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Innovation behaviour among smallholders: Evidence from the peach value chain in Cochabamba, Bolivia

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Introduction

There is increasing empirical evidence that farmers not only decide to innovate on the basis of economic and personal considerations, but also on the context of the social interactions they maintain among themselves and with agents who promote change, such as buyers, input providers, local authorities, farmers groups and many others. In fact, embeddedness in social networks can be considered as a crucial factor in an equation that explains farmers' decisions to innovate, alongside with variables depicting endowment with resources and other socio-demographic factors (Hartwich 2010). There are some studies which include social networks as variables which influence farmers' decision to innovate (eg. Bandiera and Rasul, 2006; Matuschke and Qaim 2009). However, approximating embeddedness and understanding its influence on innovation behaviour is a new research field which requires the combination of social network analysis and econometric tools.

The focus of the present research was on how communication within the social networks of farmers influences their decision to innovate. The following research questions were addressed:

1. How does communication among farmers influence their decision to innovate?
2. How do certain patterns of interaction in social networks influence the communication among farmers with regard to innovation?
3. How do business ties (contractual arrangements for the exchange of products) influence the farmers' decision to innovate?
4. Is there an inequitable distribution of income among farmers in the value chain and is this related to their innovativeness?

Why social network analysis?

Social Network Analysis is a research field which allows explaining social phenomena through the study of interaction patterns among social actors, as well as patterns at different level of analysis, like individuals and groups (Wasserman y Faust 2009). Individuals in the network with a higher degree of connectedness can be opinion leaders who tend to be early adopters of innovations (Becker 1970). An analysis of the triads may be more useful than an analysis of pairs of actors (dyads). The analysis at the triad level has to do with structural balance and transitivity concepts (Wasserman and Faust 2009). Transitivity means that, because of the forces occurring in a triad structure, a non adopter tied to two adopters will end up adopting (Krackhardt 1998, 1999). At the network level, centralized structures favor and accelerate the pace of diffusion as soon as the diffusing element—information, knowledge, or technological innovations—reaches the core actors in the network, such as opinion leaders (Rogers 2003). In general, the social network analysis is a tool to study and depict the social capital of a given structure. With that knowledge, strategies can be implemented to achieve sustainable changes, which can allow farmers to improve their livelihoods.

Material and Methods

Three communities in the Valle Alto of Cochabamba, Bolivia, were studied with regard to their social interactions and the degree to which innovations in peach production and marketing were applied. The communities were determined with the help of key informants. All peach producers (n=80) in the communities were interviewed. Variables denoting the embeddedness of farmers in social networks were derived using social network analysis with the software UCINET 6. Those variables together with variables on demographics and resource endowment were used in a multivariate regression analysis to determine if "embeddedness in social networks" significantly contributes to the continuous variable "innovativeness" of farmers. The response "innovativeness" was calculated based on the following criteria: fertilization, pruning, integrated pest management (IPM), varieties and marketing of peaches. All those factors were graded between 1 and 5, being 5 more innovative. Then, the values were normalized and the variable was a value between 0 and 1, being 1 more innovative. The exchange networks were divided in four topics regarding the communication among farmers on: traditional knowledge on peach production (C1), innovation on peach production (C2), marketing of peaches (C3) and organizational issues (C4). Only frequent communication (at least once a month) was taken into account, except for marketing networks due to the seasonality of the production. The information exchange networks were also visualized using NetDraw software (Figure 1a and Figure 1b). This allowed to determine patterns of interaction among farmers and between farmers and change agents and to relate those patterns to the innovativeness of the farmers at the individual and community level. Additionally, other variables from the social networks were derived using UCINET 6 (e.g. density, transitivity). With those variables one can determine the proportion of ties (dyads) occurring in the networks and how actively the information is flowing, respectively. Moreover, a Pearson's Chi-squared test was done to determine whether there is a difference in the outgoing ties farmers (in farmer-agent networks) have and their innovativeness.

Results and Discussion

The results show that the connectivity of farmers in social networks allows for the exchange of information on improved practices and innovations in peach production and marketing. Though the effect on "innovativeness" is significant (p-value= 0.009), its effect is marginal (coefficient= 0.002). Moreover, the variables income and business ties showed a significant effect on the innovativeness of the producers. That means that improving marketing channels through contractual arrangements can help farmers to improve their livelihoods. Table 1 shows the models with the variables influencing the response "innovativeness" of farmers.

Table 1. Regression models to determine the variables influencing the innovativeness of peach farmers

Variable	**Model (1)**	**Model (2)**
	n= 53[a]	**n=53**
Intercept	0.128	0.139
X1. Gender	0.021	0.022
X2. Age	31.4x10-5	47.4x10-5
X3. Years education	0.008 **	0.008 **
X5. Full time producers	0.047 **.**	0.051 *
X8. Peach area	-0.10x10-5	0.06x10-5
X9. Plant density	1.20x10-5	1.38x10-5
X12. Receive technical assistance	-0.045	-0.047 **.**
X15. Business ties	0.040 *	0.034 **.**
X17. log (Income 2010+10)	0.033 ***	0.030 ***
X18. NrmDegree	0.002 **	
X19. NrmInDegree		0.004 **
Fit measures:		
Standard error of residuals	0.074 (42gl)	0.073 (44 gl)
R^2	0.592	0.595

[a] Taking into account only the farmers whose plants are older than 3 years

Graphical analysis reveals that farmers exchange information on traditional knowledge in peach production (see Figure 1a) but interact less to discuss innovations (See Figure 1b). An analysis of the communication among triads of farmers showed that farmers do not communicate actively on innovation (networks with low transitivity in triads of farmers) (See Table 2). This may be due to the fact that innovations are at an early stage in this region and many farmers switched to peach production in the last years, so that their knowledge is limited. Additionally, farmers are discouraged to improve their crop because of the losses caused by drought and frost.

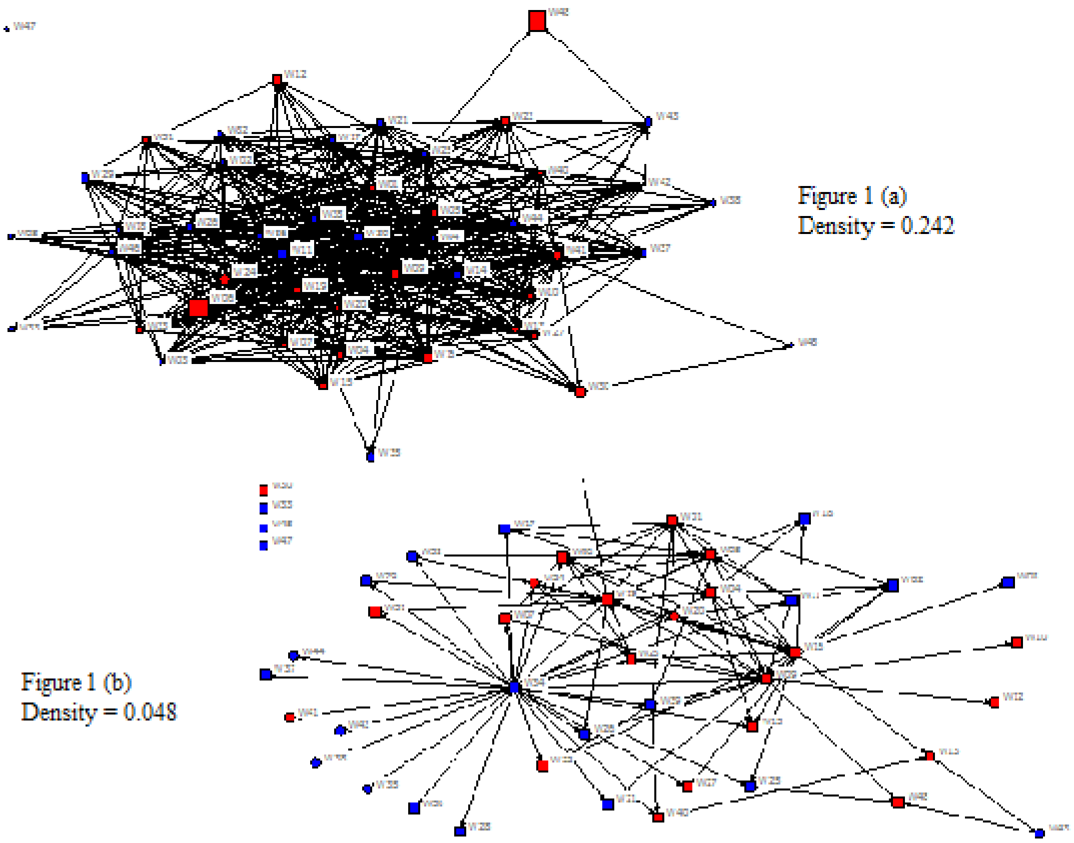

Figure 1: (a) Communication network among farmers (1-Mode network) regarding traditional knowledge in peach production (network C1) (b) Communication network among farmers (1-Mode network) regarding innovations on peach production (network C2). Community: Waña K'awa Chico. Note: Circles=don't receive technical assistance; squares= receive technical assistance; red= innovative (≥ median); blue=less innovative; (< median); size of the nodes=proportional to the peach crop area.

Table 2: Innovativeness and network properties of the studied communities

Community	Network	Density	Transitivity[a] (%)	Innovativeness[b]
1. Waña K'awa Chico	C1[c]	0.282	58.52	0.568 (0.124)
(n=48)	C2[d]	0.048	27.94	
2. Villa 2 de Agosto	C1	0.250	61.28	0.441 (0.081)
(n=20)	C2	0.066	23.64	
3. Aranjuez	C1	0.250	33.33	0.529 (0.146)
(n=12)	C2	0.106	38.89	

[a] When there is a tie from i to j, and also from j to h, then there is also a tie from i to h
[b] Based on the grading of: fertilization, pruning, irrigation, Integrated pest management (IPM), varieties, marketing of peaches
[c] Communication regarding traditional knowledge of peach production
[d] Communication regarding innovation in peach production

Additionally, the communities with one or few actors in the center of the networks were less innovative than the one with many central actors. This suggests that social interaction in Valle Alto is less strong. The decentralization of the information available to the farmers may be an option to pursue development. Figure 2 shows how interaction that farmers maintain with change agents may influence in their innovativeness. In other words, the type of agents farmers interact with may influence their innovativeness. For this particular case, input providers and qualified workers are very influencing agents. On Figure 2, it's possible to see that the less innovative farmers interact with the qualified workers while the "no innovative" farmers don't. Another finding is that the innovative farmers interact with NGOs and buyers and have direct contact with the platform of the stakeholders of the peach value chain (PLACIIT-FV), while the others don't. Moreover, the Chi-squared test showed that the number of change agents with whom a farmer interact influences in their innovativeness (X-squared = 10.0391, df = 4, p-value = 0.0397)

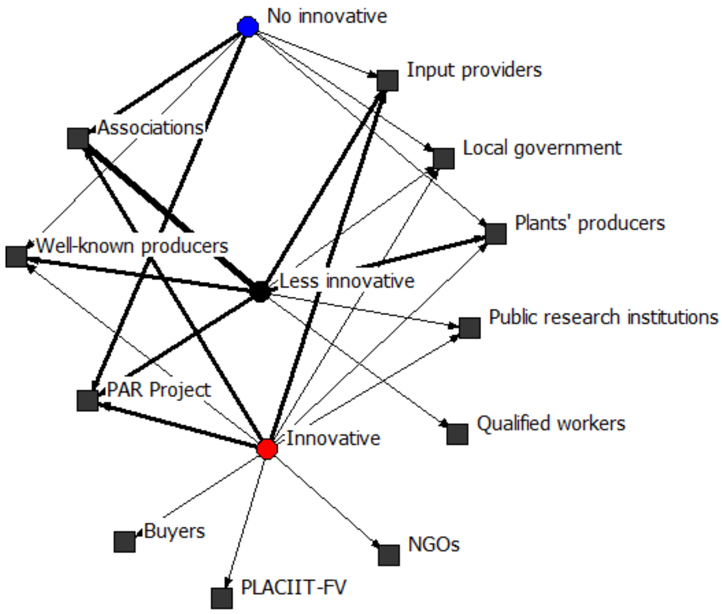

Figure 2. Average interaction of types of innovators with change agents regarding peach production and marketing. Community Waña K'awa Chico. Note: All change agents from the interaction networks: C1 (production), C2 (innovations), C3 (marketing) and C4 (organizational issues). Dots= farmers; squares= change agents. Red= Quartile Q75 (Innovative); black= Q50 (Less innovative); blue=Q25 (No innovative). Tie strength is proportional to the frequency of communication: 0 farmers= no line, 1 to 6 farmers= thick 1, 7 to 14 farmers= thick 2, ≥14 farmers= thick 3. Classification of farmers based on the continuous variable innovativeness on peach production and marketing (1= less innovative to 5= very innovative).

Conclusions and Outlook

A further analysis of the type of innovations available in the value chain reveals that many of them did not yet contribute to substantial increases in production and income. One may argue that -for this particular case- the available innovations were simply not substantial enough to measure the effect of social networking on innovativeness. Nevertheless, the findings suggest that, managers and designers of agricultural innovation projects must consider and improve social interactions when fostering innovation. They may be advised, for example, to strengthen producers associations in a way that they promote communication about relevant information for innovation and marketing opportunities. This, however, may only be effective if ideas and solutions are present inside the farming community and among development agents in order to bring considerable benefits to the potential innovators. Additionally, they may be advised to identify bottlenecks for the flow of information at the farmer and agent level. Finally development project should assess which innovations are relevant for the farmers, distinguishing between innovative and less innovative farmers. In other words, innovations should be targeted in order to bring change at different levels. Assuming that farmers would develop their own solutions is not realistic.

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