Building farmers' capacities for networking (Part II): Strengthening agricultural supply chains in Bolivia using network analysis

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Introduction to both case studies

Four major trends, namely climate change, economic globalization, HIV/AIDS, and population growth, are exposing rural communities to greater pressures and risks. The pace of change is so rapid that traditional innovation systems are generally unable to cope. As a result, many small farmers face grave threats to their livelihoods.

Innovation can be defined as the application of knowledge of all types to achieve desired social and economic ends (Hall et al. 2001). It is essentially a social process in which people learn about new ideas and adapt and use them through their interactions with others (Allen et al. 1983; Douthwaite 2002). As a result innovations generally arise out of a network of actors and relationships (Conway and Steward 1998). A growing body of literature is showing that network structure, such as which actors are linked to whom, the number of linkages, the roles that different actors play and the degree of clustering, to mention just a few, determines how effectively networks are at fostering innovation (Krebs and Holley 2004; Castells 2004; Cross and Parker 2002). Companies in developed countries are starting to use network mapping techniques to diagnose their social, innovation and communication networks as a first step to identifying measures to improve them (Cross and Parker 2002).

This paper (Part II) presents work to develop a network diagnosis tool for stakeholders involved in agricultural supply chains in Bolivia. It is complemented by a further paper (Part I) by Boru Douthwaite and colleagues in the same issue of this journal which presents a case study of work conducted by the International Centre for Tropical Agriculture (CIAT). The prototype methods used in both Parts I and II are based on social network analysis (SNA) methodology. SNA is a rapidly developing methodology that is gaining increasing popularity as an analytical and visualization tool with a wide range of applications across a number of disciplines such as health care, psychology and business organization. The focus of SNA is the nature of the relationships that exist between different actors in order to better understand how an actor's position in a network influences their access to resources such as goods, capital and information.

In both cases, the method development and testing place as part of an action research process in which 'the researcher enters a real-world situation and aims both to improve it and to acquire knowledge' (Checkland and Holwell 1998, p.9). Four hypotheses were tested as part of this research:

Clark, L. 2006. Building farmers' capacities for networking (Part II):
Strengthening agricultural supply chains in Bolivia using network analysis.
KM4D Journal 2(2): 19-32
www.km4dev.org/journal

1. Drawing network maps will help the actors involved (farmers, their groups and rural service providers) understand and visualize networks of relationships that are important to them;
2. Participatory analysis and discussion of these maps will build the capacity of the actors involved to strengthen their networks;
3. Strengthening networks will benefit the actors within them;
4. It is possible to develop a network analysis method that is simple enough for rural service providers to use with a reasonable amount of training.

Both papers explicitly build on the idea that 'rather than helping to build sustainable institutions and other capacities, technical cooperation tends to displace or inhibit local alternatives' (Fukuda-Parr et al 2002 p.5). Fukuda-Parr et al (2002) go on to say that 'the challenge should be to fully understand the local situation and move forward from there, step by step.' The papers contend that network analysis can help understand the local situation.

Neither case is complete. Both can be seen as an after-action review (Collison and Parcell 2001) carried out on the research to date. Both describe the step-by-step development of the method, what worked well, the capacity building required and what requires further consideration and research. This paper concludes with a final section to identify lessons learnt and makes recommendations for future research. The work is structured as two case study papers because the work was carried out independently and the authors wanted the authorships to reflect this.

Introduction to the Bolivia case

The work presented in this case study was conducted during the Redcampo projec[i], an action-research initiative to develop methodologies to promote the use of information and communication technologies (ICTs) to improve information flows for smallholder farmers in supply chains. Fieldwork was carried out in three project sites within the coffee, peach and chilli supply chains in Bolivia during 2005, in coordination with three Foundations for Technical Assistance (FTDAs – Spanish acronym) associated with the Ministry of Agriculture to identify existing information flows between supply chain actors. Despite having no previous experience of social network analysis, the research team recognised the potential of the tool to map the relationships in supply chains. Hence the research team faced the challenge of first developing the capacity to adapt and apply SNA to the reality of rural communities in order to test whether network maps could help identify the key actors, information flows, bottlenecks and demands in the supply chain and help to improve the communication of agricultural information between the different actors. Developing the skills to apply SNA to agricultural supply chains was a first step towards addressing our fourth hypothesis; that it is possible to develop a network analysis prototype method that is simple enough for rural service providers to use with a reasonable amount of training.

The importance of identifying existing information flows in rural communities responds to recent literature on both the digital divide (Girard 2003, Hongladoron 2004, Moetsabi 1998) as well as development theory (e.g., Fukuda-Parr et al. 2002) which state the importance of building on existing systems and networks, and not creating new ones.

Clark, L. 2006. Building farmers' capacities for networking (Part II):
Strengthening agricultural supply chains in Bolivia using network analysis.
KM4D Journal 2(2): 19-32
www.km4dev.org/journal

Central to this idea is the concept of information intermediaries who receive information and redistribute it in locally contextualised formats, giving it validity and an appearance of trustworthiness (Heeks 1999, Legesse 2002). In social network terminology these actors are referred to as brokers who have the ability to control the flow of information and resources to other less well connected actors (Burt 1992, Haythornthwaite 1996, Wellman 1997).

Understanding supply chains as social networks has emerged within a Northern industrial context to help explain the increasingly complex social and economic relationships, resulting from increasing use of information technologies (Castells 2004, Lazzarini et al 2001, Storer et al, 2003). There is at present very little written about what this same focus can tell us about how rural communities gain access to information and markets and whether or not they too can benefit from the use of ICTs to improve their livelihoods.

The work presented in this section is a first attempt to address some of these questions and develop a simple tool that can help supply chain actors, and producer groups in particular, better understand the networks in which they interact.

Methodology

In contrast to the application of SNA in Colombia discussed in Part I, the work conducted in Bolivia was in three regions where CIAT had no previous experience or contacts. The sites were selected in collaboration with three FDTAs to represent three different agro-ecological zones (Chaco, Tropics and Valleys) in order to gain a diverse range of experience so that the tools developed would be neither location nor supply chain specific. The FDTAs put us in contact with their counterpart organisations, who were conducting technical assistance on their behalf. Nevertheless the project team found itself in an entirely unfamiliar environment and the first challenge was to identify potential information intermediaries.

Although the research in Bolivia also used Cross and Parker's (2004) work as a starting point from which to design the study, it faced very different challenges to the team in Colombia and needed to quickly develop a practical tool which would help us understand the social relationships between different supply chain actors. To this end, the researchers were forced to move away from the traditional organisational applications of SNA as they needed to include a variety of geographically disperse actors in the investigation. One of the key challenges of this work was therefore identifying ways to decentralise the approach and understand its potential and limitations when applied to non-specific social groups with no clear boundaries.

Despite a growing body of literature discussing a wide range of applications of SNA, there is still very little literature that gives practical guidance in the design of a social network study (Cross and Parker 2004). After examining SNA studies used by other researchers (pers. comm. with J.C. Gallego 2003), a survey was developed and piloted to see if the questions were relevant and to develop the skills required to use social network software. The lack of literature on how to develop surveys, process data and use software was an extremely limiting factor in these early stages.

The social network element formed only part of the RedCampo research which also used more traditional survey questions to develop a profile of the different actors in each of the supply chains in order to understand their role, influence, types of information managed and specific information demands. Survey teams were contracted to interview producers while other supply chain stakeholders were contacted and interviewed directly by the project team[ii] using snowball techniques in which any actor mentioned became a potential candidate for interview.

The social network data proved the easiest to process. Basic network maps emerged almost immediately, in contrast to the more traditional questionnaire data that took weeks to analyse. The network maps focussed on three key variables: the actors, the information content exchanged between them and the communication media used. Other elements included in the network questionnaire such as frequency, reliability and timeliness of information, while responding to the researchers need to be meticulous, in fact added little to the analysis. The survey teams provided feedback that by asking too many questions the quality of the responses was compromised, as the questions became quite repetitive. This highlighted a very important issue in SNA survey design: keep it simple.

The resulting network maps make no claim to be exhaustive studies of these supply chains as limited human and financial resources restricted the number of interviews. Nevertheless this is the reality of working in rural development and suggests that it is possible for actors with limited resources to develop the capacities to use this tool. The network maps proved to be sufficiently complete to identify key stakeholders and generate useful discussions when presented to supply chain actors, suggesting its future potential as a diagnostic tool.

Results

The data was analysed and mapped using Ucinet© and Netdraw© and a report was written for each case study. While the network maps instantly gave an overview of the situation in each supply chain, the metrics generated could not be considered accurate and centrality and betweeness measures proved to be of little use as small sample size meant network maps were incomplete. The more basic metrics of in-degree (number of times named as an information source) and out-degree (number of information sources named) were much more relevant to our objectives. This provided another important lesson in developing a tool for rural development practitioners, suggesting that the cost-benefit ratio of paying for the licensed software Ucinet© would be a limiting factor in promoting this methodology and in order to disseminate the tool amongst local organisations with limited resources the decision was made to focus our attention on the visual rather than metric results generated from field work.

The overall survey results were presented to project partners and local stakeholders in a series of workshops to validate our preliminary analysis of the supply chains and confirm the utility of the tool. The network maps generated considerable interest, serving as a starting point to generate discussion of the social structure surrounding each of the supply chains.

Clark, L. 2006. Building farmers' capacities for networking (Part II):
Strengthening agricultural supply chains in Bolivia using network analysis.
KM4D Journal 2(2): 19-32
www.km4dev.org/journal

Chilli

In the chilli supply chain, in Monteagudo, Chuquisaca (Figure 1), Proinpa, the technical service provider is clearly the most influential actor, although this was also our point of contact with the producers interviewed. Analysis in Netdraw showed that two Farmer's Associations (Apromají Sauces and Apromají Pedernal) do not act as information intermediaries as they have not been named as an information source by any of their members, suggesting that organisational strengthening is required before increasing information flows to these Associations would have an impact on the producers. In general the producers lack strong links with traders and input suppliers, suggesting that the whole network structure is over dependent on Proinpa.

Experimenting with the data we can see the effect of removing Proinpa, leaving a lot of isolates who have no other connections in the network (Figure 2). Of these isolates 11 are producers who have named Proinpa as their sole source of agricultural information while the other 3 isolates are sources of information for Proinpa which have no other channel through which to flow into the network. A number of producers receive information from FONDECO which is a financial institution. The map also shows that removing Proinpa does not affect the relationships towards the right of the network map. This suggests that mechanisms to create links between producers and this cluster of actors would be one way to strengthen the network, improving information flows and consequently market access for chilli producers in this region.

Feedback

FDTA Chaco, the project partner, concluded from the map that the supply chain was over dependent on their Proinpa for information, raising concern as the project financing its activities was about to end. Their next question was what to do about it. They recognised the need to decrease dependence upon Proinpa, whilst involving them in a strategy to strengthen the network and assure that the knowledge accumulated by the project is not lost.

A meeting was held to present the results to local stakeholders which was only attended by 5 people, 3 of which were Proinpa staff. Although the meeting confirmed the results of the network map, it also raised the issue of how to strengthen local networks in the context of weak institutionality, with little interest in short term projects.

Coffee

The coffee supply chain around Caranavi, La Paz was by far the most complex supply chain studied due to the large number of different organisations, NGOs and traders involved marking the difference between supply chains with a regional-national, compared to international focus. The network map produced by this data was incredibly complex, teaching us that there are limits to the versatility of this tool in terms of visualising very dense networks. However when individual producers were removed from the map the inter-institutional relationships became clearer as can be seen in Figure 5.

Clark, L. 2006. Building farmers' capacities for networking (Part II):
Strengthening agricultural supply chains in Bolivia using network analysis.
KM4D Journal 2(2): 19-32
www.km4dev.org/journal

Figure 1: Network of actors in the chilli supply chain
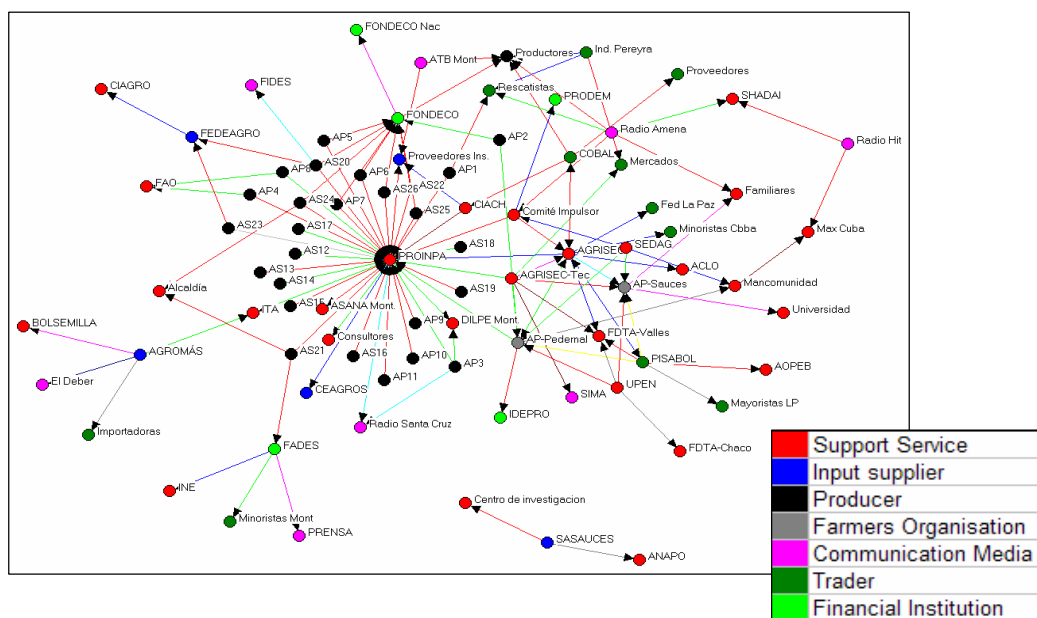
Figure 2: Chilli supply chain without most central actor (Proinpa)

Clark, L. 2006. Building farmers' capacities for networking (Part II):
Strengthening agricultural supply chains in Bolivia using network analysis.
KM4D Journal 2(2): 19-32
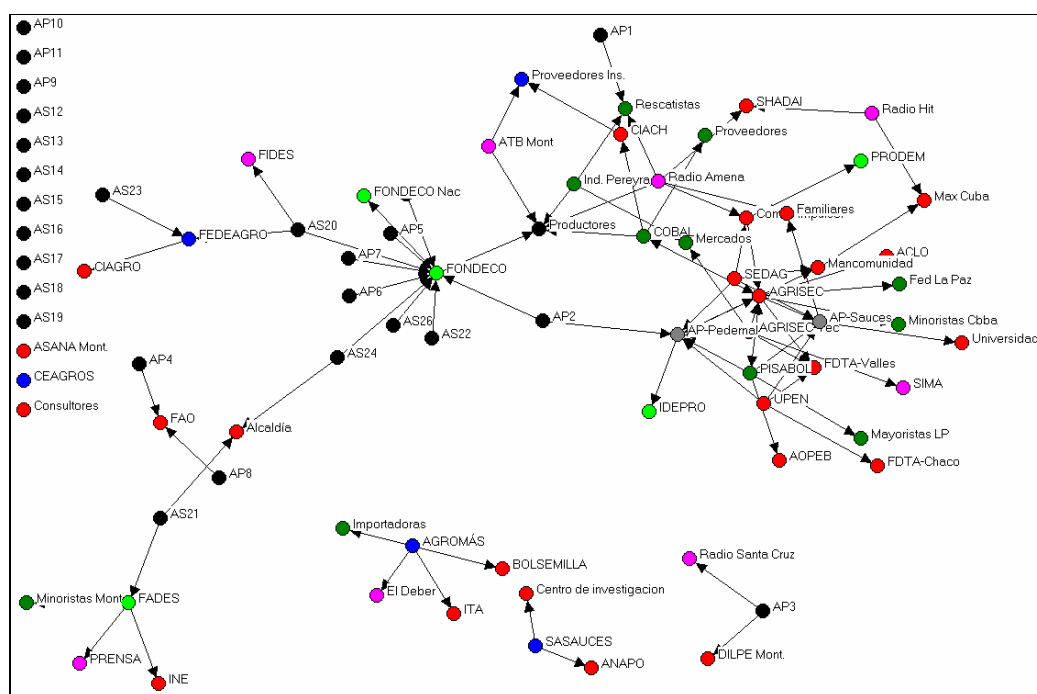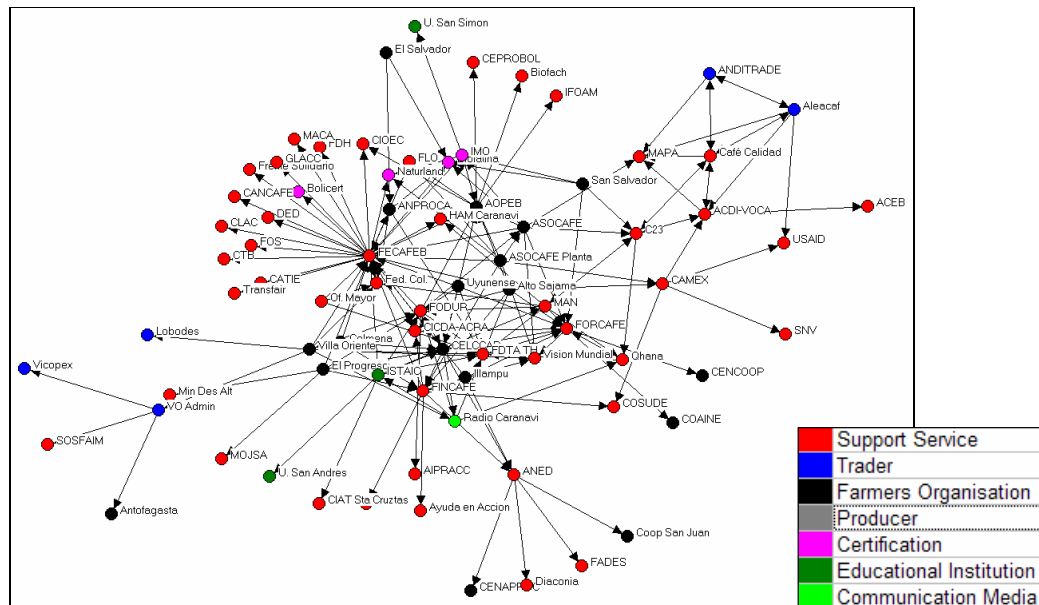www.km4dev.org/journal

Figure 3: Network of actors in the coffee supply chain without producers

While the central part of the network map is still a tangled mess (the sign of a healthy network) it is also easier to see that FECAFEB (Federation of Bolivian Coffee Exporters) acts as an infomediary for the coffee sector which has both the greatest in-degree (number of times named as an information source) and out-degree (number of information sources) in the network. On the right hand side of the network map are a cluster of actors who represent the different projects funded by an Alternative Development programme which aims to encourage coffee production as part of its coca eradication strategy. The fact that it is somewhat apart from the rest of the network suggests that it has yet integrated well into the wider coffee network.

Feedback
The project partner, FDTA Trópico-Húmedo was extremely enthusiastic about the potential of the tool such that the presentation and discussion scheduled for the morning carried on into the evening. Staff immediately started discussing how they could use the information portrayed in the maps to better understand the problems faced by a new client ANPROCA (National Association of Coffee Producers) who prior to the emergence of FECAFEB had acted as the national representative of the sector and was seeking to strengthen its position again. Analysing the network maps, they said, gave them a clearer idea of the challenge facing ANPROCA and helped them see the importance of overcoming the rivalry between the two organisations and identifying ways to work together for the benefit of the producers.

FDTA Trópico-Húmedo was also considering the possibility of accepting financial assistance to work with the Alternative Development projects. It emerged that they were hesitant about this union as they felt that such an alliance could compromise their credibility with the producers. They said they found the maps a good way to be able to voice these concerns and created a framework from which they could easily analyse the

Clark, L. 2006. Building farmers' capacities for networking (Part II):
Strengthening agricultural supply chains in Bolivia using network analysis.
KM4D Journal 2(2): 19-32
www.km4dev.org/journal

pros and cons of such a move. The FDTA Trópico-Húmedo staff were interested to develop capacities to use the tool for themselves, as they saw their work being primarily about creating relationships between different types of supply chain actors.

Subsequently the network maps were presented to a number of local stakeholders in Caranavi, where even the fact that we managed to get so many stakeholders to sit down together was seen as an achievement in itself. Quite surprisingly Rodrigo Burgoa, manager of Anditrade, a coffee processing plant with strong links to the Alternative Development programme immediately expressed his interest in the network map stating:

> *I have been working here for 10 years and I could not have explained the problems facing the coffee sector as well as you just have with these maps.*

In a subsequent conversation Rodrigo recounted how after seeing the network map he was concerned about the isolation of the Alternative Development Programme and circulated the network map amongst these projects to make them aware of their segregation. He also said that the map had led to a change in strategy as it gave him a clearer idea of the nature of the other actors in the supply chain and particularly the influence of FECAFEB. Where as previously the coffee processing plant had gone to the farmers in search of coffee, a strategy which was making the plant unpopular with coffee cooperatives, he recognised it was better to wait for farmers to come to the plant to sell their excess coffee, commenting

> *To try and break the existing organisational structure is a waste of time, there is enough coffee for everyone, we don't want a monopoly. We need to find the balance between the farmers' organisations and the private sector.*

Peaches
The peach supply chain mapped in Vallegrande, Santa Cruz was an interesting case as two principal sources of information were identified: FDF, the technical assistance provider; and, a radio programme "Correo del Agricultor" (Farmers Post and shown as Yaguari-CA in the network maps) which broadcast localised price information (Figure 7).

Experimenting with NetDraw it was possible for us to manipulate the network maps, to show information flows related to different types of content. By removing price information (Figure 8) we see that the influence of Correo del Agricultor is largely related to this subject, and is not a source of more technical information, although the popularity of its price broadcasts suggests that this would be a good medium to disseminate information and be sure it reached the farmers.

Feedback
Feedback was less positive than with the other two supply chains. The project partner – the FDTA Valles – felt that the network mapping was a distraction from other project objectives, namely designing a training programme to help farmer's better understand radio broadcasts of price information. They were not concerned that the local broadcast of Correo del Agricultor was much more popular than the FDTA Valles own price programme SIMA (Agricultural Market Information Service) as it subscribes to their own price bulletin.

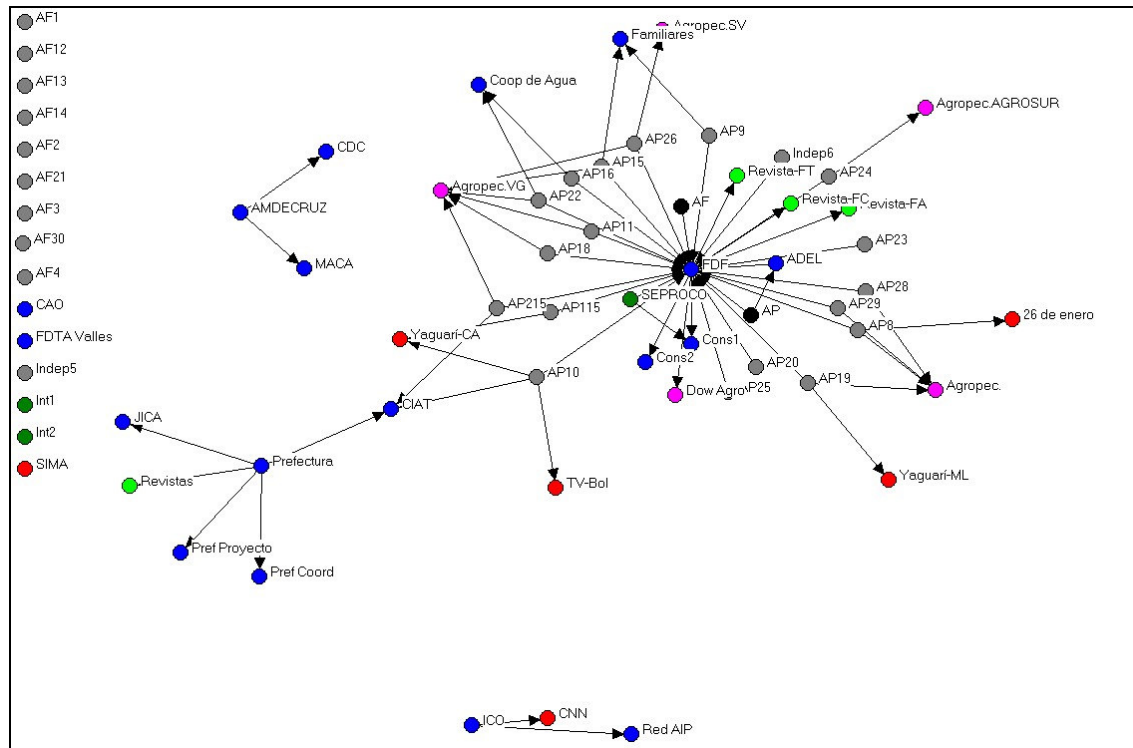**Figure 7: Network of actors in the peach supply chain**
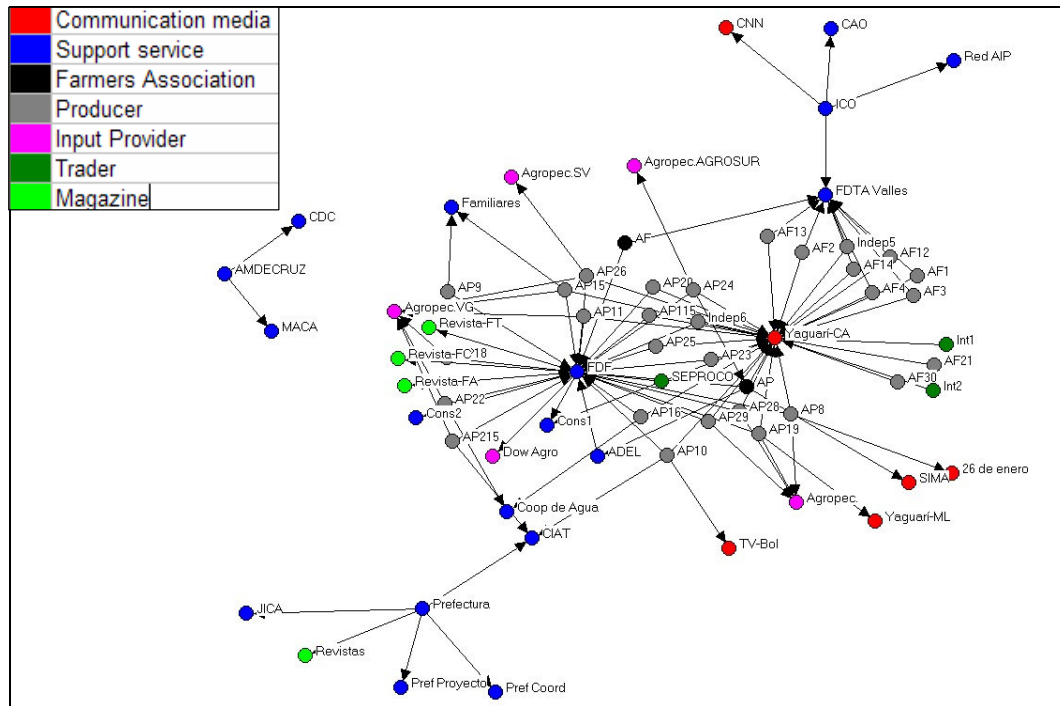
When the network maps were presented to local stakeholders at the field site, representatives of the '*Correo del Agricultor*' and local authorities did not attend. Although strategies to strengthen relationships between different local actors were discussed, this never developed beyond this initial meeting. However, the network mapping and subsequent discussion made the project team aware of a closely bonded core of actors and weak links between many local institutions which was valuable preparation for subsequent project activities.

Discussion

What was useful for the supply chain stakeholders?
The research has proved the first two hypotheses: that drawing network maps helps supply chain stakeholders visualize networks of relationships that are important to them; and, group analysis and discussion of these maps helps stakeholders identify measures to strengthen their networks. Strengthening of supply chains (hypothesis 3) will only occur when there is real motivation and commitment to change from the supply chain actors themselves. Our experience to date shows that sometimes this motivation is missing. Hence, an important research question is the extent to which network mapping and analysis itself can motivate local actors to recognise the importance of network building for themselves.

Clark, L. 2006. Building farmers' capacities for networking (Part II):
Strengthening agricultural supply chains in Bolivia using network analysis.
KM4D Journal 2(2): 19-32
www.km4dev.org/journal

Figure 8: Peach network map without price information

There was enough interest amongst the project partners in the prototype SNA methodology to develop a simple manual so that the capacities developed from this experience could be more widely shared. One of the first obstacles to this was finding a way to make the software more accessible, in terms of both ease of use and cost, having recognised that the license required to use Ucinet would limit its adoption by institutions with limited resources. A 'Manual for network mapping as a diagnostic tool' (Clark 2006) was written to give step by step guidance for survey design, data collection, creating a database in Excel and formatting the data for input directly into Netdraw, a free visualisation software. This is now being freely distributed.[iii] Follow up of use of the manual will help test the fourth hypothesis that it is possible to simplify this tool and make it accessible to rural institutions.

What was useful for the research team?

Unlike the Colombian experience, the team had no previous experience in any of the project sites and no idea of the complex social relationships existing between stakeholders in each of the supply chains. Not only did the capacity to map these networks help us to quickly identify who the key players were, it also served as a valuable tool to elicit information concerning the nature of their relationships. The project team was comprised of a mix of national and international researchers and the maps gave us credibility when discussing local problems and the need for the supply chain actors to develop strategic alliances that we would not have had otherwise.

As a first attempt to develop capacities to analyse decentralised networks, which was very much a learning-by-doing exercise, the study highlighted some key areas for consideration

Clark, L. 2006. Building farmers' capacities for networking (Part II):
Strengthening agricultural supply chains in Bolivia using network analysis.
KM4D Journal 2(2): 19-32
www.km4dev.org/journal

in the future. The results and the reaction to them by project partners and local stakeholders also suggest that further research into these areas will yield even more interesting results. While there may be more questions than answers in these early stages, formulating the questions is in itself considerable progress and allow us to be more focussed in future studies to further develop the capacity to use social network analysis as a diagnostic tool in rural development and address the issues discussed below.

What still needs more work?
Sampling
One of the key methodological issues in any social network study is how to define the boundaries of social relationships, a question that is extremely pertinent in discussing supply chains in which key actors are often heterogeneous and geographically dispersed.

The studies presented here relied largely on a reputational approach to identify key actors in the supply chain (Scott 2000), based on recommendations from project partners. Once interviewed, snowballing techniques were used, that is, named actors became potential interviewees, which made us aware of the importance of using a number of different starting points, ideally from different stages in the supply chain. There is still the need to find the correct balance with the positional approach (Scott 2000) and establish a cut-off point to delimit the study. Information sources which cannot be interviewed are still valid and should be included in the maps to demonstrate their influence on the supply chain.

Representation of the supply chain
It is important to interview and map actors from every stage in the chain. RedCampo had great difficulty locating traders and middleman who, even when identified, were extremely reluctant to give interviews. While these actors were rarely named as information sources, the study had hoped for a much more representative sample of this group as mapping the information flows between producers, middlemen and traders has the potential to yield major insights into how information flows through supply chains.

The studies used small samples, particularly of producers and traders, thus calling into question how representative the maps are of the respective supply chains. In this sense, our focus on specific project sites rather than on supply chains in general proved advantageous as even with a small sample size we were able to identify the key players. This finding has led to the hypothesis that SNA has great potential as a diagnostic tool with which to do a rapid appraisal of information flows in order to gain a general, rather than comprehensive, picture of the relationships within supply chains as an element which can help identify potential partnerships (and pitfalls) for development interventions. Further developing mechanisms to analyse feedback from the actors identified will form an important part of future research.

Individuals & institutions
A further methodological point is how to deal with social network data that involves both individuals and institutions. In future studies it may be an idea to differentiate between these two groups by using different shaped nodes in the network map. Nevertheless, the information flows between producers and their organisations are incredibly complex and to really understand communication within producer organisations merits an entire social network study. It is also important to think about the role of vague references, the most

Clark, L. 2006. Building farmers' capacities for networking (Part II):
Strengthening agricultural supply chains in Bolivia using network analysis.
KM4D Journal 2(2): 19-32
www.km4dev.org/journal

common of which are family, neighbours and technicians. While it may be interesting to look at the influence of these informal sources they can also distort the network and how to deal with this data should be carefully considered when collecting and analysing this data.

Conclusions

The capacity to use SNA to map supply chain information flows, while still in preliminary stages, has already produced some promising results, most notably the potential to use this tool as a diagnostic aid. Further work is under way to validate the method and prove hypothesis four to increase our understanding of how different types of actors can develop their own capacities and adapt it to their own specific needs, their opinions of the value of visualisation maps and most importantly the perceived accuracy of the network relationships according to the key actors identified.

Another element for further research is how the network maps can be used to stimulate participation in project activities. There are still many unanswered questions as to whether the network maps can contribute to a common feeling of identity amongst supply chain actors and facilitate the creation of something akin to communities of practise (Wenger, 1998) in which different actors identify and work towards common goals. Our experience suggests that such changes form part of longer-term objectives, requiring actors to recognise for themselves the importance and potential benefits of communication within the supply chain. For such processes to become an integral part of supply chain relationships requires the internalisation of certain values by the actors involved and while project interventions can prepare the soil and plant the seed, much patience and nurturing is required before this labour will bear fruit.

The ability to map the relationships that link actors together in networks is particularly useful given the increasing complexity of institutional landscapes in which community and producer organisations interact with a constantly changing panorama of governmental, non-governmental and private sector actors, which places serious limitations on the continuity and consolidation of successful experiences.

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Clark, L. 2006. Building farmers' capacities for networking (Part II):
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Strengthening agricultural supply chains in Bolivia using network analysis.
KM4D Journal 2(2): 19-32
www.km4dev.org/journal

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Abstract
This case study presents results from field research conducted in Bolivia to demonstrate the potential of Social Network Analysis (SNA) to characterise the network structures of supply chains by identifying key stakeholders and the information flows between them. Network maps from the chilli, coffee and peach supply chains are discussed to demonstrate the versatility of the tool in creating a visual representation of relationships and information flows in supply chains. The case study focuses on the visual impact of network maps as perceived by local stakeholders. It discusses how network mapping can help actors understand their local networks and develop their own skills to both analyse and strengthen these networks in order to support improved planning and implementation of local development initiatives. The methodological process and problems encountered while developing the capacity to apply SNA to rural communities are discussed. This work is part of ongoing action-research to highlight the lessons learned and share the steps taken to adapt and apply this methodology to make social network analysis more widely accessible to rural development practitioners.

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[iii] The manual is currently only available in Spanish. To request a copy please contact the author.