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Seeing the social capital in agricultural innovation systems: using SNA to visualise bonding and bridging ties in rural communities

Louise Clark*

Independent consultant

The aim of this paper is to highlight the complex networks that support information flows in rural communities of Bolivia by providing a visual representation of the heterogeneous organisational structures that characterise different ethnic groups. The social structures within rural communities provide development agencies with key insights into the support networks created by community-based organisations which can be used to identify strategies to reach marginalised groups. This preliminary analysis of the mechanisms through which the rural poor access new information is particularly important for agricultural development projects which aim to increase producers' awareness of new technologies or provide them with market information. This paper uses social network analysis (SNA) to demonstrate how the bonding ties of affiliation to community-based organisations and the bridging ties of relationships with local institutions demonstrate the different structural properties of rural communities. Development projects which promote local development need to understand these community structures and how they support information flows to marginalised groups.

Introduction

This paper uses social network analysis (SNA) to examine information flows related to agricultural innovation at the municipal level in Bolivia. The concept of social capital provides a framework to explore the bonding and bridging ties created by producers' relationships with community-based organisations (CBOs) and local institutions to demonstrate the different social structures created by these relationships. It is important for development agencies to understand these social structures to understand how they facilitate or inhibit groups' abilities to access and exchange information and other resources in order to maximise the impact of project activities and embed new knowledge within existing community structures.

Social capital: bonding and bridging ties

Social capital is a concept created by the combination of the strong ties of frequent contact that create bonds within groups of actors and the weak ties of infrequent contact that create bridges between groups and provide access to new sources of new information (Woolcock 1998, Narayan 1999, Putnam 2000, Schuller, Baron et al. 2000, Pretty 2003, Burt 2005). The exclusive nature of bonding ties creates groups which are difficult for outsiders to penetrate but are good for mobilising solidarity and reciprocity, while bridging ties are much

*Email: lounatclark@gmail.com

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looser, can be more inclusive and provide links to external assets and resources. This difference can be described as the support needed for getting by versus getting ahead (Putnam 2000). Thus, social groups are comprised of a combination of 'cross-linked cosmopolitans' and 'internally-linked locals' which complement each other in the transmission of information, influence and material resources through a network. (Wellman 1988, p. 43) The internal distribution of information within groups is just as important as access to a variety of information sources and while heterogeneous networks are more likely to have 'bridges' to innovative information, how this information is used within the network will depend on the strength of the internal 'bonds'.

Actors often belong to multiple social networks which they can exploit to gain access to resources, such as information (Wellman et al. 1997). Granovetter's (1973) influential paper on 'The strength of weak ties' demonstrated how weak ties are more conducive to information exchange as those with whom we have infrequent contact most likely move in different social circles and thus act as sources of new information. While bridging ties can provide access to information and opportunity, bonding ties are strongly linked to the idea of trust (Granovetter 1985, Lyon 2000, Oxendine, Borgida et al. 2003), although it is also necessary to recognise how affiliation solely within primary groups can reinforce social stratification and prevent mobility due to the norms imposed upon individuals by their group which can act as a barrier to any idea that threaten the established norm (Portes 1998, Lin 2000). Change can only happen from within and so there is a clear role for understanding both the interaction of internal and external factors and the ways in which information from external sources is proven to be trustworthy as a precursor to it being internalised by social groups (Long 1992).

The concepts of bonding and bridging ties have been used to highlight the specific social circumstances of resource-poor groups to explain the different levels of civil society activity, economic opportunity and social cohesion in a number of different contexts. This research highlights the need for investment at micro level to support associational activity, investing in the organisational capacity of social groups to increase both their bonding and cross-cutting ties to increase bridging social capital (Narayan 1999). Marginalised groups face a structural disadvantage in existing social and economic structures due to exclusion from institutions, creating a constraining factor for the poor as they engage on adverse terms and so are less able to shape social relationships – or form bridging ties (Cleaver 2005). Moreover, while social networks provide access to resources, the possibility of a collective group achieving its goals is limited when resources do not exist, no matter how strong its internal bond. Social capital cannot act as a substitute for credit, infrastructure and education although it does have the potential to increase the yield of these resources (Portes and Landolt 2000).

Finally, it is necessary to acknowledge the different interpretations of bonding and bridging ties in the literature. A number of authors (Woolcock 2001, Pretty 2003, Heemskerk and Wennink 2004) also refer to 'linking' social capital to describe the ability of groups to engage vertically with external agencies to influence policy or access resources. While recognising the importance of understanding how rural groups can develop these linking ties, this paper will focus on the bonding and bridging ties related to agricultural innovation processes. Bonding ties are understood as the ties associated with membership of community groups, associations and farmers' organisations, while bridging ties are seen as those through which rural actors interact with extension services and other local stakeholders. This distinction is also consistent with the opposing concepts of homophily and heterophily in innovation theory (Rogers 1983). Homophily is the tendency

of individuals to associate and bond with similar others while heterophily is the tendency of individuals to collect in diverse groups.

Social structures in agricultural innovation

The influence of social structures on innovation processes has long been recognised, largely due to the work of Everett Rogers on the 'Diffusion of Innovations' (1983) which recognised the importance of communication networks in innovation processes. Rogers used social network concepts to explain how ideas are shared between groups, distinguishing between homophily and heterophily. Homophilous groups emerge as individuals form links that require the least effort and are the most rewarding, surrounding themselves with people with similar interests and social backgrounds, making communication within these groups highly effective as actors share common codes. This increases the likelihood that communication will lead to a change in attitude or behaviour. However, the diffusion of innovations requires some degree of heterophily between actors, as this increases the amount of new information available, but can also lead to ineffective communication if groups do not understand each other:

> It is as unthinkable to study diffusion without some knowledge of the social structures in which the potential adopters are located as it is to study the blood circulation without adequate knowledge of the structure of veins and arteries. (Katz 1961 cited Rogers 1983, p. 25)

The present paradigm: agricultural innovation systems

Current thinking around agricultural innovation emphasises innovation systems, which recognises the complexity of innovation as a social process, involving relationships between a range of actors, institutions and technological and organisational opportunities. It is the interactions between these elements which can help us to understand how diverse actors generate, exchange and use knowledge. This approach has significant potential to capture the complexity of agents, processes of institutional change and policy in 'multi-functional, institutionally pluralistic' networks (Rivera et al. 2006, p. 588). Production of new knowledge depends upon the learning capacity of actors which, in turn, is affected by their interactions with others (Agapitova 2005). From this perspective, development is no longer understood as a result of technological change. Instead, it is the institutional context in which technological change occurs which is seen to be the significant driver of development (Spielman 2006).

This makes it necessary to identify the structural properties of agricultural innovation systems in order to fully understand the nature of existing linkages and potential alliances. As Leeuwis remarks:

> Innovation is about network building and/or reconfiguring existing networks. Key tasks and activities to that effect are social learning and negotiation, as well as process management. However, such processes cannot start from a vacuum, and require that relevant stakeholders know each other and recognise each other as relevant partners in an innovation process. (2006, p. 327)

As an emerging paradigm, there is no single empirical approach to explain the complexity of linkages within rural innovation systems. In the organisational and industrial

literature on innovation processes at the inter-firm level, SNA has been widely used to identify the relationships between firms and how these relationships affect their social capital and their propensity to innovation (Koka and Prescott 2002; Cowan and Jonard 2004).

This paper aims to provide evidence of how SNA can be used to identify actors and the linkages between them at the community level drawing upon the experience of innovation studies in industrial contexts and applying this tool to the reality of rural actors to create an additional dimension to established participatory techniques for mapping rural realities.

Participatory mapping

Among the techniques associated with participatory rural appraisal (PRA) are a number of approaches to participatory mapping. These break away from understanding maps in the traditional cartographic sense, towards using them to understand how poor people perceive their environments both geographically and socially in order to identify the issues and interactions related to a specific problem (Gupta 1989; Lightfoot et al. 1989). Such techniques are used to identify existing structures in order to inform discussion of how local systems function, where constraints exist and how best to overcome them. The potential of poor people to use maps to explain their realities and share ideas is well documented:

> It should never be assumed without careful testing that non-literate people cannot understand or use maps. Drawing maps in conjunction with farmers, whether literate or not, can to the contrary be a way of enabling them to share their local knowledge. (Gupta 1989, pp. 88–89)

However, given the multiple levels of relationships in which rural communities are involved, and the increasing complexity of commercial and support relationships, it is necessary to question whether these participatory mapping tools are sophisticated enough to capture the diverse interactions and linkages of producer groups. There are also serious problems associated with a lack of coordination between the multitudes of actors, recognising that grassroots actors often lack the skills, power and resources for management and negotiation of this complexity on behalf of their members (Berdegué and Escobar 2002).

> The lack of farmer empowerment in agricultural innovation development on the one hand and the wealth of social capital and informal innovation systems on the other provide another important challenge: the need for connectedness between farmer groups and organisations into more powerful networks. (Heemskerk and Wennink 2004, p. 90)

This need to analyse and understand actor linkages, coalitions and information flows, lead Biggs and Matsaert (2004) to call for a more actor-oriented approach to innovation systems, arguing that existing tools such as the logical framework do not sufficiently address the complexity of actor linkages or generate lessons regarding the processes which support coalition building. They suggest a series of tools that focus on identifying specific social groups or actors in a given location at a particular time, using actor linkage maps and matrices to create basic representations of the relationships between social groups. Following the tradition of early participatory mapping exercises, they state that the purpose of these tools is not necessarily to present an accurate picture of the local reality but to invite reflection amongst both local stakeholders and project team members to identify potential linkages and possible areas of intervention, as well as legitimising and rewarding actors who build linkages in their work. Moreover, these techniques provide visual support tools to understand the 'causational processes' within innovation systems and provide

a common ground for discussion of conflicting narratives. Despite these advantages, it is necessary to be aware that the results generated have political dimensions and are susceptible to manipulation by groups for their own purposes (Biggs and Matsaert 2004, p. 3). Leeuwis (2006) agrees that mapping exercises should not be regarded as a final product but rather as a tool to create group synergy by enabling all to contribute and learn, giving the results credibility as they have been created and are owned by the group, as well as leading to empowerment through collective analysis of the issues identified.

Thus, visual formats can be used to represent complex realities and relationships in order to help people understand the diversity of different perspectives within an innovation system (Chambers 2007a). Emerging techniques and computer graphics are opening up many new mapping possibilities, including the use of web diagrams to represent the different dimensions of poverty and their inter-linkages (Chambers 2007b). More sophisticated tools that build upon this tradition of visualisation are now available to support both producer groups and other actors in the wider context of support and commercial services, to better understand the complexity of the structures created by their interactions.

Understanding the structure of social capital requires exploration of the bonding and bridging ties in social networks which distinguishes between the close ties that connect homophilous groups and the weaker ties that create bridges between heterophilous groups and provide access to new sources of information. Social capital cannot be 'engineered' by development projects (Portes and Landolt 2000) and must build upon the existing structures within rural communities, highlighting the importance of working with communities to help them understand their existing structures and working with them to strengthen existing ties rather than creating new relational structures.

Methodological focus

The application of SNA in this paper aims to establish a middle ground between the qualitative focus of PRA mapping and more formal quantitative approaches to identify the bonding and bridging ties that characterise rural communities. During September 2006, some 254 producers were interviewed in 15 communities in the municipality of Entre Ríos in the O'Connor province of Tarija in southern Bolivia. The region is a mixed forest area whose main productive activities are the production of cereals, vegetables, stone fruits, cattle and natural extraction of plaster of Paris. The population is comprised of two ethnic groups, indigenous Guaraní located within a region known as Itaka Guasu, and *campesino*[1] communities of mixed descent. The study aimed to identify the different social structures that characterised these groups.

Producers were interviewed about their interactions with local institutions and their affiliation with CBOs to explore the multiplicity of associational relationships within rural communities. These data were analysed using Netdraw[2] to create two-mode network maps which represent the bonding ties between producers and CBOs and their bridging ties with local institutions.

This focus on two-mode networks is a departure from traditional applications of SNA that usually explore relationships within a specific social group, focussing on either individuals or institutions using person-by-person matrices to represent relationships. There are two types of two-mode networks, dyadic and non-dyadic which both use person by variable data sets (Borgatti and Everett 1997). Dyadic data sets describe ties between actors in two different social groups while non-dyadic data sets describe the relationship between actors and another variable, often referred to as affiliation networks, as the data demonstrate how actors are affiliated to different social groups (Wasserman and Faust 1994). The data

presented here are non-dyadic, representing the relationships between producers and a second set of nodes representing local institutions or CBOs. Examples of two-mode networks in modern SNA applications are still relatively rare and there is still much to be learned about possible visual applications, despite the lack of metric measures associated with this technique (Borgatti and Everett 1997). The data presented here are egocentric, representing producers' information sources and all ties are uni-directional and as no data was collected at the institutional level.

Affiliations within communities: bonding ties

Figure 1 shows the structure of affiliation networks, which are used to represent bonding social capital, with nodes coloured to show the ethnicity of the respondents. The black nodes represent the local level organisations named by the respondents. It is instantly possible to see the different affiliation structures of indigenous and *campesino* respondents, which form two distinct clusters. There are only four nodes that connect the two groups; however, three of the four are references to generic farmers' organisations for maize producers, groundnut producers and pig producers, all of which are important production activities in the region. The only other tie that joins the two groups is the Mother's Centre which has only one tie to the indigenous group.

The map clearly identifies the most influential social groups in both indigenous and *campesino* communities. For the indigenous community, these are the Guarani People's Assembly (APG) followed by Abatirenda, the maize collection centre which also features prominently in the map of institutional relationships (Figure 4), suggesting brokerage

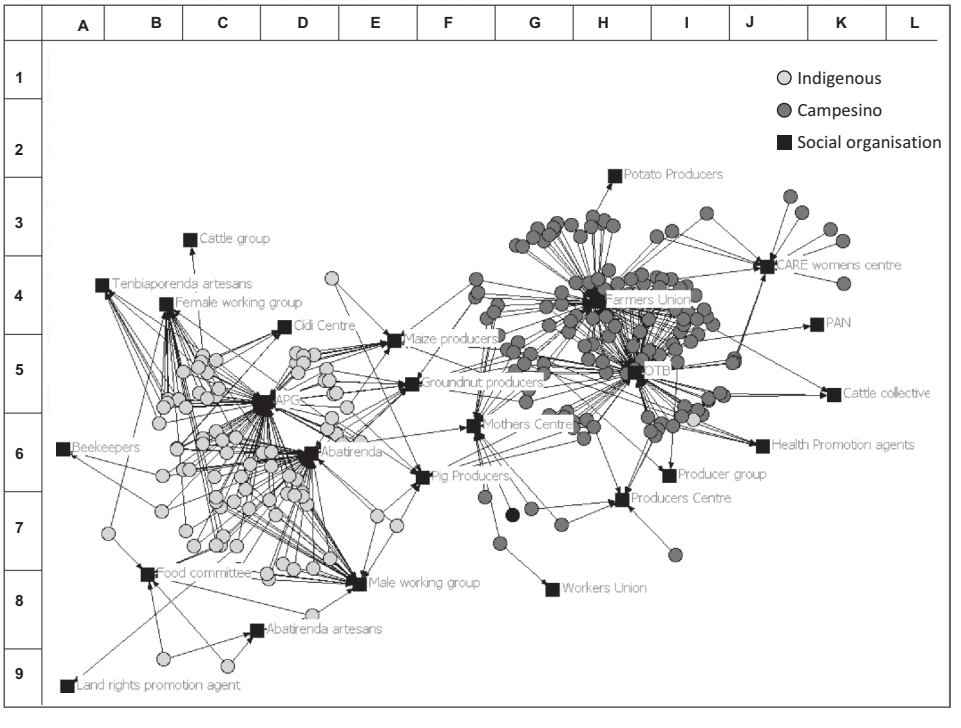

Figure 1. Bonding ties in indigenous and *campesino* communities of Entre Rios.

potential as discussed below. Of secondary importance are the working groups for men and women. Following the assumption that information is shared within social groups, these working groups are likely to provide a social space to share information on community life. The more peripheral groups are largely production and artisan groups, suggesting the weak position of farmers organisations in the Chaco region, which appear to operate more as informal groups than formally constituted associations.

The *campesino* cluster is also dominated by two associations, the Territorial Base Organisation (OTB) and the Farmers' Union. The OTBs were created by the Law of Popular Participation 1994 which contributed to the administrative decentralisation of Bolivia. OTB is a generic title that can include farmers' organisations, women's groups and other grassroots organisations. One of the purposes of creating the OTBs was to reduce the political influence of trade unions which the government felt had become too strong in rural areas. This suggests that there may be tension between the OTB and Farmer's Union and further investigation is needed to understand the dynamic that exists between these two groups. A final question concerning the OTB is why it was not mentioned by any of the indigenous respondents, as one of the purposes of creating OTBs was to increase the integration of indigenous groups into political life. These data suggest that in the Entre Ríos case, this strategy has not been effective. These results invite further investigation and reflection with local authorities in order to gain a more complete impression of the range of influence of OTBs in the region.

Another finding is the position of the Mother's Centre and the CARE[3] women's group as, although in relatively peripheral positions, the data suggests that these centres present another possible entry point into local community life as disaggregation of the data by gender shows that both men and women feel affinity with these groups.

Two of the communities in the study, Potrerillos and Tomatirenda, included both indigenous and *campesino* respondents, so focussing on the affiliations structures in these communities provides further insight into how indigenous and *campesino* groups are integrated in community life. Figures 2 and 3 show a snapshot of the network in each of these communities. In Potrerillos, the only link between the two ethnic groups is via affiliation to a Maize Producer's group. In Tomatirenda, the groups share links to the pig producer's group while the Maize producer's group is an important reference for the indigenous group but is not mentioned by the *campesinos*.

These maps suggest that while indigenous and *campesino* groups may co-exist within the same community, there is limited cohesion. Even when ethnic groups are located within the same physical space, their affiliation networks are more aligned to culture than geography. These data demonstrate how different social groups have varying affiliation networks. Better understanding of these community structures may support development professionals to target interventions to specific groups and gain more direct access to the decision-makers within communities.

Producers and local institutions: bridging ties

Figure 4 shows the structure of relationships of producers and local institutions, highlighting areas of influence and overlap of the different institutions working in and around Entre Ríos. Although the map contains no data on inter-institutional relationships, the network structure has only one component, suggesting that the majority of producers have connections with more than one institution. The map shows one tightly clustered group of nodes at the top, representing the indigenous communities, and less density at the lower part of the

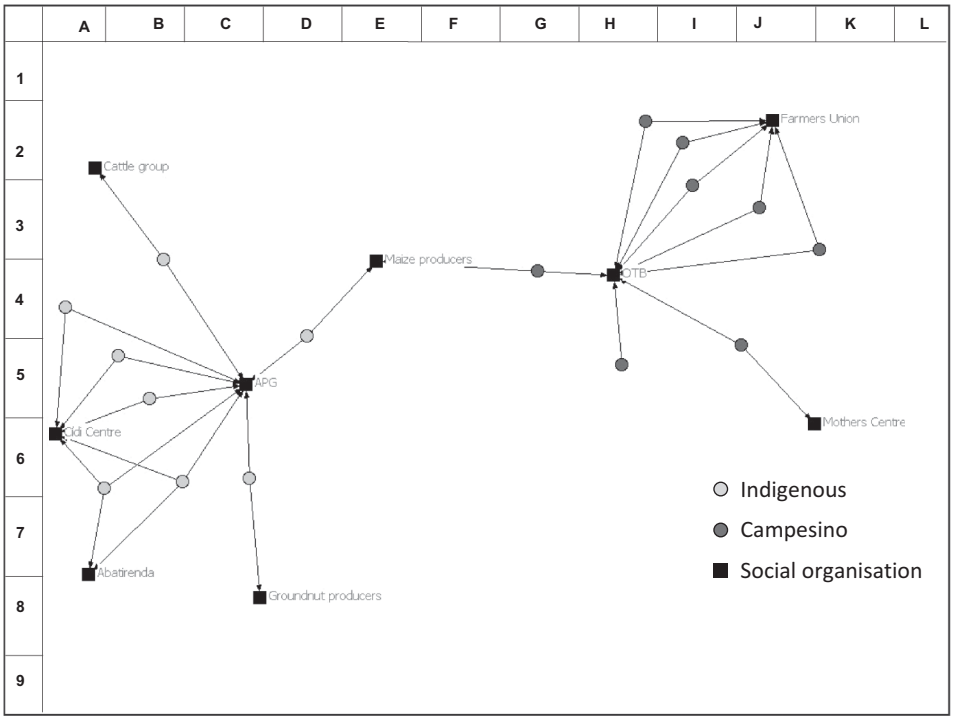

Figure 2. Affiliation by ethnicity in Potrerillos.

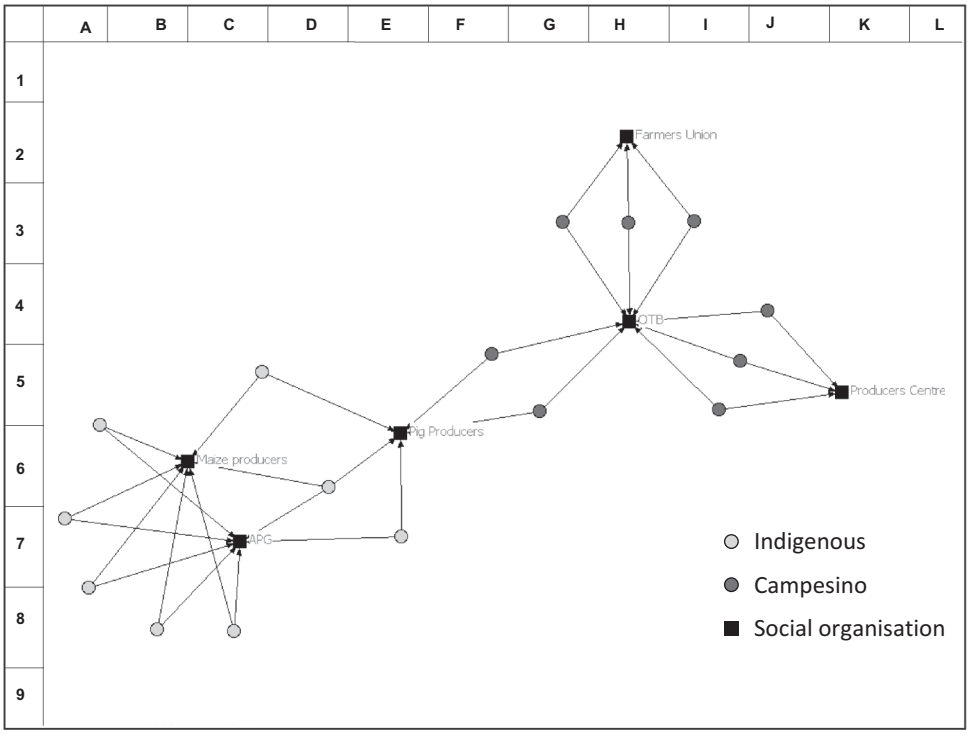

Figure 3. Affiliation by ethnicity in Tomatirenda.

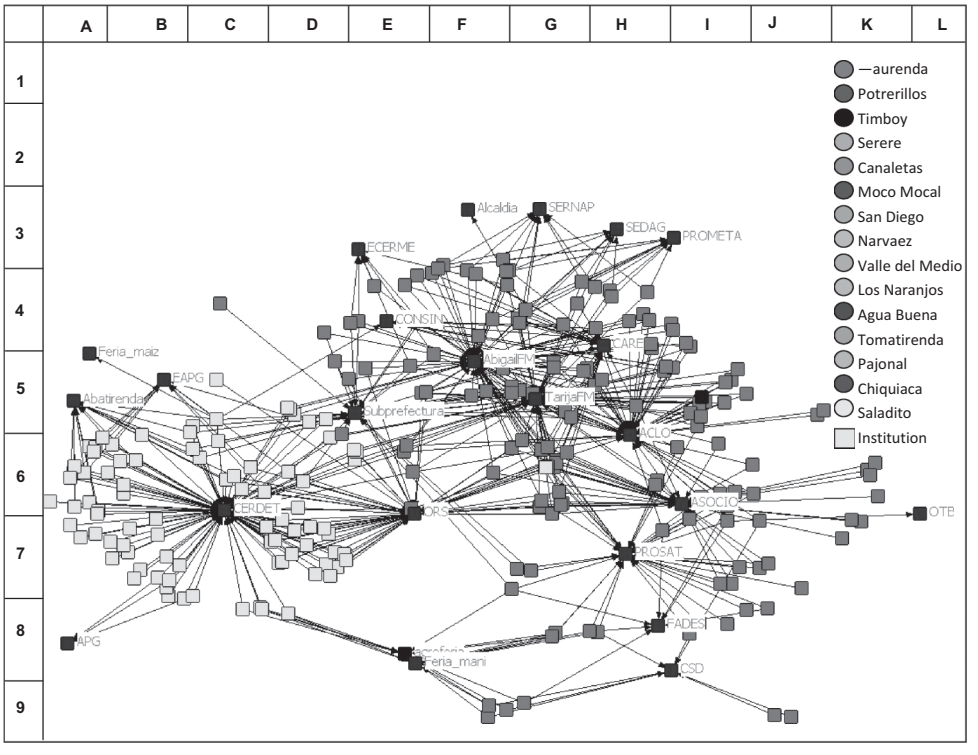

Figure 4. Institutional sources of information.

sociogram, representing the various *campesino* communities. An important factor in this observation is the geographical distance between communities; the indigenous communities are much closer to each other than the *campesino* communities. The Sub-prefecture[4] and Regional Seed Office (ORS) are the only two institutions that work with both ethnic groups suggesting important brokerage role for these institutions.

As illustrated in Figure 4, both the APG and OTB have peripheral positions in contrast to their position in the community affiliation network maps presented above. It is probable that their peripheral position is due to the fact that producers may not associate these organisations specifically with agricultural information, although their influence, as shown in Figure 1, suggests that working with these groups could have important consequences for the delivery of information to local community groups. The other node that appears in both sets of maps is Abatirenda, the maize collection centre. Its central position in both structural representations suggests that not only is the centre recognised as an important source of information but also producers feel a strong degree of affinity and ownership of the centre. Abatirenda has considerable potential to support information flows within the indigenous communities, given the combination of bonding and bridging ties.

Finally, it is possible to see the geographical focus of different support institutions. The Centre for the Regional Studies of Tarija (CERDET)[5] is the only non-governmental organisation (NGO) that is working with indigenous communities while the other institutions provide agricultural support to the *campesino* communities.

Of the institutions working with the campesino communities that were identified by the study the Small Farmers Technical Assistance Services Project (PROSAT)[6] works in six, the Loyola Cultural Foundation (ACLO)[7] in five, ASOCIO in four and CARE in three,

with considerable overlap in the geographical influence of these organisations suggesting that there may be scope to coordinate activities and explore opportunities to collaborate.

Feedback

Feedback was sought from local institutions in the form of semi-structured interviews to return the results of the study to the local population, validate the information found in the maps, and gauge reactions to the methodology amongst local institutions. Due to funding restrictions, it was not possible to complete this process with the CBOs identified in the study. The maps served to elicit more detailed information about local relationships, as stakeholders were able to contribute their own interpretation of the maps.

The Sub-Prefect stated that the maps could improve planning as they identified communities that were receiving support from more than one institution while other communities in the region have limited possibilities to receive extension support. He added that the maps highlighted the potential of combining and sharing institutional experience and delegating responsibility according to different strengths to ensure even geographical spread of extension services and also to coordinate the content of technical support provided by different organisations.

Feedback from CERDET highlighted the potential of this integral vision to support its work in the region. The informant, Ricardo Paita, explained that CERDET was interested in strengthening its relationship with the other institutions, particularly ASOCIO with which it was already collaborating as part of a national soil platform. To this end, the informant felt that the network maps could be used to engage the other institutions in a dialogue to explore mechanisms to strengthen informal alliances between extension agents. Furthermore, the informant was amazed by the insights into local reality that could be gauged from the maps enabling an outsider to speak with authority on local issues:

> When you talk about Entre Ríos, it sounds like you have been working here for 10 years. It's the only way you could possibly know so much about what happens here. (Personal communication, Ricardo Paita, 14 Nov 2006)

In an interview, the director of ASOCIO confirmed his institution's interest in strengthening networks and building relationships with other institutions active in the region. In addition to the soil network mentioned by CERDET, ASOCIO were also members of an educational network. The director explained that, in theory, exchanging knowledge was important for local institutions but was not that easy to achieve in reality and required a strong communication strategy which included all of the institutions and provided both incentive and opportunity to share information. The director of ACLO also identified similar difficulties in the creation of networks:

> There are a lot of networks but also a lot of competition between institutions that makes collaboration difficult. There is not the leadership capacity for a collective alliance. (Personal communication, Mario Torres, 16 Nov 2006)

A key result of the feedback exercise was that many of the institutions associated the information in the maps with the need to bring stakeholders together to develop a common strategy at municipal level.

Conclusions

This study presents an innovative approach to visualising the social structures of rural communities and outlines a practical tool that can identify the influence of local institutions and CBOs, based upon the understanding that development practitioners who wish to

strengthen social capital should work with existing community structures rather than seek to impose new ones (Portes and Landolt 2000). In rural Bolivia, these organisational structures have considerable influence, so understanding how structures vary across ethnic groups can help to identify potential partners and/or conflicts and encourage the local community to participate in the planning and implementation of project activities. Despite the enthusiasm for social capital within the international development community, surprisingly little attention is placed on understanding the social structures within communities in order to understand the concept in practical contexts.

The Entre Ríos data demonstrate how affiliation to networks can vary according to ethnicity and the approach can also be used to distinguish between other variables such as gender, age or education. These changing structures are important to identify the best mechanisms to target different social groups and this paper demonstrates the utility of SNA for identifying the characteristics of local affiliation networks and influential local organisations. In both the case of the APG amongst the Guaraní respondents and the OTB amongst the *campesino* respondents, the position of the organisations shifted from centre to periphery depending upon the focus of the question. This suggests that social networks have multiple dimensions, with bonding and bridging ties creating different network structures with different purposes. For this reason, it is important to consider both perspectives when seeking mechanisms to improve knowledge sharing about agricultural production practices.

Identifying these groups does not equate to gaining their trust. Rural groups have their own methods for assessing the validity of new ideas and projects which must be respected, even though these may be contradictory to project timescales or objectives. The constraining social norms that are associated with bonding ties in the literature (Portes 1998, Lin 2000) are particularly relevant in the tightly structured organisational context of rural Bolivia. Community endorsement is essential, so respect for local structures and processes is needed to ensure that project activities are accepted by local communities. Any attempts to circumvent local organisational structures can potentially destroy the credibility of development projects and lead to rejection by community members. It is important to be aware of these social structures and ask ourselves whether the interests of these grassroots groups are aligned with our development agenda. Indeed, we need to be able to adapt and adjust the development agenda to this reality, not the other way around. While we may have noble ideas of how to address social exclusion and support marginalised groups, such as indigenous minorities or women, our efforts should help these groups to integrate with the existing social fabric of community life rather than create alternative structures that are unlikely to be sustainable beyond the project life cycle.

When working within rather than against these structures, it will be members of the community who themselves take responsibility for embedding new knowledge within their organisations. In rural Bolivia, producers who work with development projects with the endorsement of their organisations have the responsibility of reporting these activities back to the wider social group. When new knowledge is shared by these established channels it is more likely that the community will discuss the value of the information and validate it in their own context, increasing the likelihood that this knowledge will remain embedded within these community structures beyond the project life cycle.

There are many factors that affect the social structures within rural communities. Understanding the influence of different features of community life can help development practitioners plan interventions and ensure that information flows reach their target beneficiaries. Evidence has been presented to show how bonding and bridging ties create different dimensions to network structures and influence how actors access information. As minority

groups often have less access to opportunities and are excluded from decision-making processes, awareness of their position within local networks and identification of the structures which support information flows to these groups may be able to increase the inclusion of these groups, ensuring that their specific needs are represented within development projects in the community.

Notes

1. Throughout this paper the term *campesino* is used to refer to non-indigenous rural farmers as it does not have the same negative connotations as the English translation to peasant
2. http://www.analytictech.com/downloadnd.htm
3. http://www.care.org/vft/bolivia/
4. Sub-Prefectural Government of O'Connor Province. Bolivian Departments are divided into 94 Provinces, headed by a Sub-Prefect who represents the Prefectural government.
5. http://www.cerdet.org.bo
6. http://www.rimisp.org/fida_old/seccion.php?seccion=181
7. http://www.aclo.org.bo/

Notes on contributor

Louise has worked on communications, knowledge management and monitoring and evaluation in the natural resources sector across Latin America and sub-Saharan Africa with a particular emphasis on understanding social networks to increase transparency of information flows and give a voice to the rural poor. She has a PhD in rural sociology from the University of London and is currently working as an independent consultant. She is at her happiest in the field working with farmers.

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