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Distinguishing patterns of learning and inclusion  
through patterns of network formation in  
developing agricultural clusters

Matias Ramirez, Paloma Bernal,  
Ian Clarke, Ivan Hernandez

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# **Distinguishing patterns of learning and inclusion through patterns of network formation in developing agricultural clusters<sup>1</sup>**

Matias Ramirez (SPRU, University of Sussex) [matias.ramirez@sussex.ac.uk](mailto:matias.ramirez@sussex.ac.uk)

Paloma Bernal (SPRU, University of Sussex) [zobernalh@gmail.com](mailto:zobernalh@gmail.com)

Ian Clarke (University of Greenwich) [I.Clarke@greenwich.ac.uk](mailto:I.Clarke@greenwich.ac.uk)

Ivan Hernandez (Universidad Nacional, Colombia) [idhernandezu@unal.edu.co](mailto:idhernandezu@unal.edu.co)

## **Abstract**

This paper discusses how network theory can help explain different patterns of inclusion of small and medium sized producers in the development of agricultural clusters. A framework based on contrasting network structures and levels of involvement of producers in the design and implementation of practices is discussed. An empirical analysis of two emerging agricultural clusters finds diverse approaches to inclusion exist. Significantly, where small producers have agency power, tensions can emerge between communities with collective values and larger producers focussed on individualized gains. Bridging these networks may be the key to combining growth opportunities with inclusion of different local producers.

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## Introduction

The increase in demand for natural-resource-based commodities and especially cash crops has opened up opportunities in a number of localities for the upgrading of producer capabilities in some hitherto underdeveloped agricultural clusters. Where land ownership is predominantly made up of small and micro producers, inclusion of these producers in processes of learning has in some areas become an important policy tool to allow small and hitherto marginalised farming communities to gain a foothold towards gaining more sustainable incomes (Gomes, 2007; McCormick, 1999)<sup>1</sup>.

However, consolidating the position of small producers through socially-inclusive trajectories has been a difficult and highly uneven process. Developing capabilities, establishing stable partnerships and knowledge transfer capacity are common obstacles (UNDP, 2010), and areas of high agricultural exports are also at times areas of highest inequality (Gibbons 2001) suggesting trade-offs can occur between economic upgrading and inclusion (Bebbington et al., 2007). The interest in this paper therefore is to understand how different network structures and participation of producer farmers in the implementation and design of new practices can lead to different forms of inclusion in the development of producer capabilities. Hence the concept of “inclusion” in developmental narratives often refers to including the marginalised and poor, whether as workers, consumers or small producers, to benefit from economic growth or the distribution of resources and services. This concept therefore has overlaps, but is not identical to that of “participation”, a well-known term in development studies that emphasizes involving communities in at least some aspects of the design and implementation of projects for the intended beneficiaries. This difference is important, for advocates of participation argue that an engaged citizenry make state projects more accountable and induce a higher level of cooperation (Mansouri and Rao, 2013). By contrast inclusion makes no such assumptions, leaving the possibility of inclusion through less democratic and authoritarian mechanisms.

We focus on two critical themes that underline this debate. The first comes under the umbrella of network cohesion and network openness. Network cohesion is seen as a precursor to achieving some degree of coordinated action by local actors (Mansuri and Rao, 2013), while network openness is required for new ideas and innovation (Burt, 2001). A second lens is associated with top-down versus bottom-up introduction of new practices. The concern is that over-centralized practices can either misrepresent or be insensitive to the needs of small and micro producers (Ostrom, 1990; Sen, 1985) and chimes with debates where the enthusiasm for networking in developmental contexts has been counter-posed by a new emphasis on the importance of empowerment, accountability and governance (Deininger and Liu, 2009; Labonne and Chase, 2008; Bebbington et al., 2007). As will be discussed later, ongoing debates continue on this question given that in many instances centralized practices are the norm.

This argument is analysed empirically using a mixed-method approach that includes a survey of producers and semi-structured interviews of relevant actors in two developing agricultural clusters. Social network analysis (SNA) is used to illustrate network structure and the strategic position of actors in terms of social ties in the network. A series of semi-structured interviews were also undertaken with local producers, service organisations and policy makers to provide further depth to our analysis of these networks.

### **Understanding inclusion through network structure**

Network formation is a recurrent topic of debate and discussion on development. It became particularly fashionable after the World Bank adopted social capital as a key policy tool in the 1990s to encourage a social agenda to reduce social exclusion and build community capacity (Bebbington et al., 2007). Networks are particularly relevant for small producers in developing economies. The fact that the delivery of everyday goods and services by the state is non-existent or highly deficient

means community groups often play an essential role in public provision (Fafchamps, 2007) which heightens the importance of connectedness. However, a broader view of network formation that takes us beyond social capital reminds us that there can be a range of network structures within which patterns of fragmentation and exclusion can also exist (Bardhan and Udry 1999; Bandiera and Rasul 2006).

In this paper we frame networks through two commonly used lenses. At one end is a spectrum composed of dense networks where social practices tend to be more homogenous among members (Coleman 1990). The benefits of high levels of connectedness emerge from the reproduction of social relationships, or social capital. For example, referring to a case study of schoolchildren in the United States, Coleman and Hoffer (1987) showed that in more connected networks of support, children are more likely to reinforce each other and therefore to complete their education and less likely to drop out. At the firm level Coleman (1990) argues that the advantage of dense networks lies primarily in the ability to establish and impose common rules and norms because network members have the power to decide who joins and who is excluded and can sanction opportunistic members. This creates a degree of predictability in the behaviour of others and allows greater investment in partner relationships. Questions can be raised about whether reducing risk is the primary motivation for establishing dense networks, after all, these can emerge as a means for a variety of reasons, including the desire to establish solidaristic values that underpin community actions (Thompson, 2003) to enhance capability (Moser 1996), or as an antidote to vulnerability (Isham (1999).

Nevertheless, a key issue is how the influence of new knowledge brought by large firms, entrepreneurs or brokers affects the rest of the network. Walker et al., (1997) argue that in dense networks, entrepreneurial behaviour strengthens social capital and inclusion because organisations are constrained to be more cooperative than firms in open networks. New knowledge thus reproduces network structure. Burt (1992) also refers to these highly dense networks as “closure” and suggests that in highly cohesive groups, strong cultures and teams can enhance trust and allow reputation to be controlled so that individuals can be trusted to collaborate.

An alternative notion of social networks by contrast eschews the advantages of dense links and extolls the virtues of information flows between rather than within dense networks (Burt, 1992). The opportunities presented by inter-network links termed structural holes can be exploited by entrepreneurs that act as brokers of information flows amongst individual actors. In contrast to the previous approach, these emphasise to a greater extent the benefits that actors have when freed from tight relationships. The key notion here is that highly dense networks can suffer from redundant information and in this scenario, the coordination costs of maintaining a network can outweigh the advantages that might emerge from it. The focus of research therefore lies in individual actors acting as brokers, the degree of access to less redundant information and the strategic position of the broker in the network. Walker et al., (1997) argue that unlike the previous social capital framework, the consequences can be that new entrants can lower overall community social capital by taking advantage of their position and exploiting opportunities for brokerage.

Two contrasting approaches therefore emerge in discussions of emerging social networks. One emphasises system level resources to facilitate governance of relationships, where early patterns of cooperation should persevere with inclusion of local actors. A second approach stresses heterogeneity, and predicts that new inputs of knowledge take place by disrupting existing dense networks (Walker et al., 1997). In terms of the relationship between the two approaches, Walker et al., (1997) suggest social capital and structural hole theory have fundamentally different implications for networks actors. In terms of development, structural hole theory predicts that new growth opportunities will fragment social capital, and sever the channels of diffusion of information to small producers. Burt (1992) on the other hand argues that although brokerage can be contradictory, it is also interdependent to closure, because communities can have a division of labour that moves between the two. Thus, where there is a large degree of fragmentation, a community will benefit from closure, leaving structural holes open. On the other hand, where new knowledge and new opportunities are required, brokerage will be more prevalent.

The balance and at times tension between more closed networks that encourage inclusion and open networks that encourage the search for new knowledge emerges repeatedly in studies of development. On the other hand, a pervasive concern in narratives of dense and cohesive networks is expressed arising from the drawbacks associated with closed and exclusionary networks or “clubs” (Fafchamps, 2007) with few overlapping connections with the outside (Pelling and High, 2005). In the context of high inequalities and weak national institutions, and where much interaction between people takes the form of relational contracting, closed groups dominated by powerful central actors create high vulnerability for smaller producers.

On the other hand there has therefore also been a preoccupation about opening up networks that stimulate greater adaptation. For example Schmitz’s (1999) well-known study of shoe makers in the Sinos valley in Brazil explained that following a successful period of collective action that allowed a group of hitherto small firms to successfully upgrade, a strategy of vertical integration with large US buyers was adopted by a small number of large local suppliers. This broke the involvement of local suppliers and excluded large numbers of small producers. Narayan (1999) therefore stresses the need for cross-cutting ties, where networks are more open and allow information and opportunities to flow to the less powerful, while Pelling and High (2005) emphasize “bridging” to encourage greater openness between actors with similar interests but different identities.

### **Top down versus bottom up and the role of strategic organisations**

Isolated from the influence of other contextual factors, information on network structure provides little information about how inclusive practices are introduced or distinguishes between authoritative, paternal or pluralistic methods of inclusion that can have fundamentally different implications on small producers. Here as well there has been a long and intense debate in post-war discussions of development.



Preferences for top-down practices are inherent in Hardin's (1968) "tragedy of commons" argument that pointed to the tendency towards over-consumption of common resources and Olson's (1965) concerns over free-riding of public goods. The need for top-down regulation and a degree of coercion necessary to protect common resources was emphasized. Centralized implementation of new practices also is argued to work best if there are benefits from economies of scale, require high levels of central coordination and where preferences and needs are likely to be more homogenous (Mansouri and Rao, 2013). If we focus specifically on the governance of networks, Cowan and Jonard (2009) make the point that a feature of all inter-organisational networks is their tendency to be dominated by a small number of organisations that have a strong ability to acquire external knowledge and develop network ties. These organisations will tend to be highly influential as leaders.

However, the development literature appears ambivalent towards the role of strong lead organisations as primary agents of knowledge transfer. Negative narratives emphasize the ability of powerful organisations to "capture" from participatory processes and that resource allocations can reflect the preferences of the rich or larger firms that have access to policy makers (Mansuri and Rao, 2013). In agricultural contexts, top-down practices have often been associated with over-domination by the state arms or paternal relations from private actors (Paré, 1990), while McDermott et al., (2009) similarly make the point that top-down practices, that are often imposed by larger influential organisations look for uniformity and can restrict the ability of local producers to define, adjust or feed into new practices. The limits of over-centralized approaches have also been severely criticized as being disempowering and ineffective and from the 1960's onwards led to new ways of thinking about participation.

On the other hand, the concept of "benevolent capture" suggests that larger organisations and elites are often in a better position to make use of and take advantage of resources through their greater learning capability and transfer these embedded resources to other local actors. This may be

more common in highly hierarchical societies where top-down values are strongly embedded such as in rural India or West Africa (McDermott et al., 2009).

By contrast, opinion has more recently shifted supporting decentralised initiatives that provide greater participation of local actors. Support for this approach includes highly influential contributions by Hirschman (1970) on collective agency, Ostrom (1990) on common pool resources and Sen (1985) on broad-based capabilities that emphasize the importance of the poor as informed participants to justify decentralized bottom-up initiatives.

### **Scenarios for emerging clusters**

The research question we pose is: under what conditions can small and medium-sized agricultural producers take advantage of growth opportunities to develop producer capabilities? We tackle this question firstly by presenting some alternative heuristic scenarios that build on Burt's (1992) distinction between high (H) and low (L) levels of bridging (or brokering) from outside the cluster (on the vertical axis) and bonding (on the horizontal axis) in figure 1. Bridges or brokers are specialised activities designed to create information variation *between* communities through structural holes, hence high levels of brokerage can fragment a coherent network as they establish unique channels of information. Low brokerage can mean high levels of redundancy of information.

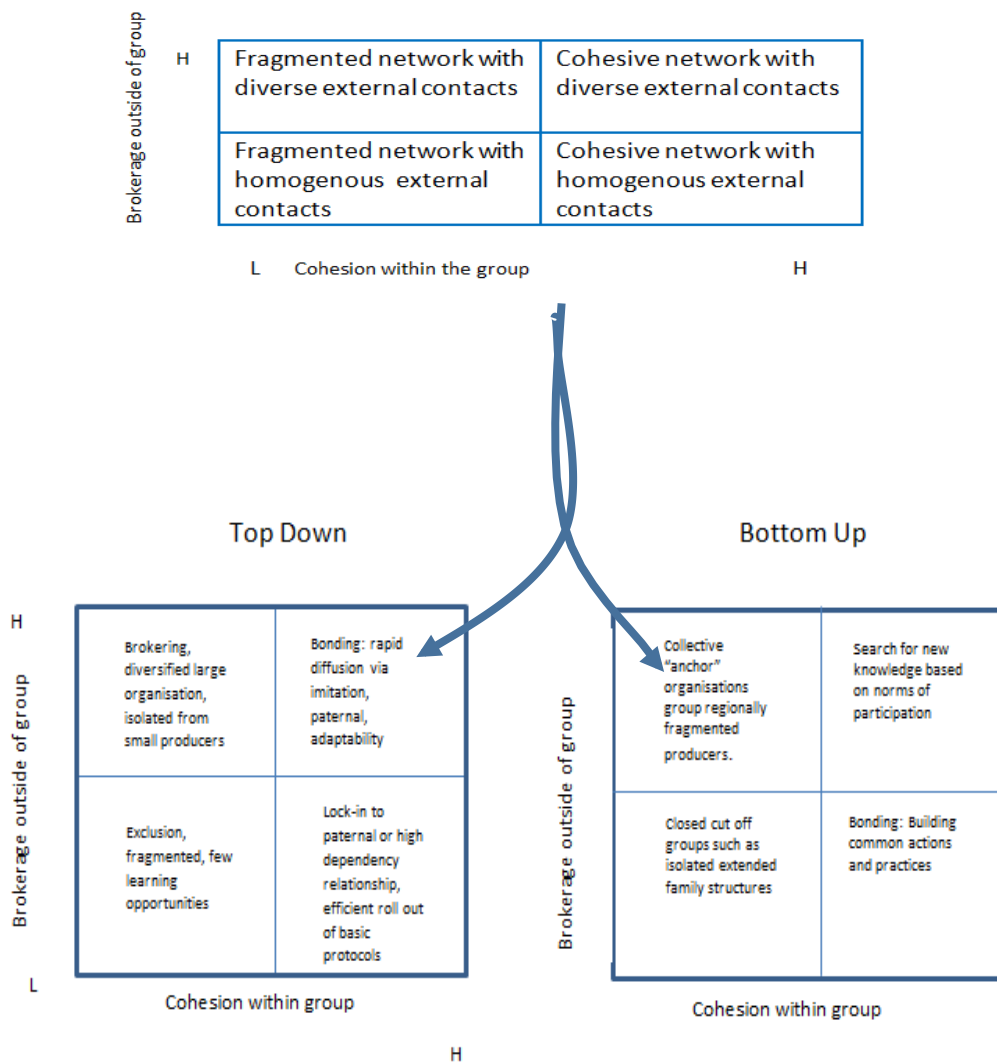
By contrast bonds on the bottom-axis specialise in building social capital and strengthening cohesion of networks. A preponderance of bonding involves protecting connected actors from information inconsistent with what they already know. Therefore links tend to be established between actors with similar backgrounds, which lowers risk, reduces exposure and therefore assumes inclusion for actors within a set boundary, that could a geographical area. In this scenario, lead organisations (whether large single producers or representatives of collectives), will tend to use their authority to strengthen collective actions. High cohesion therefore indicates (but doesn't necessarily represent proof of) a community where activities and learning are based on strong

common norms, while a preponderance of brokering is likely to lead to more fragmented relationships as organisations and actors prioritise one-to-one links.

Different levels of bonding and brokerage (high or low) generate four scenarios or quadrants as shown in the upper part of figure 1. High brokerage and low cohesion can mean that some actors have external and non-redundant ties that bring new knowledge, but others are excluded from the possibilities of learning because their networks are fragmented. High cohesion and low brokerage on the other hand mean that although networks knit together and practices can diffuse widely, there are limited opportunities for learning because of a lack of brokers with links to knowledge from outside the cluster.

The most positive scenario will be a cluster with high cohesion and bridges to external actors. Here dense networks connect actors and external networks bridge structural holes. New relationships are encouraged and built within the context of stability of existing ties, but strong bonding activity ensures that organisations can adapt to diverse links. Social capital exists alongside opportunities for learning and innovation. The bottom left quadrant is the worst performer, where low brokerage opportunities exist alongside redundancy of knowledge.

**Figure 1: Conceptualising inclusion through network structure and top-down vs bottom-up practices**



The two lower boxes in figure 1 distinguish how practices are introduced within different network structures. Where bottom-up practices predominate (bottom right), decision-making is based on extensive local discussion and efforts are made to ensure participation of small producers and their organisations. Although four different possible scenarios are posed, our interest in *emerging* clusters means high brokerage cases more relevant since there are opportunities for growth.

A high brokerage and high cohesion scenario exists where new ideas from outside will be influenced by the priorities of broad members of community. Choices of new technologies and priorities for development are therefore likely to be discussed in detail. At the same time, dense relationships allow the successful adoption of some technologies by lead users to be rapidly diffused to others through for example extensive training events. Shared use of technology is often favoured. This is echoed in McDermott et al's., (2009) study of the Mendoza wine cluster, where brokerage roles are played by government support institutes such as public research labs and training centres, who are also committed to deliver collective resources.

High brokerage but low cohesion occurs when there is a low tradition of community engagement. This may give way to new practices being introduced in an uneven and a haphazard fashion, and can often occur in initial stages of participatory development programmes, where the lead organisation faces fragmented small producers. For example Heller and Isaac's (2003) account of a participatory programme in Kerala stressed the efforts to bring the community together by encouraging certain more *democratically aware citizens* to engage in civic activities that resulted in better local government. This was a precursor to the establishment of working committees and village meetings that increased participation.

Where brokerage is low, introduction of new ideas from outside is likely to be less prevalent or given a lower priority. Thus in high cohesion and low brokerage scenarios, key organisations will focus on bonding roles, bringing together fragmented actors and creating infrastructures that can serve as a basis for common action. But without brokers, practices may well be inward looking and focus on existing experience. McDermott's (2009) description of the San Juan wine cluster in Argentina showed that despite the existence of high social capital, the lack of cross cutting ties between different social and producer communities limited broad-based learning. Hence redundancy and lock-in is possible. Where both brokerage is low and communities are largely fragmented there is a dearth of opportunities and/or capabilities amongst local actors to attain these.

As discussed earlier, formal Inclusion can also occur through top-down practices (bottom left). These can often emerge as a rapid response to emergencies, such as famine or where there is a perceived failure of civil society (Mansuri and Rao's, 2013). But they may also arise from norms and procedures emanating from a central administrative body, for example set protocols to combat an agricultural disease or to reform to energy systems based on centralised grids (Soumonni, 2010). In these cases, new technologies or organisational innovations are introduced in a more centralised fashion. New practices will tend to be the domain of lead organisations and therefore there will be limited ability for smaller producers to influence how decisions are introduced. However, top-down practices may also reflect strategies by a large company to oblige smaller producers to adopt specific practices for its benefit or indeed exclude other groups. Therefore the motivation and relationship of the lead producer with smaller producers becomes critical.

Where there are brokerage opportunities and small producers are well connected in our top-down matrix (top right), practices will be diffused fairly rapidly because of the dense nature of networks but in uniform ways through imitation and with limited scope for local discussion. For example, this is typically the case when implementing norms set by outside bodies to open export markets, such as detailed by Carbajal and Hernandez (2008) in the Mexican avocado sector. In this case study discussions tended to be limited to implementation of fixed protocols and technologies defined by outside actors. However, even here, evidence suggests that where local networks are strong, local communities can influence how technology issued as Clarke and Ramirez's (2014) discussion of intermediation in developing clusters show.

On the other hand, where brokerage opportunities exist but networks are typically fragmented in the context of top down practices, participation will be limited and practices often not suited to the needs of smaller producers. Absence of collective initiatives means small actors will typically struggle to benefit from new practices or develop the capabilities required and large inequalities can emerge and be locked-in. Where there is high cohesion but little brokerage, lead organisations can play a negative role by impeding the entry of new ideas, locking other organisations into existing ideas.

Finally, where there is little cohesion or brokerage, there will be few lead organisations able to support isolated communities in the development of capabilities.

## **Methodology and data**

The research question posed earlier is under what conditions can small and medium-sized agricultural producers take advantage of growth opportunities to develop producer capabilities?

Figure 1 suggests a series of different scenarios within which “inclusive” growth in clusters can take place and can take place. Our framework relies on a well-rehearsed argument that well-connected networks are necessary to undertake collective actions (Hoff, 2000) and open networks are necessary to foment new knowledge and innovation. However, inclusion can also occur through a variety of participative and/or centralised avenues that can have quite different consequences for producers. Moreover, over and above the nature of these particular practices, those organisations at the centre of these networks will be able to use their brokerage positions to influence whether knowledge is disseminated and how this occurs.

We empirically investigate the validity of this approach through an empirical study of two *emerging* agricultural clusters in Latin America, the palm oil cluster in the municipality of Puerto Wilches in north east Colombia and the mango cluster in the Piura area of Northern Peru. These clusters share a number of some features, but also show important structural differences. Both clusters reflect many of the characteristics of emerging clusters with a buoyant demand in international markets for their commodity product and opportunities for improved practices. However, they also resemble aspects of Altenburg and Meyer-Stamer’s (1999) category of *survival clusters* that suffer from poor entrepreneurial competence and a dearth of management skills.

Table 1 provides some of the defining characteristics of each cluster. In both cases small and medium-sized (rather than micro) producers play a significant role in terms of overall numbers of producers and in overall production. Both sectors are also highly labour intensive with limited possibilities for mechanisation. These case studies were chosen because they embody characteristics

that are relevant to this study. Firstly, in terms of how practices are introduced, the lead organisation in the palm oil cluster is a palm oil refinery firm established in 1961, whilst in the mango the central organisations are producer associations and services. This suggests a different top-down and bottom-up approach. As table 1 points out, the mango producers surveyed are split into two associations, APEM and PROMANGO. The latter organises the smaller producers with an average size of 51 Ha. By contrast, in the palm oil all but one of the producers has a smaller scale of production with an average size of nine Ha.

Two surveys of producers with identical questions were undertaken in each cluster (17 in the palm oil, 26 in the mango cluster). Analysing of survey data was undertaken through social network analysis (SNA) techniques that permit visualization and measurement of the structures of relationships and the strategic of positioning of actors in these relationships. The survey data was gathered in both clusters through identical face-to-face surveys. The question asked to firms was: “from whom did your organisation (or business) receive technical assistance and how important was this to your organisation”?<sup>ii</sup> Respondents were provided a list of organisations (producers, services, universities, consultancies) and an open section to name other organisations from whom assistance had been received and to then identify and rank organisations from whom assistance was received from 1-5 in ascending order of importance. From this information it was possible to produce a network map using open source software, *Pajek* for social network analysis.

Subsequently, the nature of local participation and motivations of lead organisations to influence both the establishment of networks and inclusion (top-down versus bottom-up) is investigated through in-depth semi-structured interviews of actors in both clusters. Information was collected on the nature of practices by small and larger firms and the extent of learning required, knowledge sharing, bonding and brokerage. The interviews in the palm oil cluster involved two ground visits in Colombia and eight semi-structured interviews. These included one discussion group with high level officials of CENIPALMA and FEDEPALMA, two interviews with small farmers representatives, two interviews with executives of large palm oil companies, one interview with the head of CENIPALMA



research and development facility and two interviews with CENIPALMA employees working in the field. We also shadowed a CENIPALMA worker over two days in the palm-oil cluster, the same area where the survey interviews took place. In the case of the mango cluster, twenty semi-structured interviews took place with owners of small and medium-sized mango firms and directors of the main intermediaries including APEM, PROMANGO, and several government agencies with offices located in Piura. The producer association congresses of APEM and PROMANGO were attended and detailed notes made as observers.

**Table 1: Summary of clusters**

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	<b>Mango</b>	<b>Oil palm</b>
	Omitting one large outlier producer, the average size of PROMANGO producers is 51 hectares and	Ranges from 7 to 26 hectares with an average of 9
<b>Size</b>	124 for APEM members.	hectares.

	Just 5 out of 26 producers employs less than 10	
<b>Employees</b>	people, although work is seasonal.	Mostly family. Some employees hired that live locally.
		Oil palm bunches are sold in local market to
	16 out of 26 producers sell product in	processing mill. E1 is the only processing mill
<b>Market</b>	international markets.	represent in this sample.
		The most recognised certification is given by the RSPO
	18 producers are certificated by GlobalGap, 4 have	(Round on Sustainable Palm Oil). Few oil palm growers
<b>Certification</b>	Tesco TNC.	certified.
		Most small farmers combine a small amount (2
		hectares) of traditional products (banana, plantain,
<b>Other livelihood</b>	Some attempt to diversify to grape production.	cassava, and corn) with palm oil.

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*Source:* Based on authors survey of mango and palm oil producers

## Industry background

The Colombian palm oil is dominated by three specific features. The first is the growing importance of small producers as a proportion of cultivated land in the industry<sup>iii</sup>. In 2011 the total area in Colombia planted with oil palm reached 427,000 hectares (Mosquiera et al., 2012). The industry is dominated by 50 large oil refinery firms who in 2010 also grew 30% of the palm fruit. However, in 2012 18.7% of the palm oil land was cultivated by small producers (through “alliances” of producers in local clusters - predominantly small farmers - and in farms of less than 20 hectares in size), up from 3.7% in 1999 (Gomez 2012), and 25% of land planted with palm oil in the last decade have been through these small holder productive alliances (Range et al., 2005). Consequently, the relationship between firms has changed, with large firms increasingly dependent on purchasing from small firms. Ten years ago large firms purchased just 30% of the fruit for refining, in 2010 this jumped to 70% (Cordoba 2011). The growing importance of small producers has come about following a government and United Nations sponsored programme of land distribution titled

“Productive Alliances” to provide small farmers alternative incomes to growing illegal drugs and to reduce violence in the countryside, a feature of Colombian rural reality, particularly in the latter part of the 20<sup>th</sup> century (Zamosc, 1990)<sup>iv</sup>. Secondly, the sector experiences excess demand, firstly as a consequence of the rise in domestic demand of palm oil for use as a bio-fuel and secondly as consequence of the spread of the *Pudricion del Cogollo* (PC), (translated *but root* disease) an airborne disease affecting tropical areas that has wiped out large numbers of palm trees. Large resources have been devoted to develop prevention measures against the PC and its treatment by CENIPALMA. Two prominent approaches include the replacement of the indigenous Colombia palm tree by the “African palm”, a hybrid, that is hoped will be more resistant. The second approach involves agricultural practices (maintenance of hydration infrastructure and weed control) and plant disease treatment (combination of fertilizer, pesticides and insecticides).

The third feature is the industry organisation in the rural areas. Small firms tend to geographically cluster around large refinery palm oil plants in so called UATTAS. The land surrounding the refinery is owned partly by the refinery firm and partly by small producers called “allies” who sell the basic produce to the larger refinery. There are therefore two key organisations at the centre of each cluster, a refinery firm and in some cases a small producer association.

The structure of the mango cluster in Piura resembles the palm oil in terms of the dominance of smaller and medium sized producers (see table 1) and production of a single agricultural commodity. This is a buyer-driven value chain and is one of the country’s most important emerging agricultural regions, although export of mangos began to increase significantly only in the 1990s when the first hot water treatment plant was installed. The demand side of the market is dominated by large wholesalers based predominantly in Europe and the US. In contrast to some other successful export clusters of Peru, such as asparagus, the short window of production means that so far in Piura there are no large dominant firms, although there is a division between larger medium-sized firms that produce and export and smaller producers that only produce and sell their products to exporters.

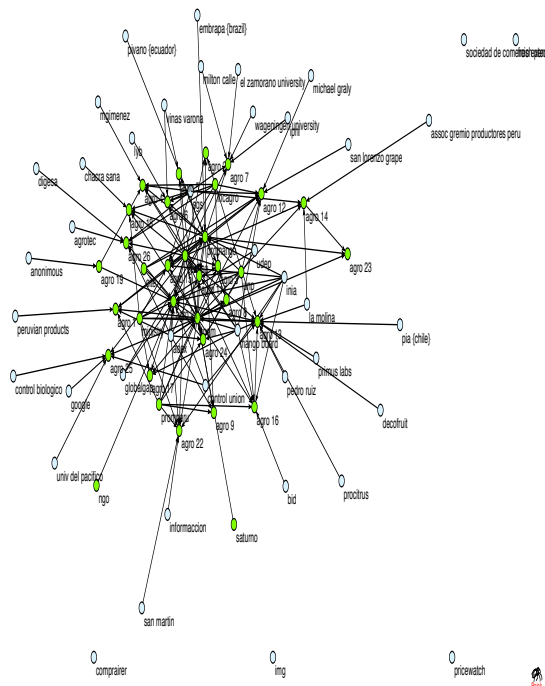
This division is reflected in the two producer associations of the region. APEM represents organisations combining exporting and production and PROMANGO, formed after a collapse of prices in 2002 that represents smaller producers. Members of both associations make up around 30% of growers and 60% of production and form the centrepiece of the study, although key organisations at local level include SENASA, the phytosanitary government body and other service organisations play important roles. A key competence is reaching certification standards necessary for exports, combating fruit plagues such as fruit fly, incorporating a greater control and improvement in the detail of production processes and technologies and establishing good networks with a range of buyers from different export markets.

### **Analysis of network coherence**

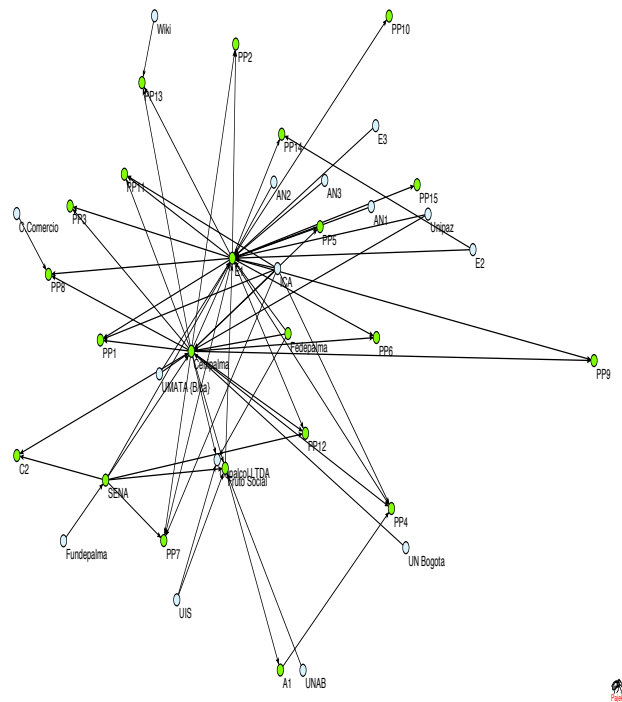
Figures 2 and 3 below provide an illustrative overview of the network of both clusters. Interviewed firms are coloured green, other organisations mentioned as knowledge providers in blue. In Figure 2 the mango cluster appears shows a highly-connected group of producer firms at the core of which are a small group of service organisations. The palm oil cluster in figure 3 illustrates a simpler hub-and-spoke structure with producer firms clustered around E1, a large local producer and refinery firm that is supplied by the surrounding small farmers and CENIPALMA, the technology arm of the producer association. Although CENIPALMA formally represents most national palm oil producers, it is mainly influenced by the larger organisations that provide most of its funding. Actors in both clusters are therefore formally connected to organisations in the centre of the network, however the mango cluster has more organisations at the centre of the network and a limited degree of inter-connections between them.

**Figure 2: Mango cluster**

**Figure 3: Palm oil cluster**



Source: Calculated from author survey of mango producers

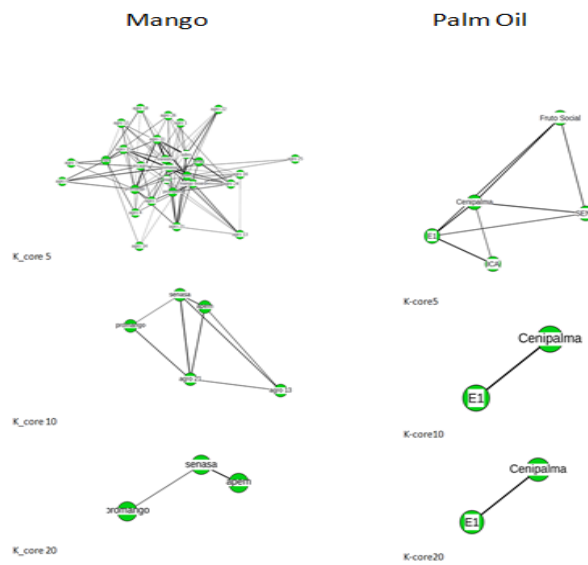


Source: Calculated from author survey of palm oil producers

Formal cohesion is analysed using K-core method, that allows observation of the number of links of all the vertices within the cluster and if any dense sub-networks exist. Table 2 shows that the mango cluster appears to be more cohesive (higher numbers of connections) than the palm oil cluster with mean average values of 3.35 and 2 respectively for each organisation. Moreover, the distribution in

the mango cluster is skewed towards higher values, 64% of palm oil firms have just two links, while 50% of mango firms have four links. Therefore, a significant majority of small farmers in the palm oil are reliant on just one or two channels of information. K-core also allows detection of cohesive sub-groups by removing the lowest k-cores from the network until this breaks up into dense components (de Nooy, 2011). In figure 4 we show how firms value the knowledge received. With values of one omitted (i.e. we just include values 2-5), the palm oil network becomes very sparse at K-core equal to five and is reduced to just two organisations at K-core equal to ten. The mango network by contrast shows five organisations at K-core equal to ten and three at twenty. It is nevertheless significant that a fragmentation is present because there are no direct lines of communication between the main organisation APEM and PROMANGO at the centre of the network.

**Figure 4: K-core value**



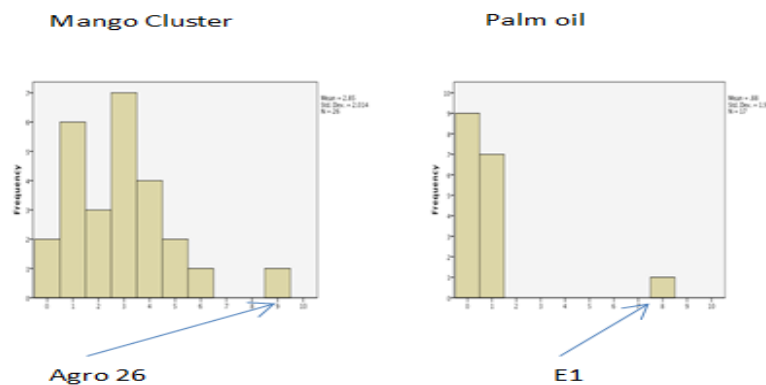
Source: Calculated from author survey of mango and palm oil producers

The mean values for the *structural holes* (the non-redundant information flows) in table 2.5 indicate a high reliance on a small number of broker organisations that have unique channels of communication. However, structural hole doesn't necessarily distinguish knowledge from inside and outside the cluster. To do this we can look at the mean of "indegree centrality from outside the cluster" (which measures knowledge coming from organisations based outside the cluster - this being more likely to have greater novelty) in figure 5. We can see that this differs significantly between the clusters and E1 is the only organisation in the palm oil that maintains significant links outside the cluster. The mango cluster by contrast shows more complexity in its structure with a greater variety of organisations with external links. The most active in this area is agro 21, a privately-owned medium-sized exporter working with overseas consultancies, but there are clearly a

broad range of different organisations, that include private producers and service providers engaged as brokers.

A revealing phenomenon appears if we compare indegree centrality from outside the cluster with outdegree centrality, i.e. brokerage and bonding. Although we saw a number prominent producer organisations are active in gaining knowledge from outside the cluster in the mango cluster, privately owned organisations do not appear willing to share knowledge, even with their associations (for example agro 21). Only the state run phytosanitary body and the producer associations show commitment to bonding and collective dissemination. By contrast in the palm oil, a single privately organisation refinery E1, acts as broker and bonder.

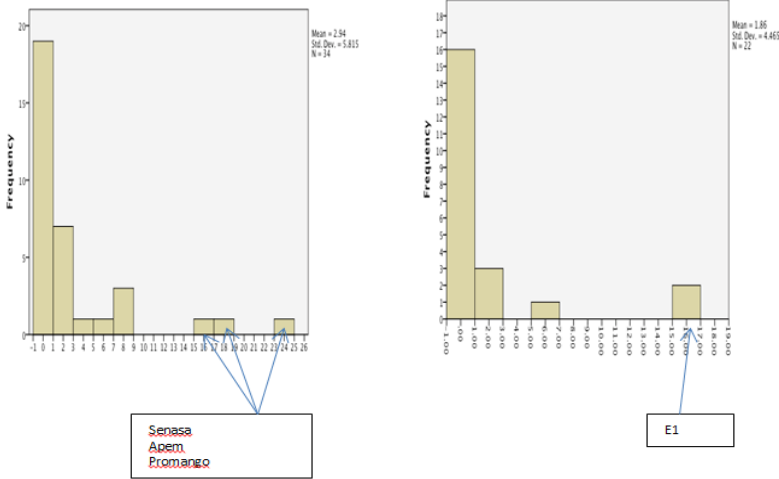
**Figure 5: Indegree from outside the cluster**



Source: Source: Calculated from author survey of palm oil producers



Figure 6: Outdegree centrality



Source: Source: Calculated from author survey of palm oil producers

**Table 2: Summary results of social network analysis**

		Palm Oil		Mango		
		Mean	Std deviation	Mean	Std deviation	Independent sample t-test (Sig. 2-tailed)
Cohesion	Indegree from within cluster	2.06	0.827	3.85	2.073	.000
	K-Core	2	.612	3.35	.745	.000
Brokering	Structural holes (betweenness centrality)	0.39	0.21	0.66	0.12	.000
Openness	Indegree from outside cluster	.88	1.9	2.85	2.014	.025
Degree of sharing	Outdegree centrality	1.86	5.81	2.94	4.46	

*Source:* Calculated from author survey of palm oil and mango producers

*Note:* Mean values have been normalised to achieve normal distribution for t-test of significant difference. It was not possible to calculate significant difference for "outdegree centrality" because too few organisations in the survey share knowledge.

We highlight three important observations from the above analysis. Firstly, rather seeing a trade-off between brokerage and bonding as earlier debates suggested there might be, in this particular context bonding (that is associated with inclusion) and brokerage to outside knowledge appear to be complementary. The palm oil cluster shows weaker network bonding and lower levels of brokerage. Secondly, there is a high level of reliance in both clusters on a small number of central anchor organisations that bring in new knowledge from outside the cluster. However, lower overall cohesion in a hub-and-spoke type network structure would indicate higher dependence (and vulnerability) on a smaller number of organisations, since there are fewer alternative links. Finally, K-core analysis demonstrated that the more cohesive mango cluster has actually developed two sub-networks. In this case, exporter firms and smaller-sized producers are organised around separate producer associations, with little knowledge flowing between the two. The next section builds on the analysis of network structure by discussing how practices are introduced using a qualitative analysis.

### **Comparing top-down and bottom-up practices**

The dominant narrative in the Colombian palm oil has centred on containing the devastation caused by the spread of the “pudricion de cogollo” (PC) disease. A structured protocol of disease control emanating from CENIPALMA’s R&D department is built upon a system of *UATTAS* (Unidades de Asistencia Tecnica), where technicians based in the palm oil refinery firms at the centre of each cluster are responsible for transferring know-how to surrounding small firms. It is therefore designed in a hierarchical top-down fashion with know-how emanating outwards from established firms and attempts to reinterpret the design of the scheme are not encouraged. As a local CENIPALMA worker commented:

*In sanitary terms, it has to be done via the scheme we developed that unifies criterion. Everybody has to speak the same language. So if there is a user and he says “I have this experience of working on this disease”....no sir, we are not going to do that, we have to follow the norms developed from the agronomic committee. We have to have a unified criteria.*

Officials of CENIPALMA commented that convincing small farmers to introduce these new techniques on their land is critical to prevent the spread of the disease. This involves thorough training of PC disease symptoms, keeping accurate records of diseased palms and assessment of PC severity (Mosquera, 2012).

Three different patterns of responses to combatting the PC in the industry were evident. The first is where large firms do not link up with small farmers. Many large firms appear unable to take responsibility for helping small farmers to implement an increasingly demanding and bureaucratic formalization of activities. However, in some cases there is there is also unwillingness because of potential conflict of governance. As an executive of the refinery firm commented:

*“I think it is very difficult for anchor (refinery) firms to reach the point that is hoped because when orders and directives come from anchor firms, who buy from them (small producers) the fruit, and lend them money... anchor firms haven't really got the authority to make them follow certain practices. We don't feel responsible for their survival, and small producers don't see us as having the authority to make them”.*

A second response, of which our case study in figure 3 is an example, is where large refinery firms have stepped in to assist small farmers in the adoption of new techniques, and other assistance such as the provision of bridging loans and donations to local schools. It is this model that CENIPALMA has hoped to institutionalize across the industry based on the close physical proximity between refinery firms and small firms in clusters. However, as intimated, a feature of the industry is the variation in relationships between firms in cluster. As a CENIPALMA official commented:

*“There are some nucleos where the leading company is only really interested in buying the fruit, it is not interested under which conditions this is produced, but there are cases of projects such as Indupalma, where there is a contract between the anchor firm and where the whole sanitary scheme is run by the anchor firm, the ally is*

*just waiting to pay off the credit and they then take charge of their plantation. So in some places it is working in others it hardly exists...this is very new and requires a change in the scheme of things”.*

Where the UATTAS function, the motivations for the refinery firm to support small producers reflects a combination of paternalism – a desire to help the conditions of small farmers– and a more pragmatic awareness of the need to invest in surrounding small farms to stabilize supply. However, as the analysis of networks suggested, in these cases small firms have very limited ability to have an input into how practices are designed and alternative approaches are strongly discouraged.

A third case, which tends to be exception rather than the norm, is where functioning small-farmer associations take an active part and in some cases lead the implementing new practices. A small farmer association representative indicated that in one cluster, the implementation of the anti-PC protocols was highly successful largely because it was led by a small farmer producer association rather than a refinery firm and enriched what was a top-down initiative.

In this sense creating strong networks of farmers and communities of practice is essential. Greater network coherence can kick-start greater agency, as small farmers will go beyond mere imitation of practices handed to them. A leader of *Coopalmares*, an association formed in 2009 (in a different cluster from that shown in figure 3), stated that members responded to the PC crisis not only by adopting the industry protocols, but also by diversifying their crops and planting traditional foods such as rice and yuca. This strategy more accurately reflects the vulnerabilities small farmers face when switching to a crop that is vulnerable to disease.

Agency and network structure are similarly important in the mango cluster, but rather than dependence on one private producer, two producer associations wield significant agency power on behalf of their members. Nevertheless their functions differ significantly, and this separation between producers and exporters is a dominant feature of the cluster. As a representative of small and medium-sized exporter firms, APEM plays primarily a brokering role by providing intelligence on prices in international markets, bringing in external experts for export certifications, opening up

export markets (currently in Asia) and establishing research partnerships with local universities. Implementation of day-to-day practices are the responsibility of individual firms.

The PROMANGO association representing small producers is by contrast overwhelmingly focused on bonding activities, helping members improve yields, sharing best practice in the use of fertilizer, treatment of trees, storage and transporting. Its annual congresses resemble a community of practice. Although our survey showed little evidence of knowledge transfer between small firms, choices regarding new technologies, such as the purchase of hot water treatment plant and diversification into grape and cacao production are discussed thoroughly, partly because the funds to buy capital and training are raised jointly and the technology is shared by all members.

PROMANGO officials recognized the natural link that exists between exporter and producer firms and acknowledged the need to strengthen the value chain. Nevertheless, as figure 4 showed, although some important firm-to-firm collaborations exist, there are few direct lines of communication between associations. As a PROMANGO official stated:

*“From APEM we receive nothing in terms of technological knowledge, a little bit of commercial information sometimes, such as databases of exporters, I’d give them one on a scale of one to five”.*

In part this reflects the asymmetry of power between producers and exporters - exporter firms often delay payment to producer firms (or don’t pay) and according to producers, charge high packing prices. However, there are also fundamentally different normative values. APEM and its members emphasize market competition, individual entrepreneurship and developing the Piura region as a marketing brand. As the APEM president noted:

*APEM is defined by entrepreneurship, there are other institutions that play a more social role, and can help the smallest producers, but our members hardly intervene in this. Our members hope to receive economic benefits, not in terms of donations, but in terms of information and other advantages we can provide”.*

PROMANGO by contrast prioritizes solidarity, and collective actions, where the needs of farmers and their families and communities guide strategies and choices of technologies. Despite high overall levels of cohesion, a more complex pattern of network structure therefore appears where grass-roots organisation encourages bottom-up practices. These will include sub-networks and niche networks that are not necessarily picked up by cluster averages.

## **Discussion and Conclusions**

This paper set out a framework to study inclusion of small-scale agricultural producers in capability building by using an approach that highlights the importance of collective actions amongst small and medium-sized producers in geographically clustered contexts (Fafchamps, 2007; Schmitz, 1995; McDermott, 2009; Bebbington et al., 2007). The framework establishes different scenarios in which inclusion can take place and by doing so contributes to the notoriously difficult task of analysing different clusters within a single multi-lens framework. Its greater usefulness however is also to provide a direction and steer for more in-depth studies on how inclusion and isolation can occur in different contexts.

In this sense, our empirical study suggested that the single most important barrier to small producer inclusion was the fragmentation of small firm networks. This was particularly evident in the palm oil cluster where, even within the confines of a top-down led set of protocols for farmers to follow, a lack of network cohesion made it very difficult for network leaders to disseminate information. However, it was also significant that small-producer networks tended to be weakest where the local large palm oil refinery firms did not engage with the producer community in the treatment process of the palm tree. Therefore network cohesion is also affected by the ability and willingness of those at the centre of the network to articulate the network by pushing forward new practices.

Where large firms did engage, it was through a top-down architecture set out by the producer association. A hub-and-spoke type network structure appeared with a dissemination pattern

designed to encourage rapid diffusion of pre-set codified protocols. Large local organisations can shepherd a community towards positive collective outcomes (Rao and Ibanez 2005), for example by setting up experimental sites that can facilitate a process of learning-by-watching (Saweda, 2014). However, power relations can be inevitably exaggerated when there is a hierarchical system of control and centralization by a small number of organisations can also legitimize the (sometimes paternal, other times authoritative, or a mixture of both) domination of an organisation.

Centralized practices can also alienate smaller actors that exist at the edges of the network that are at times adversely affected by top-down practices from providing diverse responses. Significantly, where evidence of small producer collective organisation was present, the response was a search for solutions that more closely responded to their specific needs. Mansuri and Rao's (2013) point that small producers need to work together as a prior condition to expressing new "search" strategies outside the boundaries set by large organisations appears highly relevant, even in cases where centralized practices are dominant such as combatting plant diseases or introducing certifications.

The mango cluster on the other hand emphasized the point that network growth can occur through the development of structural holes, which can fragment social capital. Despite the appearance of coherence given by inter-cluster comparisons, it was clear that brokerage opportunities tended to benefit individual firms rather than the entire cluster. Significantly, the underlying fault lines between producer and exporter communities reflected contrasting normative values of their networks. Smaller producers are reliant on solidarity and a greater degree of participation in decisions through their producer association. Hence, as was implicit in our framework, networks need to be distinguished between those that are a vehicle for joint learning and built on common values, from those whose members see the network primarily as a means to gain access to resources. Not only does this underline the importance of distinguishing network structures as argued by Burt (1992) and others, but also of distinguishing the underlying values of these (Bourdieu and Wacquant, 1992).



The conclusions for policy makers of our findings are significant. New knowledge and learning opportunities can provide impulses towards both the fragmentation and the strengthening of systemic resources. However policy makers can influence this process. Highly fragmented communities require greater network cohesion, and the engagement of central actors where they exist to help articulate relevant networks. Moreover, effective inclusion from the point of view of knowledge transfer may lie not just in the establishment of networks, but rather in ensuring that the spaces between different groups is populated with relevant intermediary actors and institutions. As Woolcott and Naayan (2000) point out, the virtue of a cohesive network is not just connectivity, but that it can bridge the divide between different types of organisations.

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<sup>i</sup> A major programme of the United Nations Development Programme is “Growing inclusive Markets” programme that is active in building market opportunities for small producers in 49 developing countries

<sup>ii</sup> This wording is similar to that used by Giuliani (2007) in her study of knowledge networks in the wine industry.

<sup>iii</sup> There are three classifications of farm size in the oil palm sector: large growers (more than 500 hectares), medium-sized grower (between 50 and 500 hectares) and small sized growers (less than 50 hectares)(Roundtable on Sustainable Palm Oil, 2013).

<sup>iv</sup> This experience has historical parallels in much of the Latin American continent, where land has often been distributed to poor farmers as a means of maintaining social peace rather than as a basis for creating an economically viable development project (Paré, 1990).



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