# A Social Network-based Communication Framework for Interest-wise Clustered Farmers

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**ABSTRACT**

*Social networks can provide an interesting theoretical framework to satisfy the requirements of farmers in terms of building a common and shared communication platform. Social network in itself is a strongly grounded theory based on graph theoretical foundations that can be extended to any cluster-type applications. We introduce the basic concepts of social network methods and its properties. The assumptions made here are that each farmer-cluster is analogous to social networks where the network actors are equivalent to actors in social networks. Using these assumptions, subsequently we develop and present the conceptual framework to map the social network properties to the techniques and requirements of the process of creating farmer-clusters that can share information, knowledge and experience across the communities, based on their particular interests in crops, demographics, soil properties peculiarities and so on.*

***Keywords:*** Social Network, Structural Holes

## 1. Introduction

"Coming together is a beginning: keeping together is progress: working together is success" (Henry Ford), Farmers can be benefited significantly from cluster-wise knowledge sharing initiatives. IT enabled networks have been found to be extremely useful in promoting the causes of farmers, as is seen in the opening case exhibit that is attached below. Given the benefits, the challenge or the research question mostly hovers around issues on creating effective clusters that can group farmers based on their specific interprets in terms of 1) the crops they harvest, 2) the areas (demographics) they belong to and the associated climatic or soil peculiarities, 3) weather information, 4) market information (i.e4. which markets they operate or aim to operate to sell their produce), etc. Using these clustering variables, one can actually develop a strong and sound theoretical framework for creating groups similar to that of web communities, with the farmers being the main actors.

This paper aims at outlining one such framework.

## 2. The opening case (source: http://www.fao.org/docrep/006/w2406e/W2406E09.htm) – Exhibit

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The goal of this case study was to survey and understand the historical and contemporary processes involved in the generation and adaptation of knowledge and technology of trees and tree cultivation by Rwandan farmers. In particular, this study focused on: (1) the dynamic aspects of Rwandan agroforestry systems, i.e. how and why these systems came into being and evolved over time, (2) the active role of farmers in the development of the agroforestry systems, and (3) agroforestry knowledge/technology production processes (i.e. processes of acquisition/adaptation of knowledge/technology from elsewhere, and generation of completely new knowledge/technologies based on farmers' own ideas and efforts).

*Methodological issues related to the identification of local tree experts*

Identification and characterization of tree experts: Tree experts, as identified through a ranking procedure and community interviews, were all farmers who cultivated many trees of a large species diversity on their land. During the ranking game, informants explained that the larger number of trees and species diversity was possible because experts had more land, more animals and manure, better soils, greater wealth and were more active in tree planting activities.

The differences between tree experts and comparison farmers (the non-experts in this study representing the general farm population) were subsequently confirmed by a socio-economic survey. The survey results showed that tree experts were older, more experience t and further advanced in the family life cycle. They had greater resources (land, labour, animals, manure) and therefore could better absorb risks associated with experimentation. Tree experts were also better informed through travel and more observant of few species and practices during travel. In addition, they were more aggressive in seeking help and advice from extension workers, neighbours and/or veterinary assistants, and in pursuing extension and projects to gain access to new technologies, such as improved seeds,tree seedlings, fertilizer, lime, management practices of trees and crops. Although not all variables included in the t r ,nal survey were mentioned as criteria by informants for the knowledge ranking exercise, the results indicate that informants were able to accurately distinguish groups of farmers within the population on key variables such as resources, wealth and tree species diversity, even if only on a relative scale. The ranking game data and observations made during game implementation provided valuable contextual information about agroforestry practices which proved invaluable in interpreting the overall results of the study. This information could not have been obtained by relying exclusively on the formal socio-economic survey. It confirmed observations by Scoones and Thompson (1994) that contrary to scientific knowledge, endogenous knowledge is manifold, discontinuous and dispersed, not singular, cohesive and systematized. As a result of "development" and other political, socio-economic and demographic processes of change, the definition of knowledge defined by a society once largely dependent upon gathering its tree products (i.e. having experience with a variety of tree species particularly concerning their utilitarian aspects) no longer appears applicable to today's situation in which people actively plant and manage trees on their own land. A more extensive kind of "knowledge of trees" is developing which includes knowledge about the planting and management of trees, their integration and interaction with crops and/or animals, as well as knowledge of their utility. It is therefore recommended that:

Future studies of endogenous knowledge of agroforestry combine qualitative and quantitative, participatory and formal data collection methods to provide both complementary and supplementary perspectives on a complex reality (den Biggelaar, 1995).

Farmer experimentation: a comparison of methods and procedures with scientific research

Identification of specific shortcomings, instead of the wholesale dismissal of local technologies as inadequate, can be an important mechanism to generate knowledge: it can be one of the means with which local knowledge can be developed in a fertile interaction with other knowledge. In this way, specific areas of local technology can be improved so that existing shortcomings are eliminated and a solution will be found with greater local relevance than whichever `external' technology (van der Ploeg, 1991).

Many farmers intuitively followed this advice. It was their strategy to solve particular problems and shortcomings by borrowing from any sources available (other endogenous knowledge systems, research and extension, etc.) to arrive at workable and profitable solutions for their conditions. It was, however, difficult to distinguish new from existing practices or to differentiate experiment from normal practice. The following suggestions are made to take such differences in perceptions into account:

- Involve farmers in the script writing for these virtual tours, perhaps first producing a tour of their own agroforestry systems and experimental activities for outsiders. This will ensure that specific factors and aspects that farmers deem im portant are included.
- Have farmers produce their own video, photo and text materials necessary for producing a virtual reality tour. Most modern video and camera equipment is easy to operate. However, some basic training will be needed on camera operation, framing and presentation.
- With the help of visual, object-based computer programming, the practices and systems depicted should focus on a single idea, practice, method, etc. The users of these programmes (for example, extension services, NGO's or other organizations) can subsequently create the appropriate tour for their audiences.
- Simultaneously, there should be more in-depth studies of the logic and reasons behind specific agroforestry systems and practices and of the methods and evaluation factors of farmers' experimental activities. These studies will provide the necessary background information for the visual material.

From the above case of Rwandan agro forestry, it can be deduced that an efficient knowledge sharing mechanism enabled by a clustering methodology, can be extremely effective in promoting best practices in farming and dissemination of experiential knowledge amongst the farmers.

The applicability of social networks in this context is very promising because:

- An analogy can be safely drawn between farmers grouped by their specific interest on crops, demographics and their variables to the web communities that also are created as clusters based on specific interest groups and priorities. Web communities have been explained by a number of good research initiatives with the theoretical support of social networks and graph theories.
- Social network theories can give a solid mathematical foundation to the farmer-cluster creation issues that may otherwise be extremely subjective and hence full of potentially contentious issues.

Consequently, in the next section we describe the social network theory basics and then propose a framework for creating framer-clusters using the framework.

## 3. Basics of Social Networks: Networks And Actors

The social network perspective emphasizes multiple levels of analysis. Differences among actors (farmer-members belonging to the same interest groups in the context of this paper) are analysed in terms of

- the constraints and opportunities that arise from how they are embedded in networks;
- the structure and behavior of networks grounded in, and enacted by local interactions among actors.
- duality of individual and structure (Breiger et al 1986)

Despite the simplicity of the ideas and definitions, there are good theoretical reasons (and some empirical evidence) to believe that these basic properties of social networks have very important consequences. For both individuals and for structures, one main question is connections.(Berkowitz 1988) Typically, some actors have lots of connections, and others have fewer. Particularly as populations become larger, not all the possible connections are present -- there are "structural holes." The extent to which individuals are connected to others, and the extent to which the network as a whole is integrated are two sides of the same coin. Differences among individuals in how connected they are can be extremely consequential for understanding their attributes and behavior. More connected populations may be better able to mobilize their resources, and may be better able to bring multiple and diverse perspectives to bear to solve problems. In between the individual and the whole population, there is another level of analysis -- that of "composition."(Breiger et al 1986) Some populations may be composed of individuals who are all pretty much alike in the extent to which they are connected. Other populations may display sharp differences, with small elite of central and highly connected persons, and larger masses of persons with fewer connections. Differences in connections can tell us a good bit about the stratification order of social groups.

Because most individuals are not usually connected directly to most other individuals in a population, it can be quite important to go beyond simply examining the immediate connections of actors, and the overall density of direct connections in populations. The second major (but closely related) set of approaches is concerned with the idea of the distance between actors (or, conversely how close they are to one another). Some actors may be able to reach most other members of the population with little effort. Other actors may have difficulty being heard. If the actors have many non-overlapping connections, the range of one connection is expanded.(Bonacich 1972) If individuals differ in their closeness to other actors, then the possibility of stratification along this dimension arises. Populations as a whole, then, can also differ in how close actors are to other actors, on the average. Such differences may help us to understand diffusion, homogeneity, solidarity, and other differences in macro properties of social groups.

*Issues Related to Size, Density and Degree*

The size of a network is often a very important. Size is critical for the structure of social relations because of the limited resources and capacities that each actor has for building and maintaining ties. As a group gets bigger, the proportion of all of the ties that could (logically) be present -- density -- will fall, and the more likely it is that differentiated and partitioned groups will emerge. Social network methods have a vocabulary for describing connectedness and distance that might, at first, seem rather formal and abstract, based on mathematical theory of graphs.(Barnes 1983,Berkowitz 1978) The precision and rigor of the definitions helps clearer communication about important properties of various social structures and often lead to insights that would not have been possible to infer with less formal approaches.

Properties: Among the various properties of social networks, following are useful in the context of our paper.

*Reachability:* An actor is "reachable" by another if there exists any set of connections by which we can trace from the source to the target actor, regardless of how many others fall between them. If the data are asymmetric or directed, it is possible that actor A can reach actor B, but that actor B cannot reach actor A. With symmetric or undirected data, of course, each pair of actors either is or is not reachable to one another. If some actors in a network cannot reach others, there is the potential of a division of the network. In the Knoke information exchange data set, it turns out that all actors are reachable by all others.

*Reciprocity and Transitivity:* It might be useful, in some cases, to classify the dyadic relationships of each actor and for it's neighborhood. The neighborhood size for each actor is the number of other actors to whom they are adjacent.

The transitivity principle holds that, if A is tied to B, and B is tied to C, then A should be tied to C. The idea, like "balance" and "reciprocity" is that triadic relationships (where here are ties among the actors) should tend toward transitivity as an equilibrium condition. (Davis 1967) A special form of this notion is what is called "balance theory." Balance theory deals specifically with relationships of positive and negative effect. (Doreian 1988) It argues that if A likes B, and B likes C, then A should come to like C. Or, if A likes B and B dislikes C, then A should come to dislike C.

*Distance:* The properties of the network so far primarily deal with adjacencies – the direct connections from one actor to the next. But the way that people are embedded in networks is more complex than this. Regarding how individuals are embedded in networks, one main approach is to examine the distance that an actor is from others. If two actors are adjacent, the distance between them is taken as one. How many actors are at various distances from each actor can be important for understanding the differences among actors in the constraints and opportunities they have as a result of their position. How many ways there are to connect between two actors at a given distance is another interesting observation. The distances among actors in a network may be an important macro-characteristic of the network as a whole. Where distances are great, it may take a long time for information to diffuse across a population. It may also be that some actors are quite unaware of, and influenced by others, even if they are technically reachable, the costs may be too high to conduct exchanges. The variability across the actors in the distances that they have from other actors may be a basis for differentiation and even stratification. Those actors who are closer to more others may be able to exert more power than those who are more distant network as a whole.

*Diameter and Geodesic distance:* One particular definition of the distance between actors in a network is used by most algorithms to define more complex properties of individual's positions and the structure of the network as a whole. This quantity is the geodesic distance. For both directed and undirected data, the geodesic distance is the number of relations in the shortest possible walk from one actor to another. The geodesic distance is widely used in network analysis.(Everett 1982) There may be many connections between two actors in a network.(Flament 1963) The geodesic path (or paths, as there can be more than one) is often the "optimal" or most "efficient" connection between two actors. Many algorithms in network analysis assume that actors will use the geodesic path when alternatives are available. When a network is not fully connected, the geodesic distances among all pairs cannot be exactly defined. The standard approach in such cases is to treat the geodesic distance between unconnected actors as a length greater than that of any real distance in the data. (Holland et al 1977) For each actor, the mean and standard deviation of their geodesic distances could be calculated to describe their closeness to all other actors. For each actor, that actor's largest geodesic distance is called the *eccentricity* -- a measure of how far an actor is from the furthest other.

To get another notion of the size of a network, one thinks about its diameter. The diameter of a network is the largest geodesic distance in the (connected) network. In the current case, no actor is more than three steps from any other very "compact" network. The diameter of a network tells us how "big" it is, in one sense (that is, how many steps are necessary to get from one side of it to the other). The diameter is also a useful quantity in that it can be used to set an upper bound on the lengths of connections that we study. Many researchers limit their explorations of the connections among actors to involve connections that are no longer than the diameter of the network. Sometimes the redundancy of connection is an important feature of a network structure. (Wellman and Berkowitz 1997) If there are many efficient paths connecting two actors, the odds are improved that a signal will get from one to the other. One index of this is a count of the number of geodesic paths between each pair of actors. Of course, if two actors are adjacent, there can only be one such path.

There are other properties of the social network like flow, influence and cohesion. These will particularly apply in studies of power networks or communication systems efficiency in greater detail. In the context of farmer-groups, the properties that have been described are adequate to reflect the farmer-cluster creation process issues.

## 4. Creating A HPT with Social Network Properties

From the above discussion, we are using the social network methods in this context with the following elements:

- The actors <-> individuals
- Framer-clusters <-> a social network of individuals

Networks can have explicit, well-defined purposes which can be formalized. Using the formal graph theory-based social network methods, variances between expected performance criterions of network elements with actual performance parameter values, can be formally measured. (Flament 1963) This in itself can serve as a valuable input for improving performance of farmer-groups.

We have discussed the various dimensions of creating Farmer-clusters in previous sections. Now using assumptions 1 & 2 as mentioned, we develop a conceptual framework to deliver these variables in a more formal way, as shown in Figure 1 below.

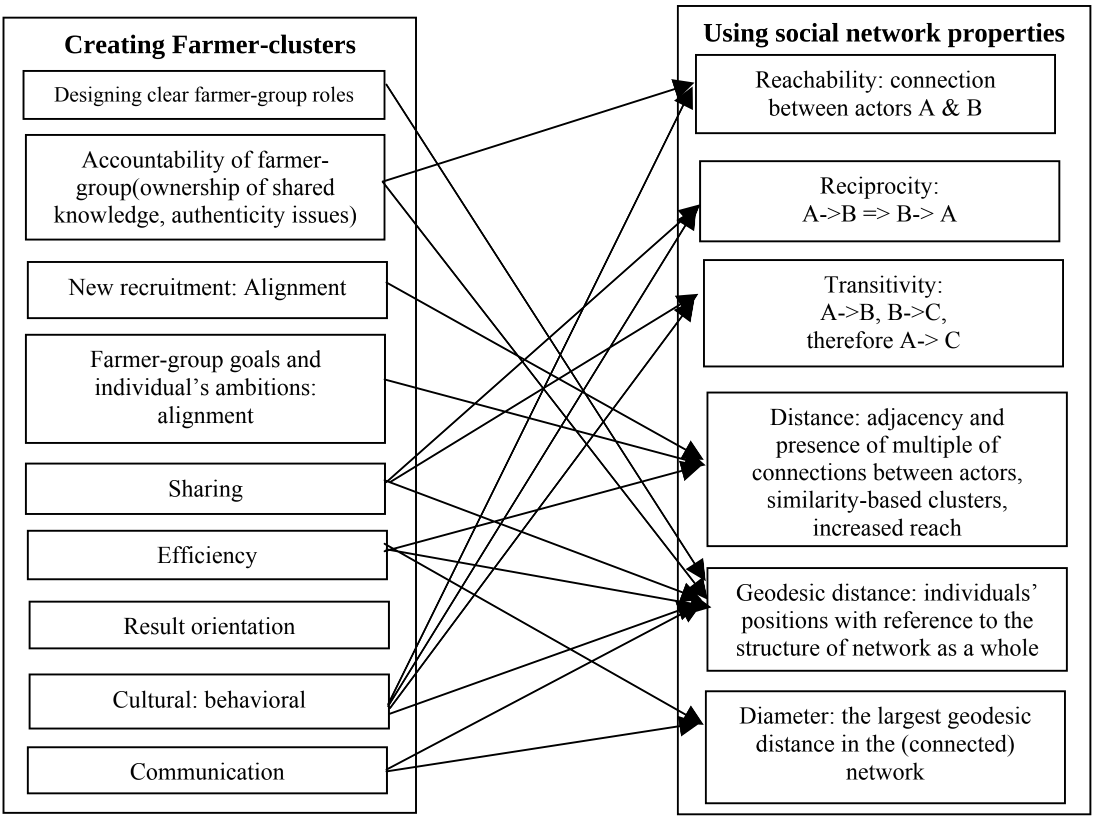


**Figure 1: A Conceptual Framework For Creating Farmer-clusters With Social Network Properties**

The connections between the techniques for creating Farmer-clusters and the social network properties can be understood by the definitions of these properties as mentioned in the previous section. For example,

- Communication depends on the geodesic distance and diameter of farmer-groups which is treated as a social network in the context of this paper. This is explained as follows:

  - The Geodesic distance refers to individuals' positions with reference to the structure of network as a whole. So it reflects the degree of connectivity of a social network in terms of the connections directly or indirectly (i.e. transitively) linking the individuals. These connections are analogous to the communication linkages in farmer-group dynamics.
  - Diameter represents the largest geodesic distance in the (connected) network. So this parameter can directly reflect the communicational effectiveness of the network or farmer-group as a whole.
- Efficiency is related to distance, geodesic distance and diameters, because efficiency in the context of farmer-groups is transitively dependent on communication. And smaller farmer-groups with multiple connections work more efficiently than others.
- Sharing relates to reachability, reciprocity and transitivity in terms of resources i.e. if A has a resource, B has access to it (reachability); and vice versa (reciprocity), and if B gets it and C has a connection to B, then C should also get it (transitivity).

This way, the other connections can be understood with reference to the definitions of the social network properties.

## 5. Conclusion Remarks

The primary advantage of using social network properties in techniques for creating Farmer-clusters lies in one property of these property parameters themselves, which facilities designing, managing and controlling a cluster as a social network, in a more formal and efficient way. That is the formal analytical approach of the social network and ability of these properties to be presented and analyzed in structured forms.

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