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The spread of innovations within formal and informal farmers groups: Evidence from rural communities of semi-arid Eastern Africa

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Abstract
Novel ideas and farming practices spread, and often enough even evolve, through interpersonal interaction and communication in rural communities. Facilitating cooperation and exchange among farmers becomes a core objective of most extension interventions. Farmers groups can play an active role to promote the diffusion of knowledge and technologies and thus to improve the efficiency and efficacy of the technology extension efforts.
This paper investigates the effect of structural and functional variables of farmers groups on the spread of agroforestry innovations among the group members. Specifically, it was hypothesized that (a) group cohesiveness, (b) group activity and (c) member motivation will each be positively related to the spread of the technologies among the group. Group social networks represent the main analytical level and units of analysis. The technology adoption behaviour of individual farm households serves to operationalize the diffusion variable.
Four full sample surveys of approximately 200 households each have been conducted in Kenya and Ethiopia. Primary data was collected using semi-structured questionnaires, expert interviews, group discussions and rankings, as well as observation. Data was analyzed employing sociometric and statistical software packages.
The research results support the main hypotheses. The study further presents empirical evidence that illustrates the innovative potential of cohesive farmers groups, and that exists in spite of the prevailing top-down and largely persuasive extension approaches that currently are being adopted in the four study areas.

1 Background and Aim of the Study

On-farm management of trees is promising option to increase the socio-economic well-being of rural populations and to simultaneously stabilize the fragile environment of semi-arid regions. In spite of considerable efforts that have been undertaken to develop and to disseminate innovative farm and tree management methods during the past decades, a very limited number of them have been adopted in practice. New concepts of rural extension work are, therefore, being developed and implemented all over the world. From the coexistence of traditional and alternative extension approaches arise the need for, and the opportunity of comparative evaluation and impact assessment.

Basing upon the hypothesis that innovative arrangements and practices emerge from social interaction rather than from the top-down knowledge transfer along the traditional technology development chain, the new paradigm stresses the facilitation of exchange and networking between farmers, research and extension organizations (Engel 1997, Leeuwis & van den Ban 2004). Besides inter-institutional cooperation and linkages, most of the new concepts simultaneously aim to initiate, intensify and institutionalize the horizontal communication and knowledge exchange among farmers. The “Farmer-to-farmer” and the “Farmer Field Schools” approaches that probably constitute the most renowned examples encourage and enable particularly innovative or trained farmers to pass their knowledge and experiences on to their colleagues. Promising results are reported of these approaches (e.g. Fetien Abay et al. 2001, Simpson & Owens 2002, Sones et al. 2003). Establishment and strengthening of farmers organizations is increasingly regarded as being a core task of extension work.

To increase the understanding of how farmers organizations contribute to the knowledge diffusion process within rural communities, the paper investigates whether structural and functional properties of such organizations influence the innovation adoption behaviour of their group members. The research is founded on the proposition that the spread of innovations is influenced by direct contacts between individuals and consequently, employs concepts and tools of the Social Network Theory. This wing of research, in particular the utilization of relational and structural network models to explain the spread of knowledge and technology,

has recently attracted increasing interest of diffusion researchers (e.g. Abrahamson & Rosenkopf 1997, Valente 1994, Guardiola 2002, Lemmens 2003, Monge & Contractor 2003, Wu & Pretty 2004).

The paper presents first empirical findings of a research that is currently being undertaken in semi-arid eastern Africa. By investigating the potential that farmers groups can have within the extension process, it aims to enhance both efficiency and effectiveness of future extension interventions in the study region.

2 Methodology

2.1 Study areas

The study was undertaken at four case study locations located in the Rift Valley and the Eastern Provinces of Kenya, and the Oromiya and Tigray Regions of Ethiopia. One to four adjacent villages have been studied at each of the case study sites, in order to involve a sample population of approximately 200 households at each site. All villages are situated within the intervention areas of internationally supported development projects that promote sustainable agroforestry practices among farmers through dissimilar extension approaches (Table 1). Although a number of smaller non-governmental institutions, partly supported by foreign donors, are also active in the study areas, the projects are currently the major providers of extension services in the villages.

Table 1: Characteristics of the study areas

	Mongorion	*Wote*	*Bola Buta*	*Abraha Atsbaha*
Investigated villages	Achawa, Mongorion, Kodoso and Poroswo	Mwaani, Kyamusoi and Kamunyolo	Menafesha, Gabriel Sefer, Goro Buta	Minda
Administrative location	Chepareria Division, West Pokot District, Rift Valley Province, Kenya	Wote Division, Makueni District, Eastern Province, Kenya	Bola Buta Peasant Association, Lume Woreda, Oromiya Region, Ethiopia	Abraha Atsbaha Peasant Association, Wukro Woreda, Tigray Region, Ethiopia
Distance to major urban centres	3 km N of Chepareria town (market place), approx. 40 km NE of Kitale, approx. 380 km NW of Nairobi	5 km E of Wote town (market place), 81 km SE of Machakos, approx. 230 km SE of Nairobi	17 km NE of Mojo town (market place), approx. 18 km NW of Nazret, approx. 85 km SE of Addis Ababa	5 km N of Abraha Atsbaha (market place), 15 km NW of Wukro town, approx. 45 km N of Mekele
Elevation	ca. 1300 m a.s.l.[d)]	ca. 200 m a.s.l.[a)]	ca. 1800 m a.s.l.[f)]	ca. 2000 m a.s.l. [h)]
Climate	P=791 mm/a; 1 rainy season (Apr-Jul) [d)], T=22°C [e)]	P=777 mm/a; 2 rainy seasons (Mar-Apr, Nov-Dec) [a)], T=22°C [b)]	P=918 mm/a[f)] ; 2 rainy seasons (Mar-Apr, Jun-Sep), T=18-21°C [g)]	P=580 mm/a; 1 rainy season (Jun-Sep), T=17-20°C[h)]
Soils	Moderate to low soil fertility [d)]	Shallow soil, low soil fertility [a)]	Vertisols, Rendzina, Cambisols[g)]	Sandy Vertisols
Population density	110 inhabitants/km² [c)]	111 inhabitants/km² [c)]	117 inhabitants/km² [g)]	n.a.
Tribe; socio-cultural development	Pokot; sedentary farming common since 10-20 years	Akamba; sedentary farmers for several generations	mainly Oromo; sedentary farmers for several generations	Tigray; sedentary farming common since 10-20 years
Development project operator	Vi Planterar Träd foundation (Swedish NGO)	Belgian Technical Cooperation (governmental agency)	German Technical Cooperation (governmental agency)	World Food Program (UN agency)
Extension approach	Technical advice, minor handouts (seeds) provided to a large number of farmers and farmers groups through project extension workers	Technical advice, technical inputs, finance provided to a small number of farmers through extensionists of the District Administrations	Technical advice, inputs, finance provided to individual farmers through Development Agents of the Woreda Administrations and Project specialists	Technical advice, inputs, finance provided to individual farmers and farmers groups through a powerful public extension service (Woreda Admin.)

Source: [a)]Jaetzold, Schmidt (1983a); [b)]GoK (2002a); [c)]GoK (2001); [d)]Jaetzold, Schmidt (1983b); [e)]GoK (2002b); [f)]Koch et al. (1990); [g)]GoE (2006); [h)]GFA 2002 (2006); Field research (2006)

Whereas the study sites are comparable in terms of bio-geographic and socio-economic characteristics, a major difference refers to the dissimilar role of farmers groups in the extension process.

2.2 Methods and research design

Data collection employed empirical social research tools. Primary data was collected using semi-structured questionnaires for household and expert interviews, as well as by means of group discussions, rankings and

observations. Secondary data was obtained from a variety of sources including published and unpublished literature. Data was crosschecked following the principles of triangulation of methods and data sources. Qualitative and quantitative data analysis was conducted using statistical and sociometric packages (SPSS, UCInet), as well as spreadsheets.

In order to allow for a socio-centric representation of the personal and group networks under study, full samples of 180 to 230 households have been interviewed at the case study locations. The samples consist of representatives of each household living in the study villages at the time of fieldwork. Additionally, households residing outside the boundaries of the delineated study villages have been traced and included in the study when they were central to the groups and networks under study following a snowball sampling procedure.

The study measures the relationship between Group cohesiveness, Member motivation and Group activity (dependent variables) and the Group innovativeness (independent variable). Group cohesiveness was captured using the sociographic indicators of Average out-degree, Group network density, Group network cohesion and Group network degree centralization (see Annex 1 for definitions and mathematical equations). Member motivation was operationalized along the five dimensions of Interest, Identification, Communication, Commitment and Involvement (after Chidambaram & Bostrom 1996)[1]. Motivation scores range between 0 (only negative ratings) and 1 (100% positive ratings). Additionally, the Average number of deviating appraisals per member in relation to general group matters was also included, such as group objectives, frequency of meetings and the availability of group statutes. This value was derived from the comparison of individual group members' and their group mates' answers. Group activity was operationalized based on the indicators of Average duration of group membership and the Year of group establishment.

Individual Household innovativeness serves to estimate the innovativeness of groups. It is derived as a compound variable from the individual adoption behaviour of group members. It was assessed based on the adoption of 22 agricultural, agroforestry and tree management innovations that reflect a range of complexity, and that represent both practices that had been introduced and promoted by the extension projects, as well as locally known practices[2]. The adoption level of each innovation was evaluated during the household interviews. Qualitative and quantitative criteria such as the year of first adoption, current plans to continue or expand the adoption, as well as peculiarities of the adopted techniques were used to classify the households' adoption level of each technology as none, trial or full level adoption. From the adoption level and the complexity rank that was assigned to each innovation by key informants (e.g. farmers, extension workers and project staff) innovativeness marks have been calculated for each household (Formula 5 in Annex 1).

Besides the over-all analyses that are based on the adoption of all 22 innovations, two individual innovations, namely Inter-cropping and Farm woodlot, shall be used to further reveal the relationship of group innovativeness and the independent variables. Both innovations have been chosen as they represent innovations of intermediate complexity (average complexity rank of Intercropping: 12.25, average rank of Farm woodlot: 9.75) that are equally practised in all four study sites. Whereas Inter-cropping represents a largely indigenous practice that is not particularly promoted by the extension services, Farm woodlot establishment and tree planting constitutes a core activity of the extension efforts in all four study sites. As the aggregate household

[1] 20 Likert-type scaled questions have been used to measure the motivation of group members. For the list of items see Annex 2.

[2] With increasing complexity: Mongorion: Direct sowing of trees/grasses; Living fences; Pruning/ pollarding; Trash lines (runoff control); Windbreaks; Enclosed pasture; Protection of natural tree regeneration; Compost making; Home nursery; Contour hedgerows; Intercropping; Improved cooking stove; Terraces/ stone lining; Water harvesting from roads; roofs etc; Improved maize varieties; Farm woodlot; Fodder banks; Seed or wildlings collection; Loan/ bank account; Chemical fertilizers/ pesticides; Gulley healing; Fruit tree grafting. Wote: Chemical fertilizers/ pesticides; Improved maize varieties; Inter-/Alley cropping; Contour-bench terraces; Gulley healing; Living fences; Prunig/ pollarding; Zero grazing/ Fodder banks; Compost making; Seed/ wildling collection; Home/ commercial nursery; Fruit tree grafting; Fruit tree orchard; Farm woodlot; Borehole/ well; Water harvesting; Water storage; Drip-line irrigation; Anti-evaporation covers; Bee keeping; Improved stove; Loan/ bank account. Bola Buta: Mulching; Tree seed collection; Boundary planting of trees; Multi-storey garden; Prunig/ pollarding; Farm woodlot; Charcoal making; Living fences; Fruit tree orchard; Bee keeping; Inter-/ Alley cropping; Area closure; Water storage; Fodder banks/ Zero-grazing; Water harvesting; Com-post making; Improved maize varieties; Contour-bench terraces; Gulley healing; Loan/ bank account; Borehole, well; Chemical fertilizers/ pesticides. Abraha Absbaha: Improved stove; Prunig/ pollarding; Tree seedling collection; Boundary planting of trees; Loan/ bank account; Living fences; Compost making; Physical tree protection; Faidherbia Intercropping; Improved maize varieties; Mulching; Bee keeping; Home nursery; Farm woodlot; Chemical fertilizers/ pesticides; Shallow well, borehole; Zero grazing/ Fodder banks; Gulley healing; Water harvesting; Homegarden/ riverbed cultivation; Water storage; Fruit tree orchard.

innovation is no adequate measure to grasp group innovativeness in relation to single innovations, the proportion of adopters of the specific innovation among the group members shall be used instead.

Demographic and socio-economic attributes have been collected as control variables.

3 Results and discussion

3.1 General findings

The large number of farmers groups that exist in the study areas, and the type of activities that they perform illustrate the long tradition and importance that mutual assistance and different forms of social organization had and still have in African societies. A total of 97 groups was reported, among them Women, Youth and Self-help groups that address a multitude of activities, such as farming and livestock rearing, handicraft and artisan occupation, the provision of micro-credits, funeral services, religious matters and labour exchange. Groups and organizations with compulsory membership have not been included in the investigation (e.g., Farmers Associations in Ethiopia). Table 3 presents an overview on the farmers groups that are currently working in the four case study sites.

Table 3: Overview on the number of farmers groups investigated in the case study sites

	Mongorion	*Wote*	*Bola Buta*	*Abraha Atsbaha*
Membership (%)	59.6	97.8	90.0	83.8
No. of groups*	11 (25)	29 (58)	2 (2)	12 (12)
Group character	formal	formal	informal	formal
Fields of work Farm mgmt.	*4*	*6*	*1*	*2*
Cash/off-farm income	*2*	*11*	*0*	*0*
Labour sharing	*0*	*1*	*1*	*8*
Several fields of work	*4*	*7*	*0*	*2*
Welfare/relief	*0*	*4*	*0*	*0*
Not active	*1*	*0*	*0*	*0*
Extension contact	8	8	0	12

* Groups with no less than 3 members (total number of groups in parentheses). Source: Field research (2006)

Between 59.6% and 97.8% of all villagers participate in at least one farmers group. The very high degree of group affiliation and the high number of groups in Wote are an expression of the history and socio-cultural peculiarities of the study area (e.g. Tiffen et al. 1994) and current policies in support of small private NGOs to attract funding for small-scale development projects. In Bola Buta, in contrast, only two groups are of major relevance that both are rooted in the tradition of mutuality and assistance among neighbours. In both groups, villagers meet in varying frequency and composition without formal membership to perform predefined tasks. Official group structures that have been set up by the government to formalize those cooperation patterns have not gained wide acceptance. This also explains why extension agents in Bola Buta do not address at least one of the investigated groups.

Out of the total number of 54 groups that have been reported in the four case study areas, only those 36 groups shall be included in further analyses that explicitly and exclusively deal with aspects of farm management, cash/off-farm income generation and labour sharing, as the causality between membership in other groups and the diffusion of innovations cannot be reasonably assumed. Due to the relatively small number of units, data from the four case study sites will be pooled and jointly analysed across cases.

3.2 Independent variable

Household innovativeness ranges between 0 (few/ simple innovations adopted) and 456 (many/ complex innovations adopted). The case study areas differ only marginally (Mongorion: 34-400, Wote: 10-406, Bola Buta: 0-395, Abraha Atsbaha: 1-456). The households of the case study sites are roughly normally distributed along household innovativeness (Figure 1).

Source: Field research (2006)

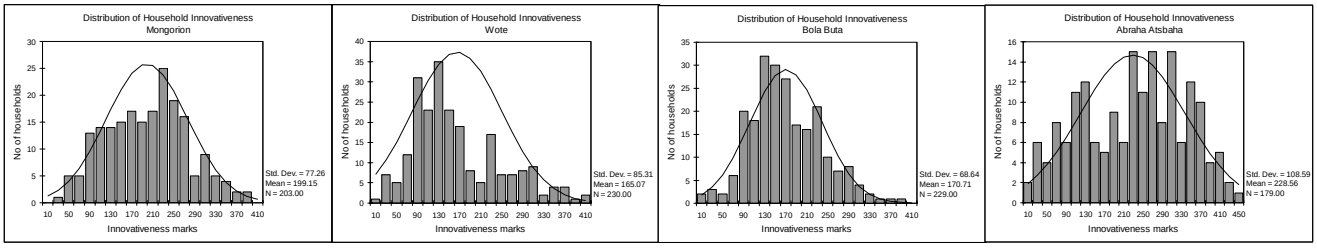

Figure 1: Frequency distribution of Household innovativeness

The slightly skewed distribution of the Wote case study area is an indication of the intensive, individual-oriented extension strategy of the development project that reaches a small number of households, only. Similarly, the slightly right-skewed distribution in Abraha Atsbaha reflects the influential governmental extension service in Tigray and the effect of strictly organized farmers groups.

Based on the adoption behaviour of its members, groups have been classified into one of the following four classes of group innovativeness (Table 3).

Table 3: Criteria for classifying Group Innovativeness and number of groups in the respective classes

Group category *Innovation*	*Very innovative*	*Innovative*	*Moderately innovative*	*Slightly innovative*
Over-all innovativeness	$MI_{group} > MI_{village}$ and $SD_{group} < SD_{village}$	$MI_{group} > MI_{village}$ and $SD_{group} > SD_{village}$	$MI_{group} < MI_{village}$ and $SD_{group} < SD_{village}$	$MI_{group} < MI_{village}$ and $SD_{group} > SD_{village}$
N	8	14	14	0
Specific innovations:	FTA>50% and FA>50%	FTA>50% and FA<50%	FTA<50% and FA>50%	FTA<50% and FA<50%
Inter-cropping* N	17	15	0	0
Farm woodlot* N	10	3	5	4

MI=Mean Innovativeness; SD=Standard Deviation of innovativeness; FTA=Proportion of full and trial adopters among the group members; FA=Proportion of full adopters among the full and trial adopters within the group; *The difference to the total of 36 groups under study is explained by non-adoption of the respective innovation by all group members. Source: Field research (2006)

In the case of the over-all analysis, those 8 groups are classified as very innovative that show an above-average innovativeness of their group members compared to the average village population, and that also show a below-average standard deviation of the innovativeness of group members compared to the respective village. Similarly, 17 and 10 out of the total number of groups are classified as very innovative in the case of Inter-cropping and Farm woodlot, respectively. At least half of the members of these groups practise the two innovations, with a majority fully adopting. Groups of least innovativeness are characterized by low average innovativeness values/ large standard deviation in comparison to the case study site, and low proportions of adopting members and full adopters, respectively.

3.3 Dependent variables

Table 4 presents descriptive statistics of main indicators of the dependent variables.

Table 4: Descriptive statistics of Average innovativeness, Group cohesiveness, Member motivation and Group activity indicators

Variables	*Indicators*	*Farm mgmt.*	*Cash/ off-farm*	*Labour sharing*	*Total*	*Sign.*
Innovativeness	Avg. innovativeness	203.48	173.17	219.21	196.90	.076
Group cohesiveness	Number of members	24.46	10.15	16.17	17.33	.34
	Number of links	55.29	26.08	64.75	49.65	.015*
	Ego's out-degree	3.74	2.09	5.69	3.69	.009**
Member motivation	Mean Interest score	0.81	0.83	0.74	0.80	.024*
	Mean Identification score	0.84	0.83	0.82	0.83	.451
	Mean Communication score	0.69	0.76	0.58	0.68	.071
	Mean Commitment score	0.71	0.74	0.50	0.67	.000**
	Mean Involvement score	0.74	0.87	0.54	0.74	.001**
	Number of deviating appraisals	0.89	1.15	0.76	0.95	.136
Group activity	Duration of membership (a)	4	8 ½	3	~ 5	.001**
	Year of group establishment	1998	1995	2005	1999	.388

*Significant (.05 level); ** highly significant (.01 level) using single-factor univariate ANOVA. Source: Field research (2006)

The average innovativeness of all groups amounts to 197 innovativeness marks. Groups that mainly deal with the generation of off-farm income and provision of rotating funds are characterized by lower innovativeness values. Groups of this field of work are also least cohesive, suggesting that the role of mostly monthly financial contributions overweighs the importance of personal contacts for groups of this type. Nevertheless, Cash/off-farm groups have been established earlier than most of the other groups, and membership duration exceeds the one of the other two categories. Member motivation is lowest in Labour sharing groups. This might be explained by the fact that groups of this type perform most of their activities on community

land or other group members' farms, which results in a comparatively small individual benefit, ergo motivation, for each member.

Although Cash/off-farm groups differ significantly from Farm management and Labour sharing groups in terms of their Group cohesiveness indicators, and Labour sharing groups are characterized by significantly lower average Member motivation scores than the groups of the other two fields of work, further analyses will not distinguish between these three categories, as there is not statistically significant deviation of Group innovativeness among Farm management, Cash/off-farm and Labour sharing groups.

3.4 Control variables

Household size, Age, Sex and Education level of the household head, Number of information sources/extension exposure, as well as Total farm size and Gross Farm income/ha serve as easy-to-capture measures to characterize the demographic and socio-economic household status (Table 5).

Table 5: Descriptive statistics of selected control variables

Indicator	*Mean*	*Range*		*N*	σ^2	*Sign.*	*Direction*
		Min	*Max*				
Number of household members	3.84	0	7.75	36	2.32	.010*	+
Age of household head (a)	32.47	0	54.27	36	17.53	.032*	+
Sex of household head	0.61	0 (female)	1 (male)	36	0.49	.026*	+
Education of household head	0.11	0 (no schooling)	1 (primary education)	36	0.32	.839	+/-
Number of information sources	4.27	0	9.33	36	2.34	.114	+
Size of farmland (ha)	2.95	0.81	9.71	36	1.88	.879	+/-
Gross Farm income (EUR/ha)	1425.09	36.03	31656.90	36	5202.79	.368	-

*Significant (.05 level) using single-factor univariate ANOVA. Source: Field research (2006)

Since the categorical variables of Sex and Education level of household head for the investigated groups in fact are dichotomous, statistical procedures usually only appropriate for scaled variables can nevertheless be applied. Out of the selected control variables, only Number of household members, Age and Sex of household head show a positive significant influence on the group innovativeness. Therefore, only these three control variables will be considered in further multivariate statistical analyses. The data furthermore suggest a non-significant, negative relationship between Gross Farm income and group innovativeness which illustrates the largely persuasive extension efforts pursued in the case study sites.

3.5 Statistical analyses

To eliminated the effect of control variables on the group innovativeness, and to clearly spell out the influence of the dependent variables, a combined multi-factoral univariate analysis of variances and analysis of covariances was conducted using the General Linear Model (GLM) function of SPSS. The GLM Univariate procedure of SPSS provides a combination of regression analysis and analysis of variance. Interactions between, as well as effects of individual independent variables can be studied. The procedure also allows investigating the effects of covariates, i.e. control variables. The results of the GLM analysis are shown in Table 6 for the over-all analysis based on all 22 innovations, the Intercropping and the Farm woodlot innovations, respectively.

Table 6: Results of the GLM analysis: Significance values and direction of the relationship (in parentheses)

	Over-all Innovativeness		*Intercropping*		*Farm woodlot*	
Indicators	*Sign.*	η^2	*Sign.*	η^2	*Sign.*	η^2
Ego's avg. No. of out-links	.006** (+)	.407	.015* (-)	.356	.000** (+)	.797
Network density	.012* (+)	.371	.068 (+)	.268	.003** (+)	.711
Network cohesion	.005** (+)	.414	.105 (+)	.239	.019* (+)	.618
Network degree centralization	.494 (+)	.131	.260 (+)	.172	.056 (+/-)	.541
Mean Interest score	.260 (+/-)	.187	.011* (+)	.371	.406 (-)	.322
Mean Identification score	.853 (+/-)	.061	.098 (+)	.015	.189 (+/-)	.424
Mean Communication score	.528 (-)	.124	.069 (+)	.268	.777 (+/-)	.185
Mean Commitment score	.188 (+/-)	.211	.001** (+)	.487	.268 (-)	.381
Mean Involvement score	.002** (-)	.450	.000** (+)	.586	.313 (+/-)	.361
Number of deviating appraisals	.672 (+/-)	.096	.148 (+)	.215	.345 (+/-)	.347
Duration of membership (a)	.022* (-)	.342	.037* (+)	.306	.332 (+/-)	.352
Year of group establishment	.331 (+)	.167	.053 (-)	.284	.443 (+/-)	.307

*Significant (.05 level); ** highly significant (.01 level) using GLM analysis. η^2 is a measure of the effect size (proportion of the explained variance). Source: Field research (2006)

The table shows a significant positive relationship for most of the Group cohesiveness indicators (Over-all innovativeness and Farm woodlot), and a number of indicators of the Member motivation variable (Over-all innovativeness and Intercropping). For the case of Farm woodlots, there exists no significant relationship for the Member motivation indicators. Of the Group activity variable, only Duration of group membership shows significance in the case of the over-all analysis and Intercropping. These findings suggest that structural properties of the group networks (i.e. Group cohesiveness), more than any other variables, influence group innovativeness. Although weaker in the case of Inter-cropping, this effect can be observed almost independently from the type of innovation under study.

The influence of the Group activity variable on Group innovativeness is comparatively low. Whereas the Average Duration of group membership has a significant effect on the innovativeness variable in over-all analysis and the case of Inter-cropping, it does not so in the case of Farm woodlot establishment. This fact once again results from the persuasive extension approaches pursued to promote particular innovations such as tree planting in the case study sites.

The relationship of Member motivation and Group innovativeness, in contrast, is more ambiguous. Whereas the results presented in this paper suggest that Member motivation positively relates to Group innovativeness in the case of Inter-cropping, this relationship is varied, if not clearly negative, for the case of Farm woodlot establishment (Figure2).

Source: Field research (2006)

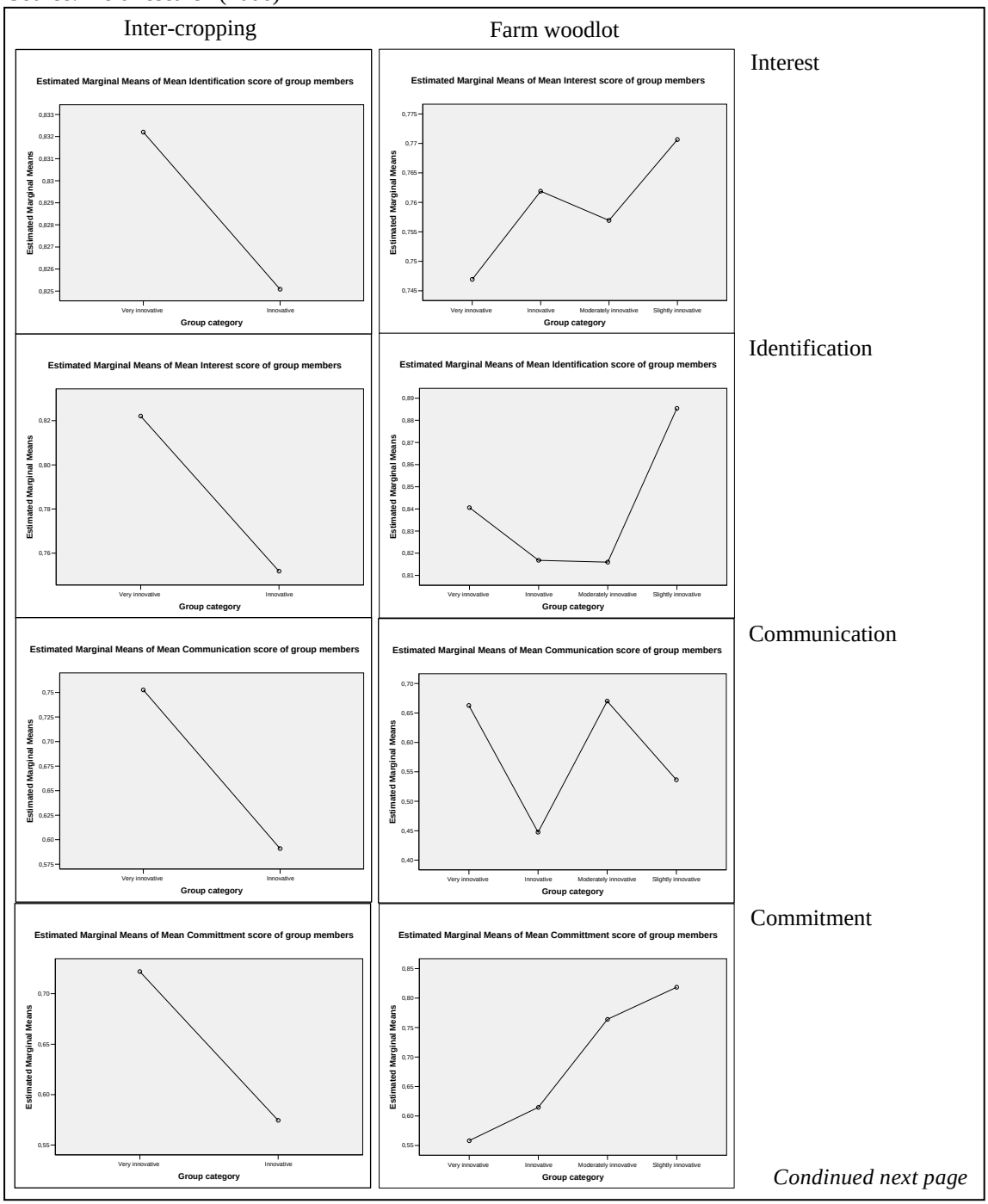

Figure 2: Estimated marginal means of selected Member motivation indicators (for Farm woodlot innovation)

Though not statistically significant, both Interest and Commitment scores show a negative relation to Group innovativeness in the case of Farm woodlots. Identification and involvement scores of very innovative groups are lower than those of slightly innovative groups. The Communication dimension does not show a distinct pattern.

One interpretation of these findings suggests that a group that has already achieved a high level of adoption of a particular innovation by its members, i.e. that has fulfilled its purpose, becomes less attractive to its members, as it is expressed by the low interest and commitment values. This view is consistent with major findings of group theory (e.g. Arrow et al. 2000). Decreasing group attractiveness would eventually lead to group dissolution and abandonment that might have been prevented in the study villages as a result of the external interventions and motivations for group continuation introduced by the extension agencies.

A second interesting aspect refers to the Involvement dimension. In the case of Woodlot establishment, least innovative groups show the highest Involvement scores that translate, inter alia, into democratic group decision making and a self-determined and participatory definition of the group agenda by its members. More innovative groups, in contrast, tend to be characterized by a top-down leadership style that is exercised by a strong board or even the external definition of work plan and group activities, e.g. by village leaders or the extension agency. This effect cannot be observed in the case of indigenous innovations, represented by the Inter-cropping example. Here, high member adoption is related to high involvement values, i.e. democratic leadership patterns. Once more this fact can be interpreted as an indication of the persuasive way of how a number of innovations, tree planting among them, is being introduced and promoted by the extension agencies, since groups that are governed externally are also likely to benefit most from the provision of inputs, such as tree seedlings etc., by the external institutions.

4 Conclusions and Recommendations

Although not equally pronounced over all innovations under study, the influence of Group cohesiveness, Member motivation and Group activity on Group innovativeness could be demonstrated. The study clearly shows that cohesive groups with intensive exchange and collaboration among members facilitate the spread of innovations within the group.

The comparative analysis along the aggregate over-all innovativeness and two selected innovations suggests that there exist innovation-specific patterns of innovation diffusion within groups. The analyses have revealed differences in particular in relation to the Member motivation variable. Further investigation, therefore, is needed to clarify the role of inherent properties of the innovations, such as perceived complexity and adoption requirements (e.g. knowledge, labour, capital etc.). Qualitative analyses of the group social networks at the level of individual group members (and not at the aggregated group level as in the current paper) is likely to yield further insights into the diffusion process that has not yet been gained with the so far adopted largely quantitative approach to data analysis.

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Annex 1

The network density refers to the total number of edges divided by the number of all theoretically possible edges in the network. It is calculated according to the following formula:

$$D = \frac{L}{2 * \sum_{k=1}^{g-1} k} \qquad (1)$$

where D represents the network density,
L represents the total number of edges in the network,
g represents the number of nodes in the network, and
$\sum_{k=1}^{g-1} k$ is the theoretically maximum possible number of edges [(g-1)+(g-2)+ ... + 1]

The network cohesion refers to the total number of mutual edges divided by the number of all theoretically possible mutual edges in the network. It is calculated according to the following formula:

$$C = \frac{L_m}{\sum_{k=1}^{g-1} k} \qquad (2)$$

where C represents the network cohesion,
L_m represents the total number of mutual edges in the network,
g represents the number of nodes in the network, and
$\sum_{k=1}^{g-1} k$ is the theoretically maximum possible number of edges [(g-1)+(g-2)+ ... + 1]

The Actor Degree Centrality refers to the total number of outgoing edges divided by the number of network peers other than Ego. It is calculated according to the following formula:

$$C'_D = \frac{x_{i+}}{(g-1)} \quad (3)$$

where C'_D represents the Actor Degree Centrality,
X_{i+} represents the out-degree of Ego, i.e. the number of out-going edges, and
g represents the number of nodes in the network.

The Group Degree Centralization quantifies the range or variability of the individual Actor Degree Centrality indices. It refers to the out-degrees (out-going ties). The index is calculated according to the following formula:

$$C_D = \frac{\sum_{i=1}^{g}[C_D(n^*) - C_D(n_i)]}{(g-1)^2} \quad (4)$$

where C_D represents the Degree Centralization,
$C_D(n_i)$ represents the individual actor Degree Centrality indices calculated by formula (4),
$C_D(n^*)$ represents the largest observed value of the individual actor Degree Centrality indices, and
g is the number of network peers.

The household innovativeness is calculated according to the following formula:

$$I_h = \sum_{i=1}^{j} (A_i * R_i) \quad (5)$$

where I_h represents the household innovativeness of household h,
A_i represents the adoption level of innovation i by household h (values are 0=not adopted, 1=trial adoption, 2=full adoption),
R_i represents the innovativeness rank of innovation i (values range from 1 to 22), and
i, j represent the indices of the 22 innovations under study.

Annex 2

20 Likert-type scale items to measure the Member motivation variable (poling in parentheses):

Interest dimension:
The group has already helped me to solve a pressing problem at my farm (+)
The group cannot contribute much to improve my life (-)
I was one of the first members who joined the group (+)
I have joined the group because everybody else did so (-)

Identification dimension:
Some group members have tried to misuse the group for their own interest (-)
If you ask the other group members who of us is most important for our group, they would probably say it is me (+)
Often, my contribution was important to successfully accomplish the group activities (+)
The group is mainly concerned with the affairs of few farmers and does not really reflect my interests (-)

Communication dimension:
Sometimes group meetings and activities had not been announced to me properly (-)
Prior to our last meeting, I was not aware of the agenda of this meeting (-)
It has happened that I came home later than anticipated from a group meeting due to heated discussions (+)
Even when I opposed some group activities initially, I have been participating in the implementation eventually (+)

Commitment dimension:
When I was not able to attend the group meeting, I have always asked someone else to deputise for me (+)
At least one of our group members has already been punished because (s)he failed to attend our activities (+)
When I was asked to take over group leadership, I had to refuse as I did not have time to do so (-)
I have occasionally evaded or skived off our group activities without excuse (-)

Involvement dimension:
Some of last year's group activities have been suggested or initiated by me (+)
The current work plan has not been adopted through a vote of all group members (-)
Some of the past group activities I have not been participating in (-)
My opinion was asked for before the latest group activity was implemented (+)