cases material transfer accompanied method transfer, although there were cases of method transfer taking place alone.
3. For the next generation, the earliest cultivator of the village became the source of planting material (and method), although farmers sought counsel from the very outside sources from whom "78" received material and method of banana cultivation.

4. The source of planting material within a generation was often restricted to a few growers. This was because they had maintained the healthiest plants till the suckers emerged. (e.g. household number 78, 8, 61, 59).
5. The number of adopters increased from generation to generation in the following manner (with well-being groups in parenthesis) –

1 (D) → **4** (1A, 2B, 1D) → **7** (2B, 4C, 1D) → **10** (2B, 4C, 4D)

Generation wise distribution of farmers on the basis of their well-being could not be explained definitely. Because, the farmers mostly belonged to the lower well-being groups (C and D) as agriculture was their primary occupation. Secondly, banana was not found to be a very high capital intensive crop and fetched good return in a manner (regular return for few months) convenient to the farmers. That means even small farmers could go for banana cultivation without much hesitation. Thirdly, and perhaps most importantly, well-being did not have sole effect on the process, other factors like family relationship, neighbourhood, friendship, adjacent lands (from where cultivation practices are learned) etc. also acted as important factors.

6. Sharing of information (often material) within generation was found to be very high. This is perhaps due to the collective interest of farmers for safeguarding the crop. The highlands of the village were concentrated on one side and most of the bananas were grown there. This resulted in collective actions, managements and exchange of information among farmers.

Figure 3 shows the spread (flow) of guava cultivation among the farmers of Basantapur. Guava has been grown in the village for the last three seasons and a distinct pattern of spread was yet to emerge. Still, it gave a valuable insight regarding the early stages of an innovation's spread. The salient observations evident from the diagram with the underlying logic/understanding are described below:

1. Two progressive farmers of the neighbouring village were the sources of the technology; one for material while the other for method and capacity transfer.
2. During the study, the farmers were depending on the external sources for the planting material as the newly grown plants of the village were not ready enough to be used as planting materials (farmer of household no. 9 acted as a vendor of guava planting material).
3. Both material and method/capacity transfer had played significant role in the process.
4. Household number 78 and 24 had learned the bending technique of guava from one of the progressive farmers of the neighbouring village and practiced it in their own village.
5. The number of adopters increased from generation to generation in the following manner (with well-being groups in parenthesis)

1 (1D) → **3** (1A, 2C) → **6** (2B, 1C, 3D)

6. Like banana, guava also was grown in medium to high lands and naturally had limitations of being spread quickly. Moreover, its cultivation was not that common as far as the previous experience of the farmers was concerned. Still, as a matter of fact, guava had, to a large extent, replaced banana in the cropping sequence and had lent a greater scope for intercropping than what banana (based cropping system) could permit.

Comparison of Prestige Scores among Different Generation of Adopters: Table 1 clearly shows that most of the farmers featuring in the earlier generations of spread of banana cultivation had higher prestige scores in the agricultural information network. The only farmer of generation 1 ('78') had highest prestige score (rank 1), while three among the four farmers of generation 2 had prestige scores in the upper quartile. Observation could also show that five out of nine farmers of generation 4 had prestige score falling in the lower quartile. This finding is similar to several other works in the related fields[7,3]. Table 2 shows that three out of four farmers of early generations (1 & 2) prestige scores in the upper quartile.

Conclusion: Although not demonstrated with statistical rigour, the present study tried to show the influence of individuals' position within information networks on their adoption decision. This has been a study rudimentary in nature and has made effort to provide some basic propositions in the given area. The information network at the grassroots, if plotted carefully, can act as an important input to extension agencies in reaching client system more efficiently. Similar study linking micro with macro situations with suitable modeling can also be proved useful for analysing agricultural knowledge and information systems. Moreover, the identified social networks can be used to support a broader livelihood related information need of the farming community which is a challenge of extension profession services in the third world[4].

Table 1: Prestige score and ranking of the farmers involved in the spread of banana cultivation in village Basantapur.

	Respondent number	Ranking of prestige score (fractional rank as %)
Generation -1	78	1 (2.08)
Generation -2	8	4 (8.33)
	9	2 (4.17)
	61	5 (10.42)
	42	24 (50.00)
Generation -3	81	6 (12.50)
	24	20 (41.67)
	56	32.5 (67.71)
	10	26 (54.17)
	69	14 (19.17)
	59	7 (14.58)
	40	34 (70.83)
Generation -4	60	3 (6.25)
	82	38 (79.17)
	54	36.5 (76.04)
	58	43 (89.58)
	55	18 (37.50)
	19	27 (56.25)
	80	40.5 (84.38)
	14	23 (47.92)
	57	43 (89.58)
	41	36 (76.04)

Table 2: Prestige score and ranking of the farmers involved in the spread of banana cultivation in village Basantapur.

	Respondent numbers	Ranking of prestige score (fractional rank as %)
Generation -1	78	1 (2.08)
Generation -2	59	7 (14.58)
	9	2 (4.17)
	24	20 (41.67)
Generation -3	81	6 (12.50)
	60	3 (6.25)
	8	4 (8.33)
	42	24 (50.00)
	10	26 (54.17)
	40	34 (70.83)

REFERENCES

1. Bandiera, O. and I. Rasul, 2003. Complementarities, social networks, and technology adoption in Mozambique. http://econ.lse.ac.uk/staff/bandiera/adoption.pdf. (retrieved on 7 May, 2007).
2. Bandura, A., 1977. Social Learning Theory. Prentice-Hall, Englewood Cliffs, NJ.
3. Borgatti, S.P., 2005. Centrality and network flow. Social Networks, 27: 55-71.
4. Chamala, S. and P.M. Shingi, 1997. Establishing and strengthening farmer organizations. In: Swanson, B. E., Bentz, R. P. and Sofranko, A. J. (Eds.). *Improving Agricultural Extension: A Reference Manual.* Rome, FAO.
5. Ellison, G. and D. Fudenberg, 1995. Word-of-mouth communication and social learning. Quarterly Journal of Economics, 110: 93-125.
6. Engel, P., 1995. Facilitating innovation: an action-oriented approach and participatory methodology to improve innovative social practice in agriculture. Wageningen Agricultural University Dissertation, University of Wageningen, Netherlands.
7. Faust, K., 1997. Centrality in affiliation networks. Social Networks, 19: 157-191.
8. Foster, A.D. and M.R. Rosenzweig, 1995. Learning by doing and learning from others: human capital and technical change in agriculture, Journal of Political Economy, 103: 1176-1209.
9. Freeman, L.C., D.R., White and A.K. Romney, 1992. Research Methods in Social Network Analysis. Transaction Publishers, New Brunswick, NJ.
10. Grandin, B., 1988. Wealth Ranking In Smallholder Communities: A Field Manual, London: Intermediate Technology Publications.
11. Lin, N., 1976. Foundations of Social Research. New York, McGraw-Hill.
12. Mazur, R. and S. Onzere, 2009. Social networks and status in adopting agricultural technologies and practices among small scale farmers in Uganda. In: Sanginga, P. *et al*. (Eds.) *Innovation Africa: Enriching farmers' livelihoods*. London, Earthscan. pp: 120-134.
13. Monge, M., F. Hartwich and D. Halgin, 2008. How change agents and social capital influence the adoption of innovations among small farmers: Evidence from social networks in rural Bolivia. IFPRI Discussion Paper 00761.New York, IFPRI.
14. Putnam, R.D., 1993. Making democracy work: civic traditions in modern Italy. Princeton, NJ: Princeton University Press.
15. Putnam, R.D., 2000. Bowling alone: the collapse and revival of American community. New York: Simon and Schuster.
16. Ramirez, R., 1997. Understanding Farmers' Communication Networks: Combining PRA with Agricultural Knowledge Systems analysis. Gatekeeper Series No. 66. London: IIED.
17. Rice, R.E. and W.D. Richards, 1985. An overview of network analysis methods and programs. In Progress in Communication Sciences, Eds., Dervin, B. and M.J. Voight, (eds.), Norwood, NJ: Ablex Publishing Co., pp: 105-165.
18. Rogers, E.M., 1986. Communication Technology: The New Media in Society. New York: The Free Press.
19. Rogers, E.M., 1995. Diffusion of Innovations. Fourth edition. New York: The Free Press.
20. Rogers, E.M. and L.D. Kincaid, 1981. Communication Networks: Toward A New Paradigm for Research. New York: The Free Press.

21. Roling, N., 1988. Extension Science: Information Systems in Agricultural Development. Cambridge: Cambridge University Press.
22. Scott, J., 2000. Social Network Analysis: A Handbook. Second edition, London: Sage.
23. Skinner, J. and D. Staigar, 2005. Technology adoption from hybrid corn to beta blockers. NBAR Working Paper 11251, Massachusetts: National Bureau of Economic Research.
24. University of Twente, 2004. Network theory and analysis. http://www.cw.utwente.nl/theorieenoverzicht/Theory%20clusters/Communication%20and%20Information%20Technology/Network%20Theory%20and%20analysis_also_within_organizations.doc/ (retrieved on April 23, 2008).
25. Udry, C.R. and T.G. Conley, 2004. Social networks in Ghana. Center Discussion Paper No. 888, Economic Growth Centre, Yale University. http://www.econ.yale.edu/growth_pdf/cdp888.pdf (retrieved on May 12, 2008).
26. Valente, T.W., 2003. Social network influences on adolescent substance use: an introduction. Connections, 25(2): 11-16.
27. Valente, T.W., 2006. Opinion leader intervention in social networks. BMJ, 333: 1082-83.
28. Van Mele, P. and A.K.M. Zakaria, 2002. The innovation tree: a new PRA tool to reveal the innovation adoption and diffusion process. PLA Notes, 45: 54-58.
29. Wassermann, S. and K. Faust, 1994. Social Network Analysis: Methods and Applications. Cambridge: Cambridge University Press.