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Knowledge networking among actors of the Rahad Agriculture scheme, Sudan

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1 Introduction

1.1 Background of the study

The agricultural sector in Sudan is considered the main contributor to the Sudanese economy in terms of GDP in spite of growing crude oil exports (MUSTAFA 2006; YASSIN 2004).Agriculture contributes about 39% of the GDP and 90% of non-oil exports (CTA 2008).Agriculture is also reflected in activities of other sectors such as the transportation, industry, and commerce sectors.

Agriculture subsectors in Sudan include both traditional and mechanized rain-fed farming; irrigated farming schemes depending on the Nile and its tributaries, livestock, and the forest sector (MUSTAFA 2006).

Irrigated agriculture in Sudan can be identified mainly by a prominence of schemes irrigated by gravity from the Nile and its tributaries, and Sudan is generally considered the largest irrigated area in sub-Saharan Africa (UNEP 2008).These schemes are the Gezira irrigated scheme falling between the Blue Nile and White Nile, which was constructed by the English in 1925 and represents half of Sudan's total irrigated area (UNEP 2008).The other two major schemes are the Rahad irrigated scheme on the bank opposite the Gezira Scheme and the New Halfa scheme on the Atbara River (UNEP 2008)(see figure 1 location of Rahad scheme).A fourth one is the El Suki irrigated scheme, which is in Sennar state and is irrigated by the Blue Nile. Many of these schemes were basically constructed on account of forests or pasture land with the intention of providing additional livelihood for pastorals in addition to achieving macro-economic agriculture production for the country (SALIH 1990; AHMED et al.2012).Irrigated schemes produce mainly cotton, sorghum, groundnuts, and sunflowers. Farming practices in irrigated schemes are more intensified than in rain-fed sectors and include rotational cropping, mechanized land preparation, regular use of improved seeds, fertilizers, pesticides, and herbicides provided by credit institutions (CFSAM 2011).

One of the reasons to establish the Rahad irrigated scheme in Sudan during the 1970s was to shift the sustainable economy based on indigenous agro-pastorals surrounding the area of the scheme to a more intensified cultivation. Agro-pastorals were settled in order to produce cash crops such as cotton, groundnuts, and subsistence produce for sorghum.The Ministry of Agriculture appointed the Rahad Agricultural Corporation to be the responsible institution for

managing the Rahad irrigated scheme, with the exception of irrigation operations and maintenance needs, which are the responsibility of the Irrigation Administration (BENEDICT etal. 1982).

The extension administration within the Ministry of Agriculture is considered the main institution providing extension services; however, irrigated schemes, including the Gezira scheme, Rahad Agriculture Corporation, New Halfa Agriculture Corporation, and Blue Nile Agriculture Corporation, are providing extension services as well (ELTAYEB 2002).

Rahad Agriculture Corporation in the 1970 had adopted the commodity approach, which was first practiced in the Gezira scheme. The commodity approach in Rahad was adopted in order to administer the newly settled nomads with farming activities. Reviewed literature on the commodity approach in the Rahad scheme proved that instruction on agricultural practices resulted in poor feedback from farmers, since they have no way just to adopt agriculture packages (EL HASSAN 2004).Later in the 80s, the World Bank in coordination with Agricultural Research Corporation introduced the Training and Visit (T & V) approach to irrigated schemes in Sudan including the Rahad scheme. Extension services reached farmers through the mechanism of the T & V system, feedback was channeled to research stations for needed recommendations and further research. However, a shortage of facilities limited the T & V approach from continuing in the Rahad Irrigated Scheme.The T & V approach here was followed by Farmers' Field Schools introduced by the Food Agriculture Organization in collaboration with the Agriculture Research Corporation.FFS in the Rahad scheme were characterized by poor attendance and a low number of training sessions (EL HASSAN 2004).In fact, many FFS in irrigated schemes in Sudan did not continue due to a lack of financial support and lack of adequate training for the trainers (ABDEL RAHAMAN 2003).

Extension in the Rahad irrigated scheme returned to perform according to the commodity approach, where extension work is a part of the administrative and managerial work of the scheme personnel (EL HASSAN 2004).

1.2 Research problem

The scientific perspective of diffusing innovations was dominant in the research and development work in agriculture for the third world during the 1950s and 1960s (GERMAN et al. 2006; GLENDINNING 2001). The diffusion of innovation according to this perspective was measured by correlating innovativeness with a number of variables such as the adopter's age, education, farm size income and access to information sources. The study of EL HASSAN (2004), a comparative study of extensional approaches adopted by the Rahad

Agricultural Corporation, is an example. In this study, adoption of designed farm practices by farmers under each extension approach was the factor essential for increasing the farm produce and thus reflects positively on the scheme performance and farmers' income.

However, according to the history of diffusion research, factors such as social networks or communication networks among members of the social system proved to be essential for diffusing innovations (GLENDINNING 2001; ROGERS 2003; GERMAN et al. 2006).Not much research considering this factor has been conducted in the third world (GERMAN et al. 2006). A few exceptions are the studies of CONELY and UDRI (2001), CONELY and UDRI (2005) cited by DARR (2008), RAINI et al. (2005), and DARR (2008). According to the notion of social organization of innovation, innovation is identified as a complex social process that occurs among a variety of actors who search for ideas and information and not only a matter of technology transfer (ENGEL and SOLOMON 1997; NEUMEIER 2012).

DARR (2008) has used many contemporary diffusion research arguments and social network theory (WASSERMANN and FAUST 1994; SCOTT 2000) to study the diffusion of agro-forestery innovations within farmers' groups in East Africa.Diffusion of innovations in the Rahad scheme is understood as the adoption and practice of irrigated agriculture by agro-pastoralists in the scheme area since 1978 (BENEDICT et al.1982; EL HASSAN, 2004). This researcher perceives adoption of irrigated agriculture in the Rahad scheme in the broad sense as a matter of communicating information on farming and livestock keeping.The researcher does not study the historical aspects of diffusion of irrigated agriculture or the factors affecting the adoption as stated in the classical models of innovations (STRANG and SOULE 1998) but rather tries to understand the role of influential actors in the present network of relations within the scheme their structure and communication pattern using arguments of social network theory (ROGERS and KINCAID 1981; VALENTE 1996; WASSERMANN and FAUST.1994; SCOTT 2000; ROGERS 2003). This focus can help one see how knowledge and information is communicated within the present structure of the scheme actors' network. Therefore, the researcher tries to prove that improving the performance of innovation in the Rahad scheme would be possible by improving the networking of the scheme actors's

This study is trying to approve that the Rahad irrigated scheme is a situation of agricultural innovation where different social actors have been communicating to facilitate the innovation. This research tries to understand who different social actors within the Rahad irrigated scheme are, what their roles are, and what their structure and communication patterns are.This research tries to answer these questions by using arguments of knowledge system thinking

and social network theory (RÖLING, 1992; WASSERMANN and FAUST 1994; VALENTE 1996; SCOTT 2000).

Using system thinking and social network analysis can help one see how the knowledge and information in farming and livestock keeping is being communicated within the present network of the scheme. Improving the networking of actors within the scheme would improve the performance of innovation in the Rahad scheme.

1.3 Research objectives

The main objective of our research is to explore knowledge and information networking among actors of the Rahad scheme in order to find out how these actors can improve their knowledge and information networking. Improving these can improve the performance of the scheme's innovation.

The main research objective can be achieved by the following these specific objectives:

- Identify the roles of relevant actors within the Rahad scheme.
- Identify the structure and communication patterns of the Rahad scheme actors.
- Identify how different actors within the Rahad scheme share knowledge on farming and livestock keeping.
- Suggest future strategies to improve knowledge networking among actors in the study area.
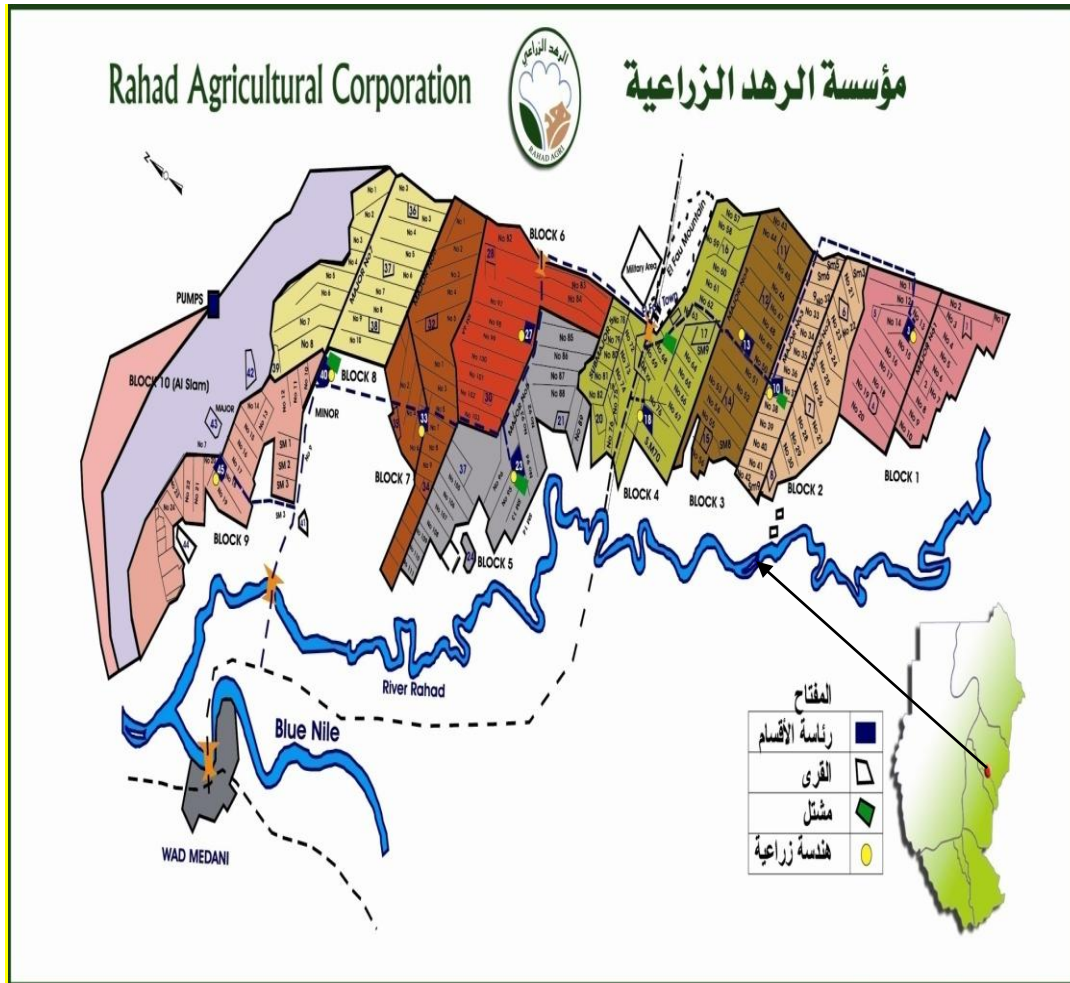
Figure 1: Map of the Rahad scheme, Location of scheme blocks (villages and farms)
Source: Rahad Agricultural Corporation, 2010.

1.4 Structure of the study

This study has eight chapters; Chapter 2 deals with the theoretical concepts on which the researcher depended in order to build her investigations with the study respondents and participants in Rahad Irrigated Scheme in the Sudan. Innovations in social systems are the main thematic concepts looked at in this study. Chapter 3 focuses on facts about the Sudanese agricultural sector, research development, and extension policy in relation to the Rahad scheme situation.Special emphasis has been put on the development and situation of the pastoral sector in Sudan. Chapter 4 is the methodological framework of this research; the researcher used a qualitative approach to conduct RAAKS methods depending on semi-structured interviews, brainstorming, and group discussions. Chapter 5 presents the roles of the Rahad scheme actors in regards to agricultural innovation in the scheme. These actors have been divided into those at the Rahad scheme level who are mainly from government institutions and some officially registered farmers' organizations, and those who live in villages who are mainly local associations and entities in Rahad scheme villages.

Chapter 6 is the main chapter in this study and discusses the network of relations in the Rahad scheme, the structure of this network and the strong and weak connections within it. The chapter presents connections at the village level; missing and weak connections are also discussed. A total network for the Rahad scheme is shown in this chapter and reflections of interviewees were used to decide the connections and relations in this network. The seventh chapter connects the objectives of the study to its results and recommendations.

The eighth chapter discusses recommendations on how to create connections in the Rahad scheme and activate them so more knowledge in the area can be gained.

The eighth chapter of the study also puts forward possible solutions and ideas that can help farmers improve connections and exchange knowledge on farming and livestock keeping within the Rahad scheme in the near and far future.

2 Theoretical review: innovations in the social system

The theoretical background of this study stems from viewing agricultural innovations as theaters of diverse communicating actors or stakeholders (ENGEL 1997). These actors go into different communication networks to seek information and knowledge about the performance of their agricultural innovations (ROGERS and KINCAID 1981; ROGERS 2003; ENGEL 1997). In order to present these perspectives, the researcher discusses basic definition concepts on innovations, and social organizations of innovations. Diffusion of innovation theory and its reflection on social network theory is also discussed on this chapter. The role of Extension in this chapter is discussed as a facilitator for diffusion of innovations.

2. 1 Innovation and social Innovations

ROGERS (2003, 12) defined innovation as idea, practice, object that is perceived new by individuals or the units who adopt the innovations. The newness of the idea for the individual determines his reaction to it. If the idea seems new for the individual then it is an innovation. It is also relevant to know that an innovation can be accepted by a certain community members, while the same innovation can be rejected by other community members.

Parallel to this view, HOFFMANN et al. (2009, 94) think of innovations as new ideas, methods or products that relate to improved problem solving. However, the newness of innovations does not necessarily mean improvement of the current ideas or practices but rather change on status quo. HOFFMANN et al. (2009, 94) also argues some innovations which are perceived new by members of the social system could be old ideas but reintroduced again.

Most studied innovations are technological innovations; technology is defined as means of uncertainty reduction that is made possible by information about the cause- effects on which technology is based (ROGERS 2003, 13). Every technology has a software or information part, and hard ware, a material part. Innovations can also be political philosophy such as Marxism's or religious ideas (ROGERS 2003). Such innovations are difficult to trace or study because it is not clear how they are adopted by members of community (ROGERS 2003).

This implies that innovations have certain characteristics to be adopted; innovations need to have relative advantages, or perceived to be better than the old idea or practice (ROGERS 2003). It needs to be compatible to the social values of the social system if not innovations will not be adopted as rapidly as it is expected (ROGERS 2003). Innovations need to be less complex and easy to understand if members of the social system are to adopt the innovations

more rapidly (ROGERS 2003). Complex ideas are adopted slowly by members of the social system. Finally, innovations that are easily to observe its effects or results are more likely to be adopted by members of the social system (ROGERS 2003).

Since innovations can be social and technical, in this section, the researcher is exploring on social innovations. POLE and VILLE (2008) believe that the notion of social innovations entered discussions within the discipline of social science instantly, but there is no agreement on its relevance or specific meaning. Instead, they developed a working definition for social innovations. In doing so, they categorized business innovations and social innovations. They think business innovation is profit-seeking, meaning it creates new ideas with the intention of making money. In their view, technological innovations and organizational innovations are examples. On the other hand, public goods that aim to improve the quality of human life, for example teaching materials that emerge from universities and other centers of learning, are difficult to treat as business innovations. POLE and VILLE's working definition explains that an innovation is a social innovation if the implied new idea has the potential to improve either the quality or quantity of life. Innovations that aim to improve education or the environment or lengthen life expectancy are examples. ADAMS and HESS (2008) present a more specific definition of social innovations. They argued that social innovations occurs when a new idea or a combination of ideas form a different way of thinking and acting that change existing paradigms. From a theoretical point of view, ADAMS and HESS (2008) think social innovation involves theorizing around three notions: economic innovation, which focuses on how people in business adopt and adapt new ideas; social capital, which is related to personal and collective well-being; and community strengthening practices, which are vital in addressing complex social issues. The most striking definition for social innovation the one was given by NEUMEIER (2012, 53). He stated that *"social innovations occur as a result of collaborative group acting in a network of aligned interests when certain actors decide to enroll in the network."* Social innovations are therefore changes that take place via many interacting identities with different desires that choose to get involved in the change. Furthermore, the definition implies a collective acting nature for social innovations. In the author's view the role of actors networking has been viewed by ENGEL as a result of social organization of innovation that is a complex social process that occurs among a variety of actors who search for ideas and information in order to improve a certain practice or change it (ENGEL and SALOMON 1997). That complex social process is constructed via interplay 'networking' performed by relevant social actors belonging to different social practices in order to improve the socio-natural environment they live in (ENGEL and SALOMON 1997).

In his definition, Engel (1997) overlooks the conflicting ideas or interests in the innovation process; however, he further suggests that negotiations between actors in the long run would harmonize conflicting views (ENGEL 1997). We can conclude that both definitions clearly point out that innovations are settings where information flows among and between different social actors. This flow of information is materialized in certain communication relationships between actors, i.e. networking (ENGEL and SALOMON 1997). Finally, regarding social innovations we need to understand that innovation is not a *technical artifact*, but it appears at the level of the *social practice* of actors (HOWALDT and SCHWARZ 2010), cited by (NEUMEIER 2012,54).

2.2 Adoption of innovation and diffusion of innovations

For individual to adopt an innovation he or she needs knowing about the innovation. Knowing about innovations would create more uncertainty about the technology on the individual's mind. Therefore he or she would seek for more information about the technology. As information seeking activities reduce uncertainty about the innovation a decision process concerning adopting or rejecting the technology can be made (ROGERS 2003). This process takes place through time, and known as the innovation decision making process (ROGERS 2003). It consists of knowledge stage when individuals get information explaining what the innovation about; mass media communication channels are effective on this stage (ROGERS 2003). The persuasion stage; accomplished as individuals or unit of innovations learn more about how the innovation functions (ROGERS 2003). What its advantages and disadvantages of the innovations, usually peer networks or opinion leaders are more effective than mass media in this stage (ROGER S2003). The decision making stage happens as the individual rationale his or her decision about the innovation, it is known that individuals usually would model point of views or experiments gained by those who adopted or did not adopted the innovation (ROGERS 2003). The implementation stage reached when the individuals engage in activities of adopting the innovation or rejecting the innovation (implementing their previous technologies or ideas) (ROGERS 2003). The confirmation stage is the enforcement of the adoption or rejection of the innovation as individuals seek more satisfying information about the innovation. The peer or neighborhood can be good sources of information here (ROGERS 2003). These five steps do not have to happen on that sequence, individuals can implement the innovation without going through persuasion stage or they can reject the innovation after implementation activities (ROGERS 2003). HOFFMANN et al. (2009) discuss the decision process of innovations adoption on line of doping of innovations that

work to solve problems and agrees that this process need not to happen systemically. On their concern the innovator during this decision process is in a risk situation by being the first to adopt and may be shunned in his social system (HOFFMANN et al. 2009, 97). However, after a period of time when others starting adopting the innovations or change their opinions, the diffusion process continues to run throughout the social system (HOFFMANN et al. 2009).

The researcher presents basic concepts of diffusion of innovations adopted from Rogers's model of diffusion of innovation. She elaborates on ROGERS' diffusion model, because interpersonal networks discussed by ROGERS and KINCAID (1981), VALENTE (1996) and ROGERS (2003) are an important focus in this research study.

The diffusion of innovations theory originated within various scientific fields including anthropology, geography, rural sociology, public health, communication, and marketing (GERMAN et al. 2006; DARR 2008).

Diffusion of innovations in literature is largely discussed by Evert Rogers; however, others have also contributed to this field (CANRIGHT et al. 2004; GERMAN et al. 2006; DARR 2008). The famous study of diffusion of hybrid corn in Iowa by RYAN and GROSS (1943) cited by ROGERS (2003) is a clear example where the time of adoption of hybrid corn was investigated in regards to the communication channels, the socioeconomic and cosmopolitan status of individuals adopting the hybrid corn (ROGERS 2003; GERMAN et al. 2006). ALLEN (1982) studied the probability that an agent would adopt a technology dependent upon whether his or her neighbor adopted that technology (CANRIGHT et al. 2004). Building upon ROGERS' diffusion models, BAUDISCH and GRUPP (2006) evaluated the market potential of innovations by constructing a survey for diffusion models. According to their survey, innovations had been identified as products or processes of a new quality, which differed significantly from their preceding states. Diffusion of innovations in their view is a spatial and temporal phenomenon that originates from innovation centers and spreads out to sub-innovation centers that are spatially, functionally, or socially peripheral. CANRIGHT et al. (2004) also agree with this model using network theorizing. CANRIGHT et al. (2004) think that diffusion of innovations happens in two steps, it starts from network centers (mountain tops) and reaches the least central nodes or groups of people.

GOGERS (2003, 5) stated that "*diffusion of innovations is a process in which an innovation is communicated through certain channels over time among the members of a social system.*" Therefore, innovations that are technologies or new ideas are shared during the communication process. The social system where the diffusion of innovations takes place is an important component. It is defined as a set of interrelated units engaged in joint problem

solving to accomplish a common goal (ROGERS 2003). Members of social system are individuals, organizations, informal groups, and subsystems (ROGERS 2003). According to ROGERS (2003), the social system constitutes a boundary within which the innovation diffuses. When studying the diffusion of innovations in social systems, it is important to look at the structure of the social system or to see the patterned arrangements of the units in the system, where they are located, and who talks to whom (ROGERS 2003). Hierarchic positions as in bureaucratic organizations where information flows in one direction from higher ranking positions to lower ones is considered a formal structure. Another type of system structure is the informal structure, which exists in interpersonal networks that link members of the system and show who interacts with whom and in what circumstances (ROGERS 2003). Interpersonal communication networks are interconnected individuals who are linked by a patterned flow of information (ROGERS 2003). The structure of the system affects the diffusion of innovations, and that happens in many ways: the effect of norms in diffusion of innovations, the role of opinion leaders and change agents, the types of innovation decisions, and the consequences of innovations (ROGERS 2003). Opinion leaders are individuals who are frequently able to influence other individuals' attitudes in a desired way (ROGERS 2003). Change agents are individuals who influence clients' innovation decisions in a direction desired by a change agency (ROGERS 2003). Change agents and opinion leaders are connected in the diffusion process, since change agents use opinion leaders to influence individuals in the system to adopt the innovations (ROGERS 2003).

ROGERS argues that there are different types of innovation decisions. There are optional innovation decisions where individuals of the social system are the main units of decision making. Collective innovation decisions happen when a consensus grows among the social systems in relation to the decision about the innovations. A few individuals who have power, status, or technical expertise in the system make authoritative innovation decisions. On the other hand, individuals have little or no influence on the adoption/rejection decision (ROGERS 2003). Rogers argues that faster rates of adoption can be found in cases of authoritative innovation decisions. The established Rahad scheme in Sudan is an example of authoritative innovation decisions, where governmental institutions including the Ministry of Agriculture, universities, and research stations are the main influencers in initiating and establishing the irrigated scheme (GALAL El DIN 1975; BENEDICT et al. 1982; EL HASSAN, 2004). The previous studies such as ROGERS (1962, 1983) cited by GERMAN et al. 2006 and RYAN and GROSS (1943) cited by ROGERS (2003) are attributed to a single research tradition in diffusion of innovations, because the diffusion of innovations has been

traced among individuals in the social system. Others such as GLENDINNING et al. (2001) and STRANG and SOULE (1998) mentioned that in classical diffusion models, knowledge and communication are important factors in adopting innovations, while the innovation, change agents, information sources, and early adopters (ROGERS 1962, 1983), or interpersonal interactions (ROGERS 2003) are significant in decision making regarding the adoption of innovations. STRANG and SOULE (1998) have evolved their criticism of the diffusion model to argue that diffusion of innovations can occur within organizations and social movements. Such diffusion models are called contemporary "macro" diffusion models. In such models, diffusion of innovation is traced through spreading behavioral strategies and changes in the structures of organizations rather than technical innovations. In this way, adoption is emphasized by the social collectiveness within the social system more than by individuals.

Instead of looking at innovativeness and an innovation's characteristics and change agents, in contemporary innovation models, the innovation process is analyzed by looking at historical contexts of the innovations rather than adoption in one snap shot of time. It is also analyzed by seeing the cultural behavior of the social system. In this point STRANG and SOULE (1998) argued that there is self-consciousness obtained by individuals during the adoption process although of the mimic contagion described in the classical innovations models.

In spite of the sound arguments of contemporary diffusion research, the classical model of innovations had been widely used to study diffusion of agricultural innovations in the third world (GERMAN et al. 2006; GLENDINNING et al. 2001).

DARR (2008) has used many contemporary diffusion research arguments and social network theory (WASSERMANN and FAUST 1994; SCOTT 2000) to study the diffusion of agro-National Forest Corporationinnovations within farmer groups in East Africa. Diffusion of innovations in the Rahad scheme is understood as the adoption and practice of irrigated agriculture by agro-pastoralists in the scheme area since 1978 (BENEDICT et al.1982; EL HASSAN, 2004). This researcher perceives adoption of irrigated agriculture in the Rahad scheme in the broad sense as a matter of communicating information on farming and livestock keeping. The researcher does not study the historical aspects of diffusion of irrigated agriculture or the factors affecting the adoption as stated in the classical models of innovations (GERMAN et al. 2006; STRANG and SOULE 1998) but rather tries to understand the role of influential actors in the present network of relations within the scheme: their structure and communication pattern using arguments of social network theory (ROGERS and KINCAID 1981;WASSERMANN and FAUST 1994; VALENTE 1996;

SCOTT 2000; ROGERS 2003). This focus can help one see how knowledge and information is communicated within the present structure of the scheme actors' network. Therefore, the researcher tries to prove that improving the performance of innovation in the Rahad scheme would be possible by improving the networking of actors within the scheme.

2.3 Knowledge and connection to innovations

Diffusion of innovations has been conceptualized as a process of communicating information and knowledge (ROGERS and KINCAID 1981; GLENDINNING et al. 2001; ROGERS 2003; GERMAN et al. 2006). There can be different approaches to gaining knowledge of agricultural innovations (GERMAN et al. 2006). Researchers can be positivists or constructivists when researching knowledge; according to RÖLING (1996), people become positivists about knowledge when they think it is detached or independent from human minds and can be questioned using different quantitative research methods. The constructivist researchers would think reality is socially constructed or understood differently by people (CHAMBERS et al. 1992) cited by (GERMAN et al. 2006). Therefore, researchers using this perspective would have to recognize the context of research as a complex system and would need to integrate the different understandings held by people (GERMAN et al. 2006).

However, knowledge and information are interconnected; explaining knowledge is not possible without talking about information (LEEWUIS 2004; HOFFMANN et al. 2009). Therefore it is important to give definition concepts on both information and knowledge in order to link them to innovations.

LEEUWIS (2004,) defined information as interpreted data or a tangible form of knowledge, more abstractly; information is defined as "*a difference in a matter energy which effects uncertainty in a situation where a choice exists among many sets of alternatives*" (ROGERS and KINCAID 1981, 48). HOFFMANN et al. (2009) mentioned that information consists of data, and data are signs that need to be analyzed. Therefore, data can be in the form of reading and writing as well as in the form of digital and electrical devices (ROGERS and KINCAID 1981; LEEWUIS 2004; HOFFMAN et al.2009).

RÖLING (1996) described knowledge as a property of the human mind; it cannot be seen between the ears. On the other hand, LEEUWIS (2004, 94) took an approach of describing concepts related to knowledge rather than describing knowledge itself. According to him, *"knowledge can perhaps be most easily understood as a collection of interconnected schemes of interpretation."* These schemes are available to humans and can be mobilized to give meaning to particular situations. By collecting schemes of interpretations, human can develop

a sophisticated understanding of a situation. In this definition, knowledge is related to meanings, interpretations, and perceptions. LEEUWIS (2004) thinks perceptions indicating knowledge are closely intertwined with information; meanings that inform about a particular state of affairs constitute information. Therefore, information according to LEEUWIS' concept is a tangible form of knowledge. However, HOFFMANN et al. (2009) think information (the processed data) links knowledge with action in a process of knowledge management. To explain this process, HOFFMANN et al. (2009) converted knowledge between implicit and explicit forms (NANOKA and TAKEUCHI 1997) cited by HOFFMANN et al. 2009). Implicit knowledge is gained by experience and difficult to explain. If knowledge is available in an explicit form, acquiring it means internalizing or making it implicit. In order to acquire implicit knowledge, it has to be socialized and made explicit to others. Therefore, according to HOFFMANN et al. (2009), knowledge is managed by internalizing information through learning and externalizing knowledge by teaching or socializing. From this connection of knowledge to action, humans learn the interaction of implicit and explicit knowledge. This researcher believes that in order to understand agricultural innovations in the Rahad scheme, one must recognize and integrate the different perspectives and understandings of the diverse actors within the scheme (ENGEL 1997; ROGERS 2003; GERMAN et al. 2006). Understanding the interaction or synergy of knowledge held by different actors hopefully improves the performance of agricultural innovations in the Rahad scheme. The detailed techniques or methods used for this purpose were to study the social network of scheme actors in communicating information on farming and livestock keeping.

2.4 Extension and the relation to diffusion of innovations

The term extension originated from academia in Britain around 1840 and means extension of the university. In the 1880s, the notion became a movement that university extension went beyond the university campus. Similarly in the United States, the term extension education emerged in the 1900s to indicate that university teaching is not only directed at students but also at communities surrounding the universities (LEEUWIS 2004).

Different nations used different terms for extension; the British and the Germans talked of advisory work or *Beratung*; both connote an expert giving advice but leaving the final responsibility for selecting the way forward with the client (LEEUWIS 2004).

Based on the preliminary concepts, the definition of extension had a dimension of education. It was assumed that the masses are living in the dark and that there is a need for well-educated

people to shed some light on their situation by means of educational activities. The extension agent took the role of sending messengers (teachers), and their audiences are in a receiving or listening role (students) (LEEUWIS 2004).

Accordingly, the definition of *Extension* is *"a service or system that assists farm people through educational procedures in improving farming methods and techniques, increasing production efficiency and income, bettering their living conditions, and lifting social and educational standards"* (MANUDER 1973, cited by LEEUWIS, 2004, 23).

The definition indicates there is an enlightenment role for extension, because extensions were expected to educate farmers on scientific innovations that would improve their income and standard of living. According to HOFFMANN et al. (2009), the aforementioned definition of extension included the production technology approach of extension during decades of scientific innovations, when science was viewed as a main drawing factor for agricultural evolution in the 1960s and 1970s see also (GLENDINNING et al. 2001; GERMAN et al. 2006). However, the definition of extension had changed to include an interventional nature of extension work conducted by a source or agency that aims to influence people on a particular manner in line with certain policy (LEEUWIS 2004). On the other hand, HOFFMANN et al. (2009) argue that extension is a wider concept and compatible with a range of other activities. However, it is essential to consider extension work as based on the situation and needs of clients. According to this argument, HOFFMAN et al. (2009) think extension is advisory work that helps others solve their problems and improve their situation through purposive action. The advisory work of extension includes both value schemes based on the humanities and practical considerations (HOFFMAN et al. 2009). By this definition, extension becomes less restrictive, including activities compatible with advisory work such as training and teaching, coaching, group facilitation, and conflict mediation (HOFFMAN et al. 2009). Extension can also means disseminating information on public interests such as environmental protection and animal welfare (HOFFMAN et al. 2009). This advisory nature of extension produces a problem-solving approach to extension (HOFFMAN et al. 2009). According to this approach, advice to farmers is tailor-made for their problem situations. An example is the client group orientation approach (HOFFMAN et al. 2009). Farmers or client groups actively participate with extension agencies in the planning, implementation, and evaluation of extension in a client group participation program (HOFFMAN et al. 2009).

Building on Rogers' models of diffusion of innovations (HOFFMANN et al. 2009), the advisory work of extension would be to work on ideas or methods that relate to improved problem solving. This means extension works to promote innovations. However, these

innovations do not need to be new or better than old practices, but innovations in the context of the defined advisory work of extension are changes in the clients' status quo (HOFFMANN et al. 2009). These changes are subjectively considered better solutions to problems (HOFFMANN et al, 2009).

HOFFMANN et al. (2009) mentioned that linking diffusion of innovation with extension work started in the United States by studying the effect of the American Agriculture Extension Service in 1920s. Numbers of farmers who adopted recommended innovations were considered as indicator of the efficiency of the extension work.

On the other hand, many scholars such as RÖLING and & WAGEMAKERS (1998) VAN WOERKUM et al. (1999), and ISON and RUSSEL (2000) cited by LEEUWIS (2004) are abandoning the term extension to reflect a shift in the role of extension from a focus on individual behavior to incorporating the idea that extension fosters new patterns of coordination among clients (LEEUWIS 2004). For example, Communication and Innovation Studies was suggested by VAN WOERKUM and RÖLING as a new name for the Extension Department in Wageningen University (LEEUWIS 2004).

In the view of these changes in definition, the term extension can be defined as a *series of embedded communicative interventions that are meant among others to develop and/or induce innovations that supposedly help resolve a usually multi-actor problematic situation* (LEEUWIS 2004).

Others such as CRISTOVAO et al. (2012) argue that in innovation settings, the role of extension can be understood as an innovation intermediary, which means an organization or body that acts as an agent or broker in any aspect of the innovation process between two or more parties HOWELLS (2006) cited by CRISTOVAO et al. (2012).

HAGA (2009) cited by (CRISTOVAO et al. 2012), argues for different systemic intermediaries in networks; facilitators can act as points of passage to external actors outside the network, bringing in experience and expertise. Facilitators can also build internal network resources and structures where the networks are governed and processed. This type of intermediary is mainly found in industrial literature. The reviewed literature proves that the concept is still theoretically fragmented (CRISTOVAO et al. 2012). Therefore, other scholars argue for a more detailed role of extension in innovations as innovation brokers (CRISTOVAO et al. 2012). An innovation broker is a type of boundary organization that specializes in brokering or facilitating the innovation process when it involves other parties (DEVAUX et al. (2010), cited by CRISTOVAO et al. 2012). KLERKX and LEEUWIS (2008a, b, 2009) cited by CRISTOVAO et al. 2012) argue that an innovation broker functions

to demand articulation, network formation, and innovation process management. Accordingly, this researcher articulates the role of extension in the Rahad scheme as an innovation broker.

2.5 Social Organization of Innovation

According to the notion of social organization of innovation, innovation is identified as a complex social process that occurs among a variety of actors who search for ideas and information and is not only a matter of technology transfer (ENGEL and SOLOMON 1997; NEUMEIER, 2012). In other words, the way in which actors organize themselves in order to carry out the search for ideas and information and achieve the aim of the innovation is the social organization of innovation (ENGEL and SOLOMON, 1997).

Along this line, innovations are understood as packages of new social and technical arrangements and practices that imply new forms of coordination within a network of interrelated actors (LEEUWIS 2004). Actors in the innovation process are individuals and/or organizations that could be sources and users of relevant knowledge (ENGEL 1997). Knowledge should be as relevant as its acquisition, and use of the knowledge should be bound to the purpose, context, and time. The results of that networking among social actors are convergences, which happen when actors confine themselves to certain alternatives relevant to the innovation (defining problems and solutions similarly). However, in reality different thoughts may coexist among actors. Resource coalitions also happen in innovation theaters as the actors' pool their resources together for a joint performance. Some actors may play leading roles; however, coordination problems may occur. Actors develop a communication network among and between themselves as they decide to make use of various sources of information (newspapers, journals, extension information, and so forth) or to exchange ideas, experiences, knowledge, and information among themselves. Consequently, certain communication practices may be adopted, and a range of communication media may exist. Informal channels of communication should be considered; communication networks among farmers, especially women farmers are quite important for studying innovation (SALOMON and ENGEL 1997; see also Rogers 2003).

Bringing aspects of technical or natural arrangements of the innovations with its social organizational arrangements is described by LEEUWIS (2004) as the evolutionary process of building effective linkages and networks in innovation processes or alignment (Rip, 1995, cited by LEEUWIS 2004).

An emergence of convergences, resource coalitions, and communication networks within a certain innovation is led by networking (ENGEL 1997). LEEUWIS (2004) discussed

networks or networking changes in the course of the innovation process. In early stages in network building, it is important to mobilize creativity, establishing linkages with outsiders or widening the network size, see also GRANOVETTER (1973, 1983) and ROGERS (2003). In later stages of network building, it is important to consolidate specific linkages and build on effective support networks, creating strong ties. However, KREBS and HOLLY (2004) think that in order to improve the performance of innovations, one must knit together the network of relations among actors. Furthermore, they defined specific stages of network building among actors of the innovations. These stages start from assembling a scattered networking of relations within the actors into hub-spoke model to building a multi-hub network that can later evolve into a core periphery network upon which actors can extend their linkages to outside sources of knowledge and information.

How social networks influence the diffusion of innovations

In this section we review how interpersonal communication or social networks lead or drive the diffusion process (VALENTE 1995, 1996; ROGERS 2003). Social networks are known to be the pattern of friendships, advice, and communication or support that exists among the members of the social system (KNOCK and KUKLINISKI 1982; BURT and MINOR 1983; WELLMANN 1988; SCOTT 1991) cited by (VALENTE 1996). The initial approach to studying the effects of social networks in diffusion of innovations was to count the number of times an individual was nominated as a network partner and to correlate this variable with innovativeness (VALENTE 1996). Individuals with the highest number of nominations (opinion leaders) were theorized to have a significant influence on the rate of adoption (VALENTE 1996). Then a more structured approach was developed by GRANOVETTER (1973), who suggested that weak ties or people who are loosely connected to the network are important for diffusing innovations within subgroups in the social system. BURT (1987) discussed that structural equivalence, which means equality of connections of people or groups within the networks, influences the adoption of innovations. BURT (1987) also discussed the effect of social network measurements such as centrality, density, and reciprocity on the diffusion of innovations. VALENTE (1996) developed his model of social network thresholds assuming that people or groups would engage in a behavior or collective behaviors based on the proportion of others already engaged in that behavior. The threshold model provides a means to determine which type of network influences lead to adoption of innovations (VALENTE 1996). Accordingly, people with low thresholds would engage in collective behavior before many others would, while individuals with high thresholds would

do so only after most of the groups had already engaged in the collective behavior (VALENTE 1996) and had an effect on the diffusion of innovations.

STRANG and SOULE (1998) also argue that cohesion ties within organizations are influential in the diffusion of innovations. Much exchange of information, motivations, and effects of diffusing practices take place between cohesion and strong connected organizations, which can lead to powerful pressure for conformity and collective actions within those organizations. On the other hand, STRANG and SOULE (1998) added that the effect of weak ties between individuals is the same within organizations and social movements. For example, weak ties between companies can help managers determine which other companies had adopted certain technologies or organizational structures. They also mentioned that collective actions such as protesting could diffuse through weak ties (STRANG and SOULE 1998). According to ROGERS (2003), units in the social system can be homophilous or heterophilous; homophily is the degree to which two or more individuals in a system talk with others who are similar to them, while heterophily is the degree to which individuals who differ in socioeconomic status, ethnicity, and the like communicate with each other.

Similar units in the system would tend to circulate the information among them. Moreover, it is argued that new ideas usually enter through members with a higher status or who are more innovative in the system (ROGERS 2003). However, homophilous interaction causes ideas to be trapped in a horizontal direction rather than vertical, which can slow down the rate of diffusion in the social system (ROGERS 2003). Heterophilous networks often connect two groups that contain two sets of socially dissimilar individuals in a system (ROGERS 2003). Heterophilous networks are called bridges by GRANOVETTER (1973) and are important in conveying information about innovations (ROGERS 2003).

In heterophilous communication, information is communicated among a wider range of units in the system. Therefore, it is believed that diffusion can occur only through communication links that are at least somewhat heterophilous. This type of interpersonal communication has been described by GRANOVETTER (1973) as the strength of weak ties (GRANOVETTER 1973, 1983; ROGERS 2003).

Theoretically, networks in innovations have been categorized into many groups, which can help one study them in empirical research. MICHEL (1969) cited by CONWAY and STEWARD 1998) argued that researchers need to define a total network of society. This total network is defined as the general ever-ramifying, ever-reticulating set of linkages that stretch within and beyond the confines of any community or organization. In order to study this total network, the researcher needs to select a particular aspect of the total network or make an

abstraction out of this network (SCOTT 1991 cited by CONWAY and STEWARD 1998). In doing so, there should be rules of inclusion for actors in the network (LAUMAN 1983 cited by CONWAY and STEWARD 1998). This rule of inclusion would depend on attributes or characteristics of actors; in this case, the network would be called attribute networks or continuous (CONWAYand STEWARD 1998; BORGATTI 2009). Inclusion can also depend on actors' participation in some specified types of social exchange where the network would be a transaction network or discrete (CONWAY and STEWARD 1998; BORGATTI 2009). A third categorizing of networks is based on social relations or kinships among actors in the network; in this case, the network is called action set network or continuous (CONWAY and STEWARD 1998; BORGATTI 2009). This categorizing is made for linkages among individuals or single actors in the networks (CONWAY and STEWARD 1998; BORGATTI 2009). However, linkages among populations of actors (groups, organizations) in the network are also categorized. The researcher would define types of friendships or joint ventures between actors in the populations or take a socio-centered approach in defining linkages among populations of actors. Setting boundaries to the analysis of social networks is also important when conducting research focused on social networks (CONWAY and STEWARD 1998) LAUMAN et al. (1983) cited by CONWAY and STEWARD (1998) argue that there are two ways to set boundary analysis; either the researcher can define the boundary of analysis on his own or according to research objectives and focus using a nominal approach, or the boundary can be defined by the actors within the studied network using a realist approach. The researcher of this study has categorized linkages among actors of the Rahad scheme using socio centric approach, and considered actors of the Rahad scheme as organizations and groups. Boundaries for analyzing social networks in the Rahad scheme had been defined by the researcher choosing nominal approach, focusing in which actors are involved in irrigated agriculture in the Rahad scheme.

2.6 Social network analysis

ROGERS (1983) and BEAL and BOHLEN (1955) cited by VALENTE (1995) had earlier stressed that diffusion of innovations is a communication process, because innovation is communicated through certain channels over time among members of a social system. The time factor is essential in these types of innovation models; innovativeness (output of innovations) is correlated by the time of adoption with the level of education, level of income, cosmopolitan status, and contact with change agents (VALENTE 1995). The role of actors

and their interactions in the settings of innovations had been neglected in those linear models (VALENTE 1995; SPIELMAN et al. 2010).

Rural sociological research has developed this classic model of innovation diffusion to other subsets of diffusion known as network models of innovations (VALENTE 1995). According to VALENTE (1995), the network is a pattern of relations that could connect members of social systems; friendship, advice, communication, or supports existing between members are examples.

Therefore, diffusion research employing a network perspective (LIU et al. 2005) stems from viewing the structure of the relations among members of the social system as a factor that shapes or constrains the spread of new ideas and practices in the social systems (BURT 1987, cited by LIU et al. 2005).

Thus network models explain innovation diffusion in accordance with the structure of the social system and the communication pattern (who talks to whom) in the social networks (VALENTE 1995). These models are also used to decide the flow of personal influence (who influences whom) (VALENTE 1995).

Therefore, the relations of a given actor or actors in the network (leadership model) (COLMAN et al. 1966) cited by (LIU et al. 2005) or relations and positions of all actors in the network structural models (BURT 1987) cited by (LIU et al. 2005) can influence the adoption of innovation.

Considering the social network structure as a factor influencing the diffusion of innovations, means that this diffusion can be searched as a relational context in addition to time influence. Researchers believe as FREEMAN(1984) cited by TRAPPMANN et al. (2011) and argue that social network analysis would study how the social structure within the innovation contexts emerged, how it evolved, and how the structure of relations exhibit consequences for behavior. Using social networks as a dimension to study innovations is a way to explain complexities in the innovation processes, which leaner models failed to explain (i.e. heterogeneity of actors and their relations) (SPIELMAN et al. 2010). The approach that was developed by (GRANOVETTER 1973) is called the strength of weak ties, where he suggested that weak ties, or people who are loosely connected to the network, are important for diffusing innovations. This has been the focus when inquiring about network relations between the actors in this research. In the following part, the researcher explores the concepts of the strength of weak ties.

GRANOVETTER (1983) argued that individuals with few links with others will be deprived of information coming from distant parts of the social system and will be confined to the

views and ideas of their close friends. This deprivation of information will put individuals in a disadvantageous position in the labor market where new ideas are spread unless these few ties become activated through a contact with another individual (GRANOVETTER 1983). For example, contact with an old friend or acquaintance telling news about a job will let the individual know the information at the right time, and he might get the job. This contact was not made by the closer friends of that person but by a rather far-reaching one (GRANOVETTER 1983).

GRANOVETTER (1973) argued that strength of ties between two or more individuals is understood as the linear combination of the amount of time, emotional intensity, intimacy, and reciprocal services that characterize the ties. Accordingly, the weakness or absence of ties would be the opposite of these categories (GRANOVETTER 1973). Negative ties that connect actors with imbalanced powers were not included in the aforementioned categories (GRANOVETTER 1973).

The source of weak ties in societies is basically related to the division of labor, because specialization of roles in societies will make individuals knows small segments of each other's personality (GRANOVETTER 1983). The reviewed literature proved that weak ties have impacts on individuals, the spread of new ideas or innovations, and finally on the cohesion of complex social systems (GRANOVETTER 1983).

The effect of weak ties on the diffusion of innovation was studied by ROGERS (1979), and ROGERS and KINCAID (1981) in their analysis of diffusion of family planning method in Korean villages (GRANOVETTER 1983).

The effect of weak ties in diffusion of innovation is mainly on their ability to reach out to groups with ideas and information different from one's own (GRANOVETTER 1983).

This effect, described by ROGERS (2003) as heterophilous links of low proximity, while rare, plays a crucial role in the flow of information about an innovation (ROGERS 2003).

The effect of weak ties is not only on diffusion of innovations, but it affects any ideas or information (GRANOVETTER 1983). Proof for that is in the study of diffusion of information among subcultures such as youth cultures by FINE and KLEIMAN (1979) cited by (GRANOVETTER 1983). They argued that although mass media can lead to widespread knowledge in societies, the extent of information spread is not linked with the use of mass media (GRANOVETTER 1983). For example youth cultures are not only communicated via controlled media but also with dirty jokes, sexual stories, aggressive humor, and more (GRANOVETTER 1983). Following this logic it is hypothesized that the diffusion of cultural ideas and symbols through communities takes place by a medium of weak ties

(GRANOVETTER1983). It is then argued that weak ties in the diffusion of innovation can lead to homogenization of societies, since ideas can penetrate through other groups who are weakly connected to the cohesive ones (GRANOVETTER 1983). However, the contents and motives of individuals for adopting certain ideas rather than others play a role in this context (GRANOVETTER 1983).

Weak ties in innovation settings can be found in the form of bridges and local bridges (GRANOVETTER 1983). A bridge is a line in the network that provides the only path between two points (GRANOVETTER 1973). Another definition for the bridge is an edge joining two nodes A and B in a graph. If one deletes this edge, A and B will fall into different components of ties (EASLEY and KLEINBERG 2010). The edge will be a local bridge in a graph if its endpoints A and B do not have tie (friend) in common (EASLEY and KLEINBERG 2010). Thus local bridges link unconnected segment of a network, which means a local bridge will tend to be maintained over time (GRANOVETTER 1983).

WEIMANN (1980), cited by (GRANOVETTER 1983) studying the social interactions in a Jewish kibbutz found that weak ties can be bridges over which innovations cross the boundaries of the social system. The strong ties in the network of each group control this process.

Weak ties in innovations settings are also found in the form of intergroup connections; persons who are members of different groups at the same time can convey information from one group to another (GRANOVETTER 1983).

Weak ties in innovations are relatively free from transitivity and less structured, and that enables them to perform the role of bridging separate cliques of subgroups carrying information to the entire network segment (GRANOVETTER 1973; GRANOVETTER 1983; EASLEY and KLEINBERG 2010). Therefore, any social system lacking weak ties will be fragmented and incoherent; new ideas will spread slowly (GRANOVETTER 1983).

On other hand, strong ties are also important in the diffusion of innovations (GRANOVETTER 1983). The stronger the tie between two individuals, the larger the proportion of people to which they are both tied (GRANOVETTER 1973). It is also argued that the speed of information flow and the credibility of information are greater through strong ties (GRANOVETTER 1983).

3 Sudanese agriculture development and extension in relation to the Rahad scheme

The researcher in this chapter is giving an introductory background to the geographical and political system of Sudan. Agricultural research and extension policies in Sudan are reviewed; moreover, information on farmers' and women's organizations is presented. Finally, a massive background on the Rahad irrigated scheme is explained. It is necessary to present such a theoretical background because planning of agricultural innovations, especially irrigated schemes in Sudan, was basically decided by the government, where the synergy between research and extension was mostly controlled by them and played a role in the performance of these schemes. This researcher found it useful to present the trends of pastoral development and livestock research in Sudan. Reviewing pastoral development is important in order to reflect the position of the pastoral sector from these innovations decided upon by the government.

3.1 Facts about Sudan

3.1.1 South Sudan separation

The comprehensive peace agreement signed between the government of Sudan and the South Sudan Liberation Movement in 2005 ended a 50-year civil war and embodied a self-determination referendum for southern people (GAFFAR 2011). The referendum in January 2011 resulted in a majority of southern citizens voting for separation from the Republic of Sudan (GAFFAR 2011). Accordingly, in July 2011 the Republic of Southern Sudan was announced and became the 143rd member of United Nations (GAFFAR 2011) (see figures 2 and 3 which present the tow republics).

Figure 2: Map of the Republic of Sudan
Source: Gaffar, 2011

Figure 3: Map of the Republic of South Sudan
Source: Gaffar, 2011

3.1.2 Geographical location, resources and political system of the Republic of Sudan

Sudan is 1.09 million square miles and became the third-largest African country after the separation of South Sudan in July 2011. Sudan is in the northeast of Africa and is one of the Horn of Africa countries. Sudan is dominated by the Nile and it is tributaries, which are considered the main salient geographical features of Sudan (GAFFAR 2011). The River Nile crosses the country from the south to the north and comprises the Blue Nile and White Nile as the main branches. The White Nile's source is in the equatorial lakes, and the Blue Nile stems from the Ethiopian highlands; the two rivers unite in Khartoum to form the River Nile (GAFFAR 2011).

Sudan has over 800 km of coastline along its northeast boarder, providing access to the Red Sea. Sudan has different climatic zones that range from arid desert in the north to semi-desert and savannah in the center and south. Summer is from March-July and coincides with the rainy season with a temperate that can reach 45 degrees Celsius during the day (GAFFAR 2011). The winter months are from November to January, where temperatures can reach 15 degrees Celsius during the day. Sudan is generally a flat country with mountains in the east where the Red Sea hills are, and in the west there is the Jebbel Marra Mountain (GAFFAR 2011). Sandy soil covers about 60% of country area mainly in the northern, northwest and northeast parts. Heavy cracking clay soils form a triangle in the central east plain of Sudan (GAFFAR 2011).

The population of Sudan is 35 million according to the 2011 census. 70% of the population is Arabs and 30% are Fur, Beja, Nuba, and Fullani. Around 70% of the Sudanese population live in rural areas and depend on livestock, farming, and forests (GAFFAR 2011).

The agricultural sector is the main source of livelihood in the country; it provides employment for 80% of population. Major agricultural exports are cotton, sesame, gum Arabic, and livestock (CTA 2008). The industry sector in Sudan depends on agricultural rural materials (CTA 2008). Industries in Sudan include ginning, spinning, and textiles, sugar, oil, flour, mill, milk canning, and timber sawing. The industrial sector accounts for 17% of the GDP (CTA 2008).

Sudan is a presidential federal and multi-party republic (CTA 2008). The political system is a multi-tiered government with clearly demarcated levels: federal, state, and local (CTA 2008). Sudan was divided into 25 states (ten of them now form the Republic of South Sudan) (CTA 2008). Each state has a Wali (ruler) and cabinet of 5-7 ministries; commissioners administer localities (CTA 2008). The federal government is responsible for policy-making, planning, and supervision (CTA 2008). The state government is responsible for policy-making, planning, and implementation, while localities are concerned with service delivery (CTA 2008).

3.1.3 Evolution and changes of local authorities, and resource management

Sudan originally was a country consisting of many tribes, which are social units organized by groups of traditions and customs (ALNAEM 2010). The traditions and customs of tribes sometimes agree or disagree with the traditions of neighboring tribes, and that is how the external relations and interactions of a tribe are formed (ALNAEM 2010). Every tribe has a homeland or *dar* of its own, over which the tribe claims access to land, water, and pasture,

etc. (EL SAMMANI and SALIH 2006). This type of organization in Sudan was known as the *Ashair* time; tribes had Sheikhs who ruled or controlled members of tribe with a consensus formed by the harmonies of unwritten customs and traditions or *al aurf* (ALNAEM 2010).

This system is considered common property regimes in natural resources. In sush systems usage of land, water, and pastures is managed and regulated by local institutions such as the tribes and their social relations (KIRK 1993). This type of management was nesesatiy on marginal sites as pasture land where mobility and extensiove mode of protection charectrized livestock keeping (KIRK 1993). In central Butana for example Shukria tribe had the right to exploit pasturesince the tribe had property rights to wells, however, other tribes were allowed access to pasture through kinships and leanages with Shukria tribe (ABU SIN and SOLIEMAN, 1995; KIRK 1993). KIRK (1993) have described common property regimes in Sudan as an institution that showed the specific social relations between the owner of the rights and other actors in regard to the pasture and water resources. However, the rights to resources had also involved social mechanisms of formal rules (contracts between ethnic groups) and informal constriants between tribes such as sanctions over misuses and quotas for numbers of animals getting a pasture(KIRK 1993). Common property regime was a flexible system since it is sentenced to the locality and has the capacity to adjust to changes; there was a great control in imposing sanctions.Moreover, adjustments were not implemented rapidly(KIRK 1993).

The Anglo-Egyptian era (1898-1956) considered the *Ashair* system or common property rights to be a cheap tool to rule and control the massive land of Sudan and renamed the system the native administration (KIRK 1993; ALNAEM 2010; SAAD 2010). The native admnistration according to (KIRK 1993, 56), is endorsement of informal rules and constraints and the further development of formal rules with a view to a peaceful adjustments of interests through contracts,

In the native administration, the traditional land tenure inistitutions were retained and actively supported, meaning that each tribe was assigned a Nazir, the highest authority in the tribe, an Omda, the second authority in the tribe who represented the Nazir in remote areas, and sheikh, the third authority in the tribe and the smallest representative of tribal authority in the villages or residential areas (KIRK 1993; ALNAEM 2010; SAAD 2010). This diagram was almost the same in all tribes with some differences in names that varied from one ethnic group to another (ALNAEM 2010; SAAD 2010). Authority given to tribes according to legislation of the native administration was judiciary authority, mainly for the Nazir, to resolve disputes among tribal members such as land claims, thefts, and sometimes killing (ALNAEM 2010;

SAAD 2010). Tax estimation and collection was handled by sheikhs and Omdas, who handed the taxes to the authority's representative (inspector of the locality's council) (ALNAEM 2010; SAAD 2010). They also organized the movement of pastorals in common pastures. According to KIRK (1993) the autohirites (from the nazir to the local sheikhs) acted as trustees of common property who carried out allocation, management and control fuctions within the group.

Generally it can be concluded that communal land tenure institutions were retained by colonial in their neccessaty form and further developed (KIRK 1993). However colonial government had supported a state ownership claim to communal land for cases where individual or common property could not be substantiated by official registrations or other legal authorities (KIRK 1993). This claim was known as the land settlement and registration ordinance 1925 which could be the first step to a degeneration process of common property regimes to open access in the Sudan (KIRK 1993).

Unclaimed lands were considered a crown land by colonial and later after independence was a national land. By this legislations tribes or different groups are formally had the rights to use the land (KIRK 1993). On another step large scale mechanization and irrigated projects have enforced adjustment capacities on local institutions for altering areas of grazing and numbers of livestocks (KIRK 1993). The final step of changing commom property regimes in Sudan to open access is the total abolishing of local laws (native administration) when pasture was declared as unaccupaid and open grazing land (KIRK 1993).

Other authors such as ALNAEM (2010) and SAAD (2010) are viewing abolishing of native administration in 1971 as an evolution of Sudanese nationality and Western democratic concepts. They argued a number of educated and enlightened people started criticizing some of the negative aspects of native administrations (the benefits of some social services were centered on the leaders' kin); they demanded reconsideration and solutions to the native administration (ALNAEM 2010; SAAD 2010). Since the authority of local groups was termininated and no appropriate obligations were imposed upon users, the situation created an open access to resources; example is the rapid exploiting for pastures to fatten animals (KIRK 1993).

Crimes including thefts and land intrusions were difficult to control by the alternatives of native administration (ALNAEM 2010; SAAD 2010). After three decates of open asscess resources' utilizations, the authorities started to establish legal principles with a concern to strengthen traditional authorities' including Butana area (KIRK 1993). The Salvation government accepted the native administration as a legitimate organization of Sudanese

society that had helped maintain stability in the country for ages and worked to develop the legislation of the native administration made by the former democratic government (ALNAEM 2010; SAAD 2010). However, there were some challenges faced by the return of the native administration; the level of education and social interaction of people in some areas of Sudan made it difficult to accept much of the authority or the regulations given to local leaders (ALNAEM 2010). Specifically, local leaders in central and northern Sudan were not recognized as governors who possessed administrative and security powers (ALNAEM 2010). Local leaders, many of whom were now sons of formal leaders, needed training and capacity building in order to adjust to the social, economic, and political environment where they perform their roles (ALNAEM 2010).

3.2 Agriculture in Sudan

The agricultural sector in Sudan is considered the main contributor to Sudanese economy in terms of GDP in spite of growing crude oil exports (MUSTAFA 2006; YASSIN 2004). Agriculture contributes about 39% of the GDP and 90% of non-oil exports (CTA 2008). Agriculture is also reflected in the activities of other sectors such as transportation, industry, and commerce. Agriculture and related activities provide 80% of the labor force in Sudan (MUSTAFA 2006; YASSIN 2004). Year-to-year changes in agricultural production greatly affect the level of poverty and food security of the Sudanese people. Moreover, the agricultural sector was the main source of Sudanese exports before oil extraction in 1991 (MUSTAFA 2006).

Agricultural subsectors in Sudan include both traditional and mechanized rain-fed farming; irrigated farming schemes depending on the River Nile and its tributaries, livestock, and the forest sector (MUSTAFA 2006).

3.2.1 The traditional and mechanized rain-fed sectors

Traditional rain-fed farming is mainly found in northern and central Sudan. This sector is characterized by small farms ranging from 2-30 or 10-50 hectares relying on the labor-intensive use of hand tools (UNEP 2008; CFSAM 2011). Traditional rain-fed farming in the eastern and central regions of the northern states of Sudan is to some degree mechanized, where traditional farming relies on tractors for plowing but utilizes manual labor for most other farming practices. The farm size in this case is usually larger than the average (CFSAM 2011).

Farmers in the traditional sector tend to rotate crops, perform more timely and frequent sowing, weed more, and have higher sowing rates than in mechanized rain-fed farming (see next section) (CFSAM 2011). The traditional rain-fed sector in 2010 contributed to 90% of millet, 38% to sorghum, 67% of groundnuts, and 38% of sesame grown in the country but these figures can vary from one growing season to another due to rain fluctuations (CFSAM 2011).

The traditional rain-fed sector in some states of Sudan such as North Kordofan and Darfur is stressed by droughts, desertification, and population increase (UNEP 2008). In the area of Nuba Mountain in South Kordofan, the traditional sector was converted to a mechanized scheme (UNEP 2008). Traditional rain-fed farming in Sudan was practiced for years and proved to be sustainable when the population was low; however, demographic, political, and technical changes are distorting the sector (UNEP 2008).

Farming in rain-fed areas using mechanization was founded by the British in the Gedarif area in 1944 in order to plant sorghum to feed the English army in East Africa (UNEP 2008). After Sudanese independence in 1956, mechanized farming was expanded by the government, and the private sector (mainly individual farm owners) was supported to invest in mechanized rain-fed farming (UNEP 2008). At the present time, mechanized rain-fed farming covers 6.5 million hectares, extending from the Butana plains in eastern Sudan to South Kordofan in central Sudan. This area includes parts of the states of Gedarif, Kassala, Blue Nile, Sennar, White Nile, and South Kordofan. The main crops cultivated in this sector are sorghum, sesame, groundnuts, and to a lesser extent cotton and sunflowers (UNEP 2008).

In rain-fed mechanized sectors, farming can be described as a low cost of agricultural inputs with fluctuating rain falls in scattered locations leading to low yields in cropping (CFSAM 2011). The sector provides 40% of sorghum and 62% of sesame produced in different sectors (CFSAM 2011).

Mechanized rain-fed farming can be considered an extensive shifting cultivation with tractors exploiting the land and causing soil exhaustion. (UNEP 2008) Therefore, mechanized rain-fed farming has environmental, social, and economic consequences, for example, disruption of forests and preexisting social systems and soil erosion due to improper crop rotation (UNEP 2008).

However mechanized rain-fed farming is still a major source of agricultural production and caused domestic production to grow 40% in 2006 (UNEP 2008).

3.2.2 Irrigated farming sector

This sector is identified mainly by a prominence of schemes irrigated by gravity from the River Nile and its tributaries, and Sudan is generally considered the largest irrigated area in sub-Saharan Africa (UNEP 2008). These schemes are the Gezira irrigated scheme between the Blue Nile and White Nile, which was constructed by the English in 1925 and represents half of Sudan's total irrigated area (UNEP 2008). The other two major schemes are the Rahad irrigated scheme on the bank opposite the Gezira scheme and New Halfa on the Atbara River (UNEP 2008). A fourth one is the El Suki irrigated scheme in Sennar, which is irrigated by the Blue Nile. These schemes produce mainly cotton, sorghum, groundnuts, and sunflowers. Finally, there are five major sugar schemes, four of which are government schemes (UNEP 2008). The fifth and largest sugar plantation is the Kenana Sugar Company, which is an international public-private joint venture (UNEP 2008).

Farming practices in irrigated schemes are more intensified than in rain fed sectors and include crop rotation, mechanized land preparation, and a regular use of improved seeds, fertilizers, pesticides, and herbicides provided by credit institutions through a program called scheme-based credit (CFSAM 2011). The average yield produced in the irrigated sector is economically higher than in the rain-fed sector; it contributed 26% to the Sudanese GDP in 2002 (CFSAM 2011; YASSIN 2004). The government owned most of these irrigated schemes until 2010, when a privatization policy was implemented as a solution to aging and inefficient infrastructures of those schemes (CFSAM 2011). In the Gezira scheme, irrigation was transferred to land owners with the name of water user associations, and crop decisions were given to farmers (CFSAM 2011).

Mechanized irrigated schemes are associated with some environmental issues including ongoing use of pesticides and a legacy of obsolete pesticide stocks (UNEP 2006). Water pollution occurs from sugar factories, canal siltation, soil salinization, and yield reduction (UNEP 2008). Other social impacts are mentioned in the following sections.

3.2.3 Forestry

Forests and woodlands in Sudan are estimated to be 1,857 hectares ranging from arid and semi-arid zones to sub-tropical and tropical zones (GAFFAR 2011). The types of forests in Sudan are natural forests and irrigated forests, and the dominant trees are acacia species (GAFFAR 2011). The forests of Sudan provide a variety of goods including timber in round and sawn forms (EL NOUR 2010). Forests are also sources of arboreal biomass for domestic

energy supplies and building material as well as a large number of non-wood forest products (EL NOUR 2010). However, forests in Sudan are mainly used for gum Arabic production and other subsistence (MUSTAFA 2006). National Forest Corporationactivities provide opportunities for employment and income generating activities in almost all of the Sudan; it also provides feed requirements for livestock (ADAM 2010). Forests are continuously being encroached by agriculture and urbanization or other degrading factors (ADAM 2010).

3.3 Agricultural research in Sudan

Cotton produce dominated the Sudanese economy in the first half of the century. Therefore, cotton research was the main focus, and many research stations and research farms were established to focus research on irrigated cotton (BEINTEMA et al. 1995). In 1931 an agricultural research services unit was established in order to consolidate agriculture produced by the Gazira scheme. This unit was integrated into the Department of Agriculture and Forest in 1938 and was renamed the Agricultural Research Institute. Its purpose was to supervise research on crops produced in other parts of Sudan. This unit later developed into the Agricultural Research Corporation, which is presently the institute responsible for conducting agricultural research in Sudan (BEINTEMA et al. 1995).

The demand for locally produced food crops grew markedly in World War II and continued to do so in the following years. Research on mechanized grain production began in 1945 and extended to include research on sesame andground nuts (BEINTEMA et al. 1995).

Agricultural research continued focusing on irrigated crops as other irrigated schemes were established. In accordance research stations were established in areas of irrigated schemes including Sennar station in central Sudan, New Halfa, and Rahad stations in eastern Sudan. Those stations were supposed to conduct research on irrigated crops, mainly cotton, in addition to horticulture crops, legumes, and wheat (BEINTEMA et al. 1995). One aspect of agricultural research after independence was to intensify and diversify crop production practices, mainly in irrigated schemes (BEINTEMA et al. 1995). Research also reacted to the initiation of many sugar cane schemes, and one main research station for sugar crop was established (BEINTEMA et al. 1995). Only a limited amount of research was directed towards problems faced by small farmers in the traditional rain-fed sector (BEINTEMA et al. 1995). International agencies were the ones who responded to this shortage; USAID and the World Bank supported programs that aimed to strengthen research activities on rain fed crops, sorghum, millet, groundnuts, range land, and farming systems (BEINTEMA et al. 1995). Unfortunately, in the mid 1980s, the civil war between northern Sudan, and southern Sudan

intensified and led to marked deterioration in Sudanese economic performance. Thus, research activities were affected as fewer funds were allocated to operate research projects (BEINTEMA et al. 1995).

After the cease-fire and achievement of a comprehensive peace agreement in 2005, agricultural research continued in the same manner with the exception of some institutional changes that were introduced. Different research institutions, including the Agricultural Research Corporation, were to be supervised by a new established Ministry of Science and Technology (ARC 2007). This institutional change meant that research would be monitored, facilitated, and funded by the Ministry of Science and Technology (ARC 2007).

3.3.1 Evolution of the Agricultural Research Corporation as the main research institution

In 1967, research activities of the Agricultural Research Institute (mentioned above) increased substantially, and the division administratively became an autonomous body within the Ministry of Agriculture and was renamed the Agricultural Research Corporation.

The headquarters of the ARC is in Wad Medani (175 km south of Khartoum) and oversees five regional stations, nine provincial stations, a sugar research station, the Food Research Center, National Forest CorporationResearch Center, and Fisheries and Marine Biology Center (BEINTEMA et al.1995).

In the ARC, there are four technical committees that have representatives from various stakeholders and are specialized to review, evaluate, and approve the release of agricultural technologies developed by the ARC and other institutions. Those committees are the crop husbandry committee, pest and disease committee, and food technology committee (ARC 2007).

The ARC is also engaged to a considerable extent in technology transfer and extension activities. Technology transfer comprises three main types: farm trials, verification of yield trials with participation from farmers, and researcher-managed and farmer-managed trials. Finally, they put pilot plots in farmers' fields with supervision by researchers and active engagement of extension workers (ARC 2007).

The ARC also undertakes a number of extension-related activities such as running farmers' field schools, conducting field days, producing extension leaflets, and disseminating information via public media (ARC 2007).

The Agricultural Research Corporation directs most of research towards crops but also does research on livestock, especially animal feed and range management. It also conducts research on forestry, fisheries, marine biology, and food processing (BEINTEMA et al. 1995).

3.3.2 Present strategy of agricultural research

In July 2006, the president of the Sudan announced the adoption of a five-year agricultural development plan also known as the agricultural revival plan for 2007-2012 (CEM 2009). Planners assumed that a lack of technical capacity in the supporting bodies was critical in constraining the achievement of the objectives of development programs in the country (CEM 2009). Therefore the program of agricultural revival was announced and aimed to achieve five objectives, among them reducing poverty by 50% in 10 years, achieving a balanced regional development, and maximizing the value added of agriculture commodities through processing (CEM 2009).

Reducing poverty would subsequently lead to improved food security among the poor, vulnerable groups in the country.The aim of the program, in striking a balanced development among the different regions of Sudan, would encourage the stability of rural people and reduce the pace of rural-urban migration, especially in conflict and post-conflict areas in Darfur and East Sudan. Achievement of balanced regional development based on the comparative advantages of their natural resources would support the objectives of poverty reduction, food security, and protection of natural resources (CEM 2009).

Integrating production into manufacturing is a new dimension that will transfer agricultural economic activities into new frontiers and open opportunities for employment and marketing of agricultural products from Sudan (CEM 2009).

Agricultural policies that help achieve these objectives are as follows:
- Raising producers' capacities and making the village a center of services to the small producers.
- Institutional reform.
- Increasing public expenditures for agriculturally related infrastructures, research and extension, education and training.
- Promoting private investment in agriculture (CEM 2009).

A priority project for agricultural revival is to create an appealing environment for encouraging private sector investors to take a leading role in the development process of the country. This policy has been implemented by inviting companies such as Kinana to invest in irrigated schemes in Sudan (CEM 2009; CFSAM 2011).

The main activities of agricultural revival programs are rehabilitating irrigation infrastructures, supporting agricultural inputs such as pesticides, fertilizers, and fuel (MINISTRY OF AGRICULTURE and FOREST 2010), financing and supporting processes of technology transfer, research, and agriculture extension (MINISTRY OF AGRICULTURE and FOREST 2010), applying projects of water harvesting, applying agricultural finance insurance, developing a revolving fund to reduce agricultural risks (MINISTRY OF AGRICULTURE and FOREST 2010), connecting the financing of production inputs with farmers' commitments in applying agriculture packages(MINISTRY OF AGRICULTURE and FOREST 2010) and distributing improved seeds at 50% of cost for small-scale farmers(MINISTRY OF AGRICULTURE and FOREST 2010). The agricultural revival program also has implications on improving the environment such as by supporting organic farming and forest plantation (MINISTRY OF AGRICULTURE and FOREST 2010).Other implications of agricultural manufacturing support private investment in and marketing and handling of agricultural products (MINISTRY OF AGRICULTURE and FOREST 2010).

3.4 Pastoral sector in Sudan

Pastoralism in Sudan is understood as a type of land use determined by rainfall intensity and distributions. Pastoralism is practiced all over the country; therefore, pastoralism can be divided according to climatic zones in the country or according to types of livelihood. According to climatic zones, there is the pure nomadism of herding camels, sheep, and goats by Abbala in semi-arid and arid areas of northern Sudan. Semi nomadic agro-pastoralists combine cattle and sheep herding with a form of cultivation in central and northern Sudan. Finally, a sedentary system where cattle and small livestock are reared close to villages occurs mainly in a central belt from Gedarif to Kordofan to Darfur (UNEP 2008).

Other scholars describe pastoral livelihood in Sudan as nomadic and semi-nomadic, nomadic are Abbala, semi nomadic are Baggara, Abbala are pure nomadic who move with camels between arid and semi-arid zones of Sudan (SALIH 1990; AHMED et al. 2012). Baggara are semi nomadic who combine farming of crops such as groundnuts, sesame, millet, and cotton with moving with cattle within the western savanna, which lies between semi-desert in northern Sudan and rich savanna on the boarders of the Republic of Southern Sudan (SALIH 1990; AHMED et al.2012). There are also agro-pastoralists who depend on farming and less on livestock found in settled arrangements (irrigated schemes and mechanized rain farming, traditional rain-fed farming) (SALIH 1990; AHMED et al. 2012). They are found in semi-arid

zones and desert, mainly inhabited by Hammar Kabaish, Shukria, Beja, and Hawawir distributed from eastern Sudan to western Sudan (SALIH 1990; AHMED et al.2012)

The settled farming population who keep mainly sheep and goats arose in small villages. Their animals usually graze in groups herded under the supervision of one shepherd. This form of livestock keeping is found mainly along the Nile (AHMED et al. 2012).

It is argued that the nomadic and semi-nomadic pastoralists keep the greater portion of livestock; they contribute to 25-40% of the total population of Sudan and contribute to 92% of Sudan's national herd. Therefore, when the contribution of livestock to the national economy is mentioned, it refers to the contribution of traditional systems of nomadic and semi-nomadic pastoralists. Agro-pastoralists in settled arrangements also keep a considerable part of Sudan's national herd, especially goats and sheep (AHMED et al. 2012).

Pastoralists in Sudan form 20% of the total population (expected to be less after the separation) and account for almost 40% of livestock wealth. Livestock production (mainly meat) contributes to 20% of general domestic growth of the country (AHMED et al. 2012).

3.5 Approaches for developing the pastoral sector in Sudan

During the Turkish-Egyptian rule (1821-1881), policies towards pastorals were mainly manifested in Zakat collection, while health services and vaccination of herds were minor priorities (SALIH 1990). In the Mahdist rule (1881-1898), the relation between the state and pastoralists was tax payment and conscription of men to the army (SALIH 1990). In Anglo-Egyptian condominium rule (1898-1956), the colonial government recognized local communities' positions, and thus the nomadic Sheikhs' ordinance was created, which then expanded the powers of sheikhs and legalized the hereditary powers of tribes leaders, meaning tribes were given user rights to utilize grazing areas (SALIH 1990; KIRK 1993; EL SAMMANI and SALIH 2006). Moreover, punishment measurements for misuse of these areas or any misbehavior of tribe members were allocated to tribe leaders (SALIH 1990; (KIRK 1993; EL SAMMANI and SALIH 2006). However, veterinary services and health facilities introduced by colonial rule proved to be not widely used by pastorals (SALIH 1990). Scholars argue that this local ruling of tribes created a fallacy among social scientists that pastorals in Sudan enjoyed these policies, while in reality pastorals were isolated and were not brought in to central economic planning at the time (SALIH 1990). Establishment of the Gezira scheme in 1923 displaced many pastorals from their traditional grazing areas and farms to new unfavorable ecological zones (SALIH 1990). Mono-production of cotton for export was adopted, but no planning for integrating livestock and agriculture production was

considered. The same can be argued about the White Nile schemes established by colonial rule in 1938 to produce cotton and subsistence crops (SALIH 1990). In these schemes only 20% of livestock remained within the scheme areas and many pastoralists had to dispose of their stocks due to shortages of grazing land by the White Nile banks, which were formerly accessible to them.

On post independence era, Butana grazing area was also subjected to construction of irrigated schemes such as New halfa and Rahad Scheme (KIRK 1993; CFSAM 2011; AHMED et al. 2012). In 1991-92 a survey was conducted in central Butana to study the implication of changing pastures to arable land, on indicaters of material poverty of groups of the area (KIRK 1993). 72% of the surveyed households were households who did not want to aquire arable land had the smallest heds, worked as poorly paid daily workers and depended on food aid. Households, who diversivied property rights in pasture land with leasehold land, had complementary fodder at their disposal to pursue the traditional mobile livestock keeping. Households which settled near irrigated areas only succeeded in optimizing the utilization of resources by combining harvest residues and natural pastures. They also practiced livestock keeping in entrepreneurial basis and secured transporting of services by Lorries as additional sources of income. The results of the survey indicate that the surveyed groups were becoming different better off groups (KIRK 1993). Results also showed that the accessable natural pastures were combined with harvest residues to keep livestock (KIRK 1993).

SALIH (1990) argued that establishment of large agricultural schemes was accompanied by some interest in investing in livestock development, concentrating more on introducing and advancing technological inputs such as vaccinations to control diseases and the adoption of livestock production management techniques. This approach resulted in an increased livestock fertility rate (AHMED et al. 2012). In the 1980s the famous famine that hit Sudano-Sahil resulted in losses of livestock and rural urban migration of pastoralists to seek other livelihoods. The government continued crisis management policies towards livestock rather than development (AHMED et al. 2012). The draughts and general environmental degradation led to massive losses of herds; however, the government was more interested in solving problems of food shortages rather than developing the livestock sector (AHMED et al. 2012). Therefore, there was no defined policy towards pastoral development such as introducing small-scale development projects for pastoralists that suited the needs of their communities (SALIH 1990). Unfortunately, the post-independence government continued the same policy and extended scheme construction; examples are the Rahad irrigated scheme, New Halfa irrigated scheme, and El Suki irrigated scheme (CFSAM 2011; AHMED et al. 2012).

AHMED et al. (2012) conclude that the performance of livestock in post-colonial governments was constrained by favoring large-scale irrigated schemes; this policy was reflected in a loss of land and little or no infrastructure development in pastoral areas.Scholars such as KIRK (1993)is arguing that the changing of land tenure in Sudan since colonial era passing through nationalism and total abolition of local inistitutions, is the reason for the present open access to natural pastures and growing of socioeconmical differences within groups depending on livestock keeping.

3.6 Research policies in the livestock sector

Local veterinary services were made available when a veterinary department was established to control animal disease outbreaks (BEINTEMA et al. 1995). In 1913 the department was organized into four sections; one was the veterinary survey section working on pathology examinations. This section expanded to become the veterinary research division under the Ministry of Animal Resources and focused research on animal diseases (BEINTEMA et al. 1995).

Research on animal production started in 1957 with the establishment of three regional stations throughout the Sudan (BEINTEMA et al. 1995). In 1973 two more stations were established for poultry and dairy research. The five stations were merged and named the Animal Production Research Administration (APRA) in 1971 (BEINTEMA et al. 1995). In 1970 the veterinary survey section started to establish the central veterinary research laboratories in Khartoum-Soba in addition to other regional laboratories within Sudan (BEINTEMA et al. 1995). Generally, it can be concluded that veterinary research was mainly interested in healthy stocks and animal production; therefore, technical facilities were allocated to work on these issues. On the other hand, research on developing range management or the social and economic aspects of the pastoral sector was minor and not integrated with other relevant research activities (SALIH 1990; AHMED et al. 2012).

The Ministry of Livestock concerned with research on veterinary medicine and animal health on this line of research universities such Khartoum University is involved in research on crops production and veterinary medicine and animal health (BEINTEMA et al. 1995).

3.7 Extension and extension approaches used in Sudan

In 1957, the first extension station was established in South Sudan in the Meridi district (MINISTRY OF AGRCIULTURE and FOREST 2007). In 1958 the Ministry of Agriculture and Irrigation established the agricultural extension division under cooperation with the

government of the United States; at that time extension services were directed at the newly established irrigated projects, but then gradually the services covered all agricultural activities in Sudan (EL TAYEB 2002). Therefore, the number of extension stations increased to 12 stations by 1972 (MINISTRY OF AGRCIULTURE and FOREST 2007). Until that time, extension was a section in the Ministry of Agriculture. However, in 1991 the administrative structure of the Ministry of Agriculture witnessed some changes in functions and names. Ministerial Decree No. 288, July 1991, gave the national extension service the name Federal Information and Extension Administration, making extension an administration within the Ministry of Agriculture (EL TAYEB 2002). The Infromation and Extension Administration within the Ministry of Agriculture is considered the main institution providing extension services; however, irrigated schemes, including the formal Gezira scheme, the Rahad Agricultural Corporation, New Halfa Agricultural Corporation, and Blue Nile Agricultural Corporation, provide extension services as well (EL TAYEB 2002). Extensional approaches used by the corporations were introduced by international development agencies, e.g. the training and visit approach and farmers' field schools (EL TAYEB 2002). Moreover, in remote areas of the country such as western Sudan (Gebel Marra), extension services were provided by some international non-governmental organizations (EL TAYEB 2002; EL HASSAN 2004).

In 2000, the name of the Federal Information and Extension Administration was changed to the General Administration for Technology Transfer and Extension (MINISTRY OF AGRCIULTURE and FOREST 2007). This administration includes the agricultural engineering administration, seeds administration, agricultural extension administration, agricultural information administration, and capacity building administration (MINISTRY OF AGRCIULTURE and FOREST 2007).

Since we are concerned with extension, the major responsibilities of the Agricultural Extension Administration are as follows: conduct extension research studies in order to maintain ideal extension modules, evaluate extension programs through meetings and workshops, provide technical know-how to extension workers and agriculture stakeholders and address rural households technically, economically, and socially in order to improve their livelihood (MINISTRY OF AGRCIULTURE and FOREST 2007). Responsibilities of Agriculture Extension Admnistration include also conduct of filed visits to oversee the effect of extension programs, exchange of extension experiences localy and internationally to enrich the Sudanese experiences (MINISTRY OF AGRCIULTURE and FOREST 2007)

3.7.1 Traditonal extension approaches

Field inspectorate approach (commodity approach)

This approach emerged in Sudan due to the establishment of the Gezira cotton scheme in 1929, when the country was under Anglo-Egyptian rule (1898-1956). This approach was also known as the commodity development approach (EL HASSAN, 2004). The idea of the approach is that the type and time of agricultural practices were forced by field inspectors. The tenant system, where land is released more than owned by tenants, gave the governing authority control of that system; in other words, change in agricultural behavior was forced by what was known the Sudan Gezira Board (DORAN 1980). According to DORAN (1980), this enforcement of behavior was the equivalent of extension.

Later in the 1960s and 1970s when most irrigated projects in Sudan were established including the Rahad scheme, the inspectoral approach was duplicated in their initial years 1977-1986 (WORLD BANK 1985; EL HASSAN 2004). The inspectorate approach depends mainly upon field inspectors as extension workers who have different functions to perform regarding the crops. Such functions include managerial, regulatory, administrative, and supervisory ones. However, the education function has also been given minor consideration (EL HASSAN 2004).

Communication methods used in this approach include field visits, group meetings, home visits, officer visits, campaigns, and workshops (EL HASSAN 2004). The approach was successful in improving the production of cotton but failed to do so with other crops such as sorghum, groundnuts, and vegetables (EL HASSAN 2004).

The conventional approach

In 1958 a national extension service was established in the country in cooperation with the United States Operation Mission (DORAN 1980). The extension services followed the American pattern of the land grant college system (DORAN 1980). The paradigm emphasized education more than inspecting through the extension module of transferring technology packages to farmers (DORAN 1980; EL HASSAN 2004).

The conventional approach aimed to increase production of food and export crops (EL HASSAN 2004). Different extension methods used by the approach were field visits, agricultural extension meetings, demonstration plots, cinema films, and radio programs (EL HASSAN 2004). The conventional approach was used in different parts of the country, but

the Gezira scheme retained its authoritarian system, although an extension department was established there (DORAN 1980). This duplication of systems can clearly reflect the confusion created by extension when implemented in an inspectoral or authoritarian manner versus using extension as a means of education (DORAN 1980). DORAN (1980, 43) argued that *"extension in Sudan since the establishment of the national system is comparable to the pendulum of a clock swinging between the imposed authoritarian system of the inspectorate and the classical extension model based on underlying educational tenets."*

The conventional approach reflected on improving production of different crops, especially in northern and central Sudan (EL HASSAN 2004).

Commodity approach in the Rahad agricultural scheme 1977–1986

The commodity approach was the first extension approach to be used in the Rahad irrigated scheme (EL HASSAN 2004). The approach was applied from 1977 to 1986, mainly to increase the quality and quantity of cotton production (EL HASSAN 2004).

The approach started with a maximum of one extension manager and one assistant extensionist at El Fau, the headquarters of the scheme; the two were authorized to instruct agricultural staff in the Rahad scheme with technical advice (EL HASSAN 2004). The number of extensionists increased gradually, and in 1985 an extension department was formed and worked to provide information through extension meetings, radio and television programs, posters, cinema shows, extension campaigns, and others (EL HASSAN 2004). The field inspectors were responsible for providing extension services to the tenants and had many jobs to do besides this function (EL HASSAN 2004). Managerial work, administrative work, regularity work, plus educational functions were the responsibilities given to the field inspectors (46 total inspectors) (EL HASSAN 2004).Each inspector was responsible for serving 200-350 tenants in addition to supervising the water guard production committees (farmers committees) and the Samads (contacts farmers) (EL HASSAN 2004) .

In general, extension work through the commodity approach in the Rahad scheme was characterized by weak linkages between research and extension (EL HASSAN 2004). There was one formal linkage between the two represented on the distribution of the recommended technical packages of cotton to field inspectors (EL HASSAN 2004). Farmers had no way simply to adopt the packages; however, the field inspectors who were already overloaded by managerial work had no time to perform effective extension work (EL HASSAN 2004). Therefore, the commodity approach in Rahad was described as a top-down approach without participation from tenants (EL HASSAN 2004). Extension was directed only to cotton while neglecting other crops (EL HASSAN 2004).

However, the success of the commodity approach was reflected by improvements in cotton production at the time of application (EL HASSAN 2004). It also played a major role in establishing the main infrastructure in the the Rahad scheme (EL HASSAN 2004).

The FAO fertilizer program approach

SWANSON (2001) cited by (EL HASSN 2004) mentioned that the approach was implemented in 1977 by the FAO in many areas of Sudan in order to train farmers on how to use chemical fertilizers (EL HASSAN 2004). Accordingly, the approach aimed to raise the production of food and cash crops through the economic use of fertilizers, to assist the Agricultural Bank of Sudan in providing fertilizer to target groups (EL HASSAN 2004). The approach depended on demonstration plots, field and home visits, field days, radio and television programs, and posters (EL HASSAN 2004).

Evaluation has proved that the approach had a direct impact on improving the production of agricultural crops in quality and quantity, and farmers became aware of how to use fertilizers (EL HASSAN 2004).

3.7.2 Training and visit approach

In the 1960s and 1970s it was known that the role of extension in developing agriculture was becoming less attractive (HUSSAIN et al. 1994). Therefore in 1980s, the training and visit approach (designed by Benor and others) was supported by the World Bank to improve extension performance (HUSSAIN et al. 1994).

The measures of the training and visit system were mainly to remove non-extension duties (e.g. supply of inputs and collection of agricultural statistics), increase extension-farmer contact through a well-programmed schedule of 2-week visits, use contact farmers with close links to extension who were responsible for passing extension messages to other farmers, increase training of village extension workers through regularly conducted courses, and form close links between extension and research to ensure the relevance of extension messages to farmers' needs (HUSSAIN et al. 1994).

The training and visit system in Sudan was introduced in the mid-1980s by the World Bank through the agricultural training and extension project (ARTEP) as an attempt to link (extension- research) (EL HASSAN 2004). The institutions that directly benefitted from this World Bank project were the Information and Extension Administration (see following section), Agricultural Research Corporation, and the Faculty of Agricultural Sciences Gezira University, in addition to the Rahad agricultural scheme, and the New Halfa irrigated scheme(EL HASSAN 2004) . The approach was also introduced in other parts of the country

including the Blue Nile Corporation, Khartoum state, and Northern state (EL HASSAN 2004).

The training and visit system was designed as research recommendations were designed in extensional information and applied by trained extension staff in the corresponding irrigated schemes (EL HASSAN 2004).

The main communication methods used by the approach in Sudan were the monthly workshops, training sessions, field days, on-farm trials, field and home visits, demonstrations, radio, and television programs (EL HASSAN 2004).

KUMOR (1991) cited by (EL HASSAN 2004, 53) declared that the approach in the Rahad scheme had motivated farmers to adopt new crops, new varieties, better cultural practices, and irrigation management. Moreover, research technologies that had been kept within the research station were now transferred by T & V approach.

However, other evaluators such as (IFAD 1992) have found that the training and visit system was expensive and not necessary in irrigated schemes where farms are close to each other. Moreover, the training and visit system had an administrative format or diagram that could be difficult to sustain if a project were to phase out. Therefore, a less expensive, smaller, and more efficient service of extension would be adequate (IFAD 1992).

The Training and Visit approach in the Rahad scheme 1986-1994

The training and visit (T & V) approach was introduced in the Rahad scheme in 1986. First the approach began by injecting extension services into the commodity approach in two sections of the scheme (EL HASSAN 2004). Then in 1988 the field inspectors were relieved from regulatory work by introducing professional extension with unified services (EL HASSAN 2004). The extension work was carried out by two extension workers in each of the nine sections of the Rahad scheme (18 extension workers) (EL HASSAN 2004). Extension activities reached most farmers through the mechanisms of the T &V approach (EL HASSAN 2004). In this approach, at the headquarters or El Fau there were a technical committee, team of scientists, and subject matter experts who would communicate the extension department with extension information(EL HASSAN 2004). The extension department consisted of extension officers at the section level who would direct information to extension workers at the village level (EL HASSAN 2004).

The extension workers worked with contact farmers, who represent 10% of the total number of farmers in each block (EL HASSAN 2004). Contact farmers and other farmers adopted recommendations of crops technical packages demonstrated via the T & V system methods (EL HASSAN 2004). Therefore, a technical committee for the T & V system in the Rahad

scheme made a decision in 1993 to introduce the system in the entire Rahad scheme to replace the commodity approach (EL HASSAN 2004). EL HASSAN (1993, cited by EL HASSAN 2004, 75) showed that application of the T & V approach led to the improvement of linkages between research and extension. The linkages between the extension department and the Rahad research station were secured through monthly workshops headed by the chief of the Rahad research station in order to discuss extension messages or information needed to be shared with farmers (EL HASSAN 2004). The T & V approach resulted in regular visits of extensionists to the field, which helped solve practical problems faced by farmers (EL HASSAN 2004). The staff was continuously trained as part of the system packages (EL HASSAN 2004). The welfare of farmers improved due to the increase in gross returns from the joint effect of both yield and price increase (EL HASSAN 2004). However, EL HASSAN (2004, 76) argued that the need of continoues facilities limited the sustainability of theT & V approach in the Rahad scheme.

3.7.3 The Integrated approach

This approach was introduced in Sudanby the German Agency for Technical cooperation (GTZ) in 1986. It aimed to improve the production of vegetables and fruits as well as promote the concept of integrated pest management among farmers (EL HASSAN 2004).

The approach also specifically aimed to improve fruit and vegetable yields and develop the concept of integrated agricultural services (EL HASSAN 2004) .The common extension methods used were home and field visits, on-farm trials, and field days. The approach was taken to most states of Sudan including Khartoum, Northern state, Blue Nile, and Gezira state (EL HASSAN 2004). The approach achieved a positive impact on fruit and vegetable production (EL HASSAN 2004).

The integrated rural development approach

This approach was introduced in Jebel Merrah, southern Kordufan, from 1980-1995. It was financed by the Arab Development Fund and the European Economic Committee (EEC). The approach consisted of seven components: agriculture extension and credit, adaptive research, community development, engineering, finance, administration, and monitoring and evaluation. These components were believed to achieve integrated rural development in the area.

3.7.4 Farmers' field schools

In the 1970s, the Food Agricultural Organization in its approach was convinced that small demonstrations, informal groups, cooperative organizations, and farmers' field school were more effective means to reach farmers (ABDEL RAHMAN 2003). A farmers' field school is a group of 20-30 farmers meeting on their field or closer in order to be trained in certain skills, and attitudes and become more dependent upon them to solve problems related to their farming (ABDEL RAHMAN 2003). Weekly field training is the basic idea of farmers' field schools, which can be divided into three stages (ABDEL RAHMAN 2003). First, a trainer would meet farmers on their farm to discuss a certain training subject for the week, and then they would go to the field or farm to collect observations of the crops, certain agricultural practices, or insects (ABDEL RAHMAN 2003). Second, the trainer and farmers would collect samples of infected plants or insects, then they would go back to discuss what they saw or collected (ABDEL RAHMAN 2003). Finally, the trainer would summarize the observations, and the farmers would decide the topic for the next week (ABDEL RAHMAN 2003). According to EL HASSAN (2004, 55), the approach goes beyond the objective of increasing production to understanding the ecosystem and ecological environment for sustainable and healthy agricultural development.

In Sudan, farmers' field schools were implemented within the FAO/ARC (Agricultural Research Center) project development and application of integrated pest management in wheat and cotton on irrigated schemes such as the Gezira scheme, Rahad irrigated scheme, and some regions of Gezira and Sennar states (ABDEL RAAMAN 2003; EL HASSAN 2004). The extension communication methods used in this approach include weekly field meetings, demonstrations, field days, posters, leaflets, and workshops (EL HASSAN 2004).

The project also initiated the implementation of FFS on vegetable farming because of excessive use of pesticides by farmers (ABDEL RAHAMAN 2003). In 1993 Sudan became the first African country to implement farmers' field schools, modifying them to suit the social and economic situations of Sudanese farmers (ABDEL RAHAMAN 2003; EL HASSAN 2004).

Evaluation studies have proved the success of FFS in Sudan; according to EL HASSAN (2004, 55), the approach had a direct impact on the change in attitude, behavior, and skills of the farmers by using the IPM concept to reduce the effects of pest damage.

In Sudan during 1996-97, FFS was adopted as a national policy of extension (ABDEL RAHAMAN2003). However, many FFS in irrigated schemes did not continue due to a lack of financial support and lack of adequate training for trainers (ABDEL RAHAMAN 2003).

Farmers' field schools in the Rahad scheme 1994-2000

The first farmers' field school in the Rahad scheme was established in village 39, where 35 farmers were trained (EL HASSAN 2004). In 1994/95 season, the second school was established at village 37 (EL HASSAN 2004). In the next year, another 6 schools were added (EL HASSAN 2004). The number of schools gradually increased until it reached 18 schools with a total number of 600 farmers in 1997 (EL HASSAN 2004). The main communication methods of FFS in the Rahad scheme were weekly field training sessions, demonstration plots, field days, on-farm trials, and on-farm visits (EL HASSAN 2004). The FFS worked alongside of the T & V approach and aimed to make farmers aware of the principles of integrated pest management (EL HASSAN 2004). The school sessions involved 20-35 farmers who met once a week under a tree near their fields to receive training on IPM and other extension activities (EL HASSAN 2004). In the FFS approach, new labels were given to the extension offices, at the El Fau level there were IPM planning and supervision teams who directed the IPM field advisory committee (extension department) (EL HASSAN 2004) . The committee would direct the IPM extension team (extension officers at section levels) and the latter was connected to the IPM FFS extension team at the village level who directly contacted farmers (EL HASSAN 2004).

AHMED and KAWTHER (1997) cited by (EL HASSAN 2004, 77) mentioned that FFS held in the Rahad scheme were characterized by poor attendance of farmers and a low number of training sessions. Shortages of irrigation water and a lack of financing at the time could have discouraged farmers from attendance. It is also argued that some field inspectors (extension workers) had no interest in adopting FFS activities.

FFS in the Rahad scheme can be described as a bottom-up approach in which farmers reflected their own problems on farms (EL HASSAN 2004). It is also argued that researchers in the Rahad scheme worked on what was needed by farmers, and thus the linkages with the Rahad research station were strengthened further (EL HASSAN 2004). Unfortunately, application of FFS in the Rahad scheme was timed with low efficiency in technical performance in the Rahad scheme, and the approach needed more facilities for its continuity (EL HASSAN 2004).

According to EL HASSAN (2004), extension in the Rahad irrigated scheme returned to perform according to the commodity approach, where extension work is a part of the administrative and managerial work of field inspectors.

3.8 People's organizations in Sudans

Sudanese national farmers' union

The first Famers' Union in Sudan was the Nuba mountain farmers' union in 1930; the union was not officially recognized until 1941 (ABD ELRAHIM 2011). Then other farmers' unions were established such as Zaidab farmers' union in 1947 and the Gezira Farmers' Union in 1948 (ABD ELRAHIM 2011). Different farmers' unions in Sudan thought of creating a national farmers' union that included the scattered unions (ABD ELRAHIM 2011). In 1976 the first Sudanese national farmers' union was established and followed the Labor Ministry (ABD ELRAHIM 2011). The union consists of a president, secretary, and treasurer in addition to members (farmers in rain-fed areas and irrigated schemes) (ABD ELRAHIM 2011).

The Sudanese National Farmers' Union was established, consisting of farmers' unions in rain-fed farming areas and ones in irrigated schemes (ABD ELRAHIM 2011). The respective institutional bodies that the union formally coordinated with were the Ministers' Council and the National Council in addition to financial institutions, marketing institutions, scientific, research, and technical institutions, and related international institutions (ABD ELRAHIM 2011) The National Farmers' Union has strategic and practical objectives that allow it to fulfill its mandate(ABD ELRAHIM 2011) The union strategically aims to improve the welfare of farmers and the sectors related to farmers (ABD ELRAHIM 2011) (. It aims to achieve sustainable social and economic development in Sudanese rural areas, to achieve national food security, and to become involved in environmental protection (ABD ELRAHIM 2011). The National Sudanese Farmers' Union also works to initiate general agricultural policies in the country especially on finance policy, marketing policy, and providing farming inputs (ABD ELRAHIM 2011). The union is assigned to provide farmers access to technical services including extension, training, and research (ABD ELRAHIM 2011).

Farmer and pastoral organizations in Sudan

In 1992 a law to organize farmers and pastorals was deliberated by the constitutional document of 1989 to defend the rights of the members and educate them (MINISTRY OF JUSTICE 2011). The law divided farmers into farmers and pastorals and designated them as bodies that communicate with the executive government institutions to demand their rights, and sometimes they get involved in social and political events (MINISTRY OF JUSTICE

2011). Accordingly theses bodies failed to achieve their role in developing farming and animal sectors in spite of the available natural resources in the country(MINISTRY OF JUSTICE 2011) , especially when the government announced the policy of economic liberation in the beginning of the 1990s (EL AMIN and EL MAK 1997).

Moreover, termination of government financing for economic activities was another factor that constrained the farmers' and pastorals' organizations from working effectively (MINISTRY OF JUSTICE 2011) Recently the executives of the program of Agricultural Revival (CEM 2009) asked the executive office of the Sudanese Farmers' Union to seek an alternative law that can assist producers in making better use of available resources in the country (MINISTRY OF JUSTICE 2011).

Therefore, the law of owners of agriculture and animal production was introduced, and voluntary organizations would be established for owners of agriculture and animal production (MINISTRY OF JUSTICE 2011). Every organization would be independently managed, financed, and would have its own technical performance (MINISTRY OF JUSTICE 2011). The organization would work to achieve its objectives and missions (MINISTRY OF JUSTICE 2011).

The organization aims to assemble potentials and abilities of producers and implement policies and plans to increase efficiency of agriculture and animal production in the country from a low producing economy to a high producing and competitive sector (MINISTRY OF JUSTICE 2011). The law sets many specific objectives that mainly focus on achieving national food security (MINISTRY OF JUSTICE 2011). One means to achieve this objective is to supply finance, inputs, machines, and equipment needed for agriculture and animal production from inside or outside the country and develop marketing channels for production imports (MINISTRY OF JUSTICE 2011). The law suggests that pastorals and farmers should compose organizations that are called owners of animals and agriculture production (MINISTRY OF JUSTICE 2011). These organizations should be represented at locality and state levels as well as at the federal level (MINISTRY OF JUSTICE 2011). The organizations are assigned to provide and manage technical services, commerce, production processes, inputs, marketing, and manufacturing of agricultural and animal production in rain-fed areas and irrigated schemes. Until the time of data collection, that law was not brought into practice. Farmers and pastorals are not gathered in one identity but they work according to their respective unions.

Sudanese Women's General Union (SWGU)

The Sudanese Women's General Union was formed in 1990 as a national voluntary nongovernmental organization (SWGU 2010). The union is institutionally aligned with the Sudanese Council of Voluntary Agencies (SCOVA) of the Ministry of Humanitarian Aid (SWGU 2010). The SWGU used to have twenty-six main branches in the different states of northern, southern, eastern, and western Sudan (pre South Sudan separation, present data is not available) (SWGU 2010). These branches extend from centers to local levels to villages forming branches and sub-branches (SWGU 2010). The total numbers of the branches and sub-branches is about 27,000 (pre-South Sudan separation) (SWGU 2010).

Eligibility for membership in the SWGU is for women who are more than 18 years old (SWGU 2010). The union has been recognized by the federal and state governments and is in the process of being registered at the secretariat of the Commission of Women at the Economic and Social Council in the United Nations (SWGU 2010). Mainly the SWGU aims to promote and empower women socially, economically, and politically (SWGU 2010). Political empowerment of women can be explained as protecting women's attained constitutional rights (SWGU 2010). The SWGU aims also to improve the welfare of women and children and to achieve substantial reduction in their mortality rates (SWGU 2010). Socially SWGU aims to educate women in religion and civic affairs and help women participate in peace building and dissemination of culture. The means to achieve these objectives are through conducting research and studies on matters that concern women socially, economically, and politically (SWGU 2010) and disseminating the results of this research to relevant ministries and financing agencies so that the mentioned agencies can donate funds to implement projects based on the conclusions of the research (SWGU 2010).

The SWGU also uses vocational and professional training for women to gain skills necessary for employment, and working experience, which can increase their living conditions and well-being (SWGU 2010). The SWGU initiates the formation of specialized societies and collaborates with existing specialized centers and initiatives that help promote and empower women (SWGU 2010). The union offers funds and collaborates with specialized institutions and centers that work on illiteracy education, personal hygiene, first aid, childcare, religion, and civics education (SWGU 2010).

3.9 Background of the Rahad irrigated scheme

3.9.1 Resettlement of agro-pastorals in the Rahad agricultural scheme

Prior to establishing the Rahad scheme, socio-economic surveys were made of agro-pastoral villages that were supposed to be settled in the scheme area. The survey was conducted in villages that were supposed to be reallocated in the southern, central, and northern areas of the scheme.

Villages that were reallocated in the southern part of the scheme were known as villages of the eastern Rahad River, villages of western Rahad River, villages north of Mafaza (GALAL EL DIEN et al. 1975). Villages of the El Fau area were reallocated in the center of the scheme.

For the survey of villages that were reallocated in the northern area of the scheme, the villages were divided into six squares; every square was named after a village name, and every square would contain around 18-25 villages (GALAL EL DIEN et al. 1975).

Planners were aiming to settle closely knit people together in order to reduce the shock of moving them to a new place (GALAL EL DIEN et al. 1975). They also thought that if different tribes were asked to live together in one place, problems or conflicts might occur among them (GALAL EL DIEN et al. 1975) .Socio-economic data was collected from people before moving them to the scheme area, because planners anticipated improving the standard of living of the people in addition to technological implementation in the Rahad scheme. According to the report's author, GALAL EL DIEN (1975, 221), *"the Rahad scheme aimed to bring new people into the area and worked to utilize available resources in society with maximum possibilities to meet needs, improve the standard of living, and change traditional situations in the area so that detailed information on living situations were collected, which can help make policies and planning for services in accordance with scientific and logical analysis of information gathered from people."*

Surveys of southern villages included collecting information on the level of education, age, sex, religious beliefs, social services available in the villages such as shops, mosques, schools, clinic points (GALAL EL DIEN et al. 1975). A survey estimating the number of livestock owned by villages was also included in that social survey (GALAL EL DIEN et al. 1975). According to survey documents, in addition to planting cash crops, the scheme will integrate livestock with crop rotation (GALAL EL DIEN et al. 1975). This planning was developed because people around the Rahad scheme, especially the southern area of the scheme, depend mostly on cattle and sheep besides traditional rain-fed farming (GALAL EL DIEN et al.

1975) .It is mentioned that due to ecological factors, those people started to settle and farm even before the establishment of the scheme (GALAL EL DIEN et al. 1975). See also (SALIH 1990), but livestock is still very important for their livelihood. Surveys have mentioned that integration of livestock will make better use of the scheme and be economically more beneficial instead of depending only on crops for exporting or local markets (GALAL EL DIEN et al. 1975). The number of livestock surveyed forced planners to integrate or make use of it in the scheme (GALAL EL DIEN et al. 1975). Integration of animals into the scheme will balance soil fertility and diversify productivity there (GALAL EL DIEN et al. 1975).

Survey in the north of the scheme collected more details on socio-economic information, and surveyors tried to depict actual numbers of livestock instead of estimations (GALAL EL DIEN et al. 1975). The outcome of the survey in northern villages showed that most people work on rain-fed farming, then trading, and then grazing livestock. The level of health services was low; few or no health services were in the area; there were few to no education services and a high level of illiteracy of around 90% prevailed. Housing was in poor condition; people and animals were not separated; and the area was contaminated with malaria and smallpox. People were dominated by their traditions and customs.

3.9.2 Geographic location and climate conditions of the scheme

The Rahad scheme is one of the most recently settled areas in Sudan, and there has been relatively new expansion to irrigated agriculture in the country, which was suggested after the construction of the Rosieries dam in 1966 (IBRAHIM 2004).

The Rahad irrigated scheme is situated within 14° 23″ – 13° 43″ latitude North, and between longitude 34˚ 23″ and 33˚-30″ East (IBRAHIM 2004). The scheme politically falls in two states: Gedarif and Gezira, The El Fau locality lies about 260 km southeast of Khartoum and is the headquarters of the scheme (BENEDICT et al. 1982). The scheme covers an area of 140 km in length (north-south, and 15-25 km in width (IBRAHIM 2004).

The total scheme area is 334,728 hectares but the cultivated area is 147,698 hectares, cultivation of the scheme was planned in three phases: the first phase was cultivated in 1977 (located in Gedarif); the second phase was cultivated in 1982 (falls in Gezira); preparing and planning of the third phase took place in 2010 (RAHAD AGRCIULTURAL CORPORATION 2010; MINSITERY OF IRRIGATION 2007).

The scheme lies in a semi-arid climate; the area's annual rainfall varies from 300 mm in the north to 450 mm in the south with a draught period of about eight months. The rain occurs

between June and October, with heaviest falls concentrated in August. The temperature in April is 40 ˚C maximum and 36 ˚C in October as a secondary maximum. January is the coldest month with 17 ˚C average (IBRAHIM 2004; RAHAD AGRCIULTURAL CORPORATION 2010).

The soil of irrigated land of the Rahad scheme lies within the central clay plains of Sudan. The clay content of the soil increases from 50% to 60% in the northern part of the scheme to 80% in the southern part (IBRAHIM 2004; RAHAD AGRCIULTURAL CORPORATION 2010).

3.9.3 Irrigation of the Rahad scheme

The scheme is irrigated from a pump station established in a village called Mena on the Blue Nile Bank (BENEDICT et al. 1982; BRAHIM 2004; RAHAD AGRCULTURAL CORPORATION 2010). The pumped water irrigates the scheme before the rainy season (May-June) and during winter (late October- February), through a 79 km canal connecting to the Abu Rakham Barrage or dam (BENEDICT et al. 1982; IBRAHIM 2004;RAHAD AGRICULTURAL CORPORATION 2010). During the rainy season (July-October), the scheme is irrigated by gravity from the Rahad River (BENEDICT et al. 1982; IBRAHIM 2004; MINISTRY OF IRRIGATION 2007). Figure 4 represents irrigation of Rahad scheme from Abu Rakham Dam at Rahad River until sections of the scheme.

Details of irrigation of Rahad scheme are as followsThe 79 km canal would support the Rahad River with water to irrigate the scheme from the Blue Nile (MINISTRY OF IRRIGATION2007). The water taken from the Blue Nile first comes from the Dindir River (another tributary of the Blue Nile) before it reaches the Rahad River, so siphoning or tunneling was suggested to be established under the Dinder River in order to bring water to the Rahad River (MINISTRY OF IRRIGATION 2007). This operation takes place in the summer and winter (MINISTRY OF IRRIGATION 2007). In the rainy season from July-October, water from the Rahad River is used to irrigate the scheme directly using Abu Rakhm dam, which shifts water from the Rahad River to a main canal in the Rahad scheme (MINISTRY OF IRRIGATION 2007).

To conclude, sources of irrigation in the Rahad scheme are as follows: the seasonal Rahad River that runs from the Ethiopian mountains from July to October; water used from the Rahad River is 400,000,000 m^3 to 800,000,000 m^3 per year (MINSITRY OF IRRIGATION 2007). Then there is the Blue Nile using Mena pumps and a connecting canal (MINSITRY OF IRRIGATION 2007). A third considerable source of irrigation is seasonal rain that varies

from 250 ml/m^3 in the north of the scheme to 400 ml/m^3 in the south of the scheme (MINSITRY OF IRRIGATION 2007).

The following sketch, figure 4 shows the irrigation of farms in the Rahad scheme. The idea of this sketch is that irrigation water is controlled by the Aburakhm Dam on the Rahad River and runs into the major canal in the scheme. Along the canal there are four conjunctions or kantar, distributed at 22, 36, 76, and 101 kilometers from the source (the dam on the river) (MINSITRY OF IRRIGATION 2007). From each conjunction, major canals are found to carry water in to sub-canals (*abu eishrin*); the latter will lead to sub-sub canals (*abu sitta*) that irrigate farms (MINSITERY OF IRRIGATION 2007). From project documents it is understood that the efficiency of all canals that carry water to the scheme farms has been degraded to different levels by clay, which negatively affects the quantity of irrigation water in farms MINISTRY OF IRRIGATION 2007). Moreover, canals frequently break due to heavy rains (MINISTRY OF IRRIGATION 2007). Cleaning and maintenance operations have been implemented to solve the problems (MINSITRY OF IRRIGATION 2007). The Irrigation Administration in the Rahad scheme had been dissolved in the KIAS Company because maintenance and irrigation operations were performed by the company. The situation frustrated many staff members in the Irrigation Administration who remained as supervisors of personnel (FIELD DATA 2010).However, in June 2012 KIAS Company had withdraw from Rahad Scheme, the present administrational and technical connection of Irrigation Administration to Rahad Scheme is not clear.
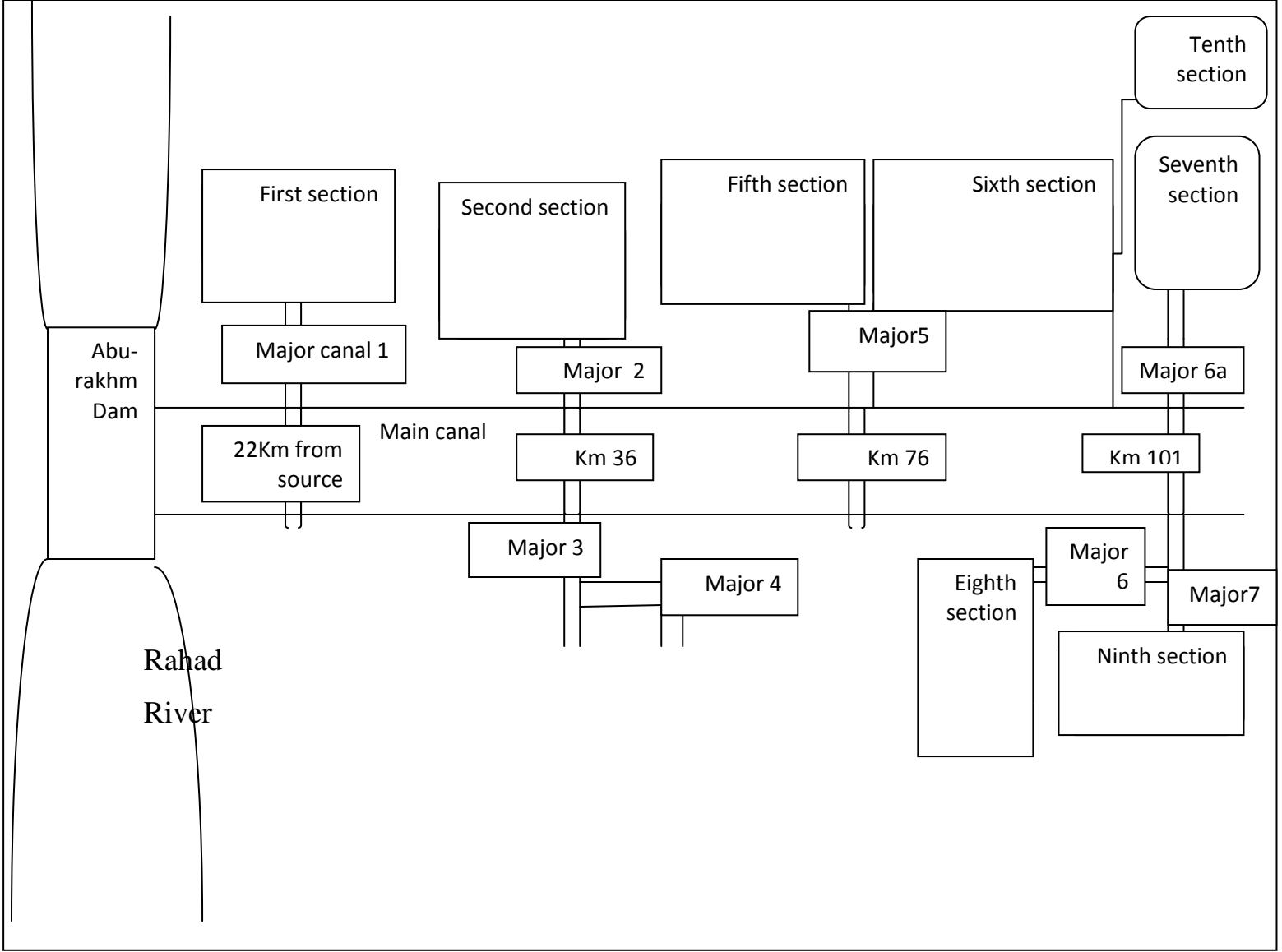
Figure 4: Irrigation of the Rahad scheme from the source to the sections
Source: Ministry of Irrigation 2007.

3.9.4 Institutional set of the the Rahad scheme

After construction of the Roseris hydroelectric dams in the 1960s, the government of Sudan planned to establish the Rahad irrigated scheme (BENEDICTet al. 1982). Establishment of the Rahad scheme aimed to shift the sustainable economy of indigenous agro-pastorals surrounding the area of the scheme to become more intensified cultivation (BENEDICT et al. 1982). The government anticipated that the standard of living, income, housing, nutrition, education, and values of those people would be improved (BENEDICT et al. 1982). In accordance with that planning, the Rahad scheme establishment was funded by many funding agencies; among them are the international development association, Kuwait Fund, Saudi Fund, and the government of Sudan (BENEDICT et al. 1982).

The Ministry of Agriculture appointed the Rahad Agricultural Corporation to be the responsible institution for managing farm operations in the Rahad scheme (BENEDICT et al.

1982). Managing irrigation operations and maintenance needs are under the responsibility of the Irrigation Administration (BENEDICT et al. 1982).

General Manager

Deputy General Manager

| Spinning manager | Agric. engineer manager | Planning and research manager | Finance and supply manager | Investment manager (animal production section, and seeds prodcution | Farm manager (includes information and technology transfer dept.) |

| Civil engineering manager | Operating and maintenance manager | Services and public relations manager | Personnel manager |
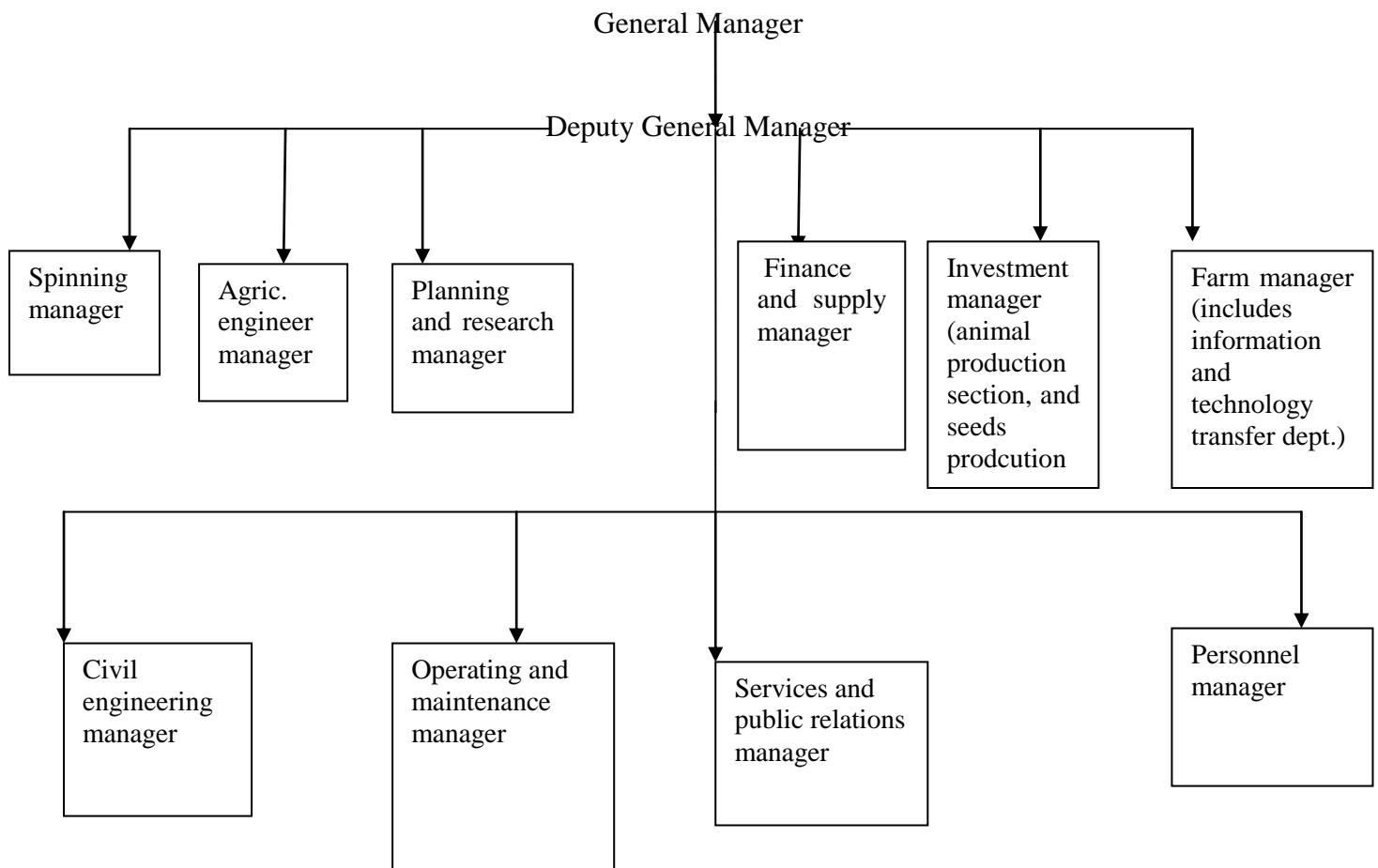
Figure 5: Administrative structure of the Rahad scheme
Source: Planning and Research Administration, 2010.

The above diagram reflects the administrative diagram of the Rahad Agricultural Corporation from 1977-2009) (PLANNING and RESEARCH ADMINISTRATION 2010). The Department of Extension and Technology Transfer falls under the administration of the farm manager; connection to extension was through a technical committee assigned by the general manager. The Farmers' Union is directly connected at the managerial level (PLANNING and RESEARCH ADMINISTRATION 2010).

Administratively the scheme is divided into 3 groups: southern, central, and northern groups; each group consist of three sections also known as blocks (RAHAD AGRCIULTURAL CORPORATION 2010; BENDEDICT et al. 1982) (see table 1). Every section contains five villages; villages were given numbers from 1-46 (RAHAD AGRCIULTURAL CORPORATION 2010; BENDEDICT et al. 1982) One village from each section is selected as the head of the section: village 10 is the head of southern section, village 23 is the head of the central section, and village 40 is the head of the northern section (RAHAD AGRICULTURAL CORPORATION 2010; BENEDICTt et al. 1982). Every village holds a farming area, but one village is selected to be the head of the block. Each village contains a primary school, health unit, filtered potable water, staff housing, and an agricultural office (BENEDICT et al. 1982). Markets and workshops are additionally constructed at the head of the block (BENEDICT et al. 1982).

Section /block	Villages	Location of the section
First section	1-5	South of the scheme
Second section	6-10	South of the scheme
Third section	11-15	South of the scheme
Forth section	16-20	Middle of the scheme
Fifth section	21-25	Middle of the scheme
Sixth section	26-30	Middle of the scheme
Seventh section	31-35	North of the scheme
Eighth section	36-40	North of the scheme
Ninth section	41-46	North of the scheme
Tenth section	18 villages	North of the sheme / under construction

Table 1: Sections and villages in the Rahad scheme
Source: Planning and Research Administration 2010

Average village distance from the head sections is about 3-5 kilometers, and the distance of the sections from El Fau city varies from 15 kilometers, the nearest section, to 65 kilometers the farthest section (PLANNING and RESEARCH ADMINISTRATION 2010)

During data collection, a tenth section was planned to be established in the north of the scheme as the third phase of the Rahad scheme. The social development section of the scheme aims to introduce new crops that have higher economic return such as sugar beets and include agricultural manufacturing. Establishing section ten is expected to reduce migration to outside areas of the scheme, improve the level of income, and diminish local poverty (PLANNING and RESEARCH ADMINISTRATION 2010) .

3.9.5 Social services in the the Rahad scheme

During the initial years in the Rahad agricultural scheme, funding was allocated to relocate the population, prepare village sites, and extend funding for settlers to construct grass huts (BENEDICT et al. 1982). Five villages out of the 46 in the scheme already pre-existed before construction of the scheme; those villages were added to the newly established villages in the scheme (BENDEDICT et al. 1982). Village construction and settlement began first in the south of the scheme; then people from northern areas of the scheme were settled afterwards (BENEDICT et al. 1982). By 1981 almost all villages in the Rahad scheme contained at least one mixed primary school, one dressing station or dispensary, one market area used for marketing crops, livestock, or general market goods, a sand filter, and one public pipe (BENEDICT et al. 1982). Data collected from the Social and Economic Development Administration in the Rahad scheme shows that by 2006, there were 143 basic schools in the Rahad scheme, 31 secondary schools, 6 hospitals, 6 health centers, 41 dressing stations, 75 mosques, 102 khalwa, 30 kindergartens, 60 clubs, 36 water filters, and one TV station (RAHAD AGRICULTURE CORPORATION 2006).

In the Rahad irrigated scheme, there is a network of aging asphalt roads joining the different sections of the scheme with the headquarters at El Fau (RAHAD AGRICULTURE CORPORATION 2010). El Fau is connected with asphalt roads to Khartoum, the capital, and connected to Port Sudan; the main Port of Sudan (RAHAD AGRICULTURAL CORPORATION 2010). There are irrigation networks of canals and an electricity power station that works with 13.5 megawatts connected to the national electricity network (RAHAD AGRICULTURAL CORPORATION 2010).

There are four ginning factories for cotton ginning. There are the Rahad Agricultural Research Station, bank services, and telecommunication services. In the Rahad scheme there

are store houses of about 2000 m^2, and fuel tanks are available in different sections of the scheme (RAHAD AGRICULTURAL CORPORATION 2010).

3.9.6 El Fau locality as the headquarters of the the Rahad scheme

The Locality of El Fau lies in northwest of Gedarif state. It contains the southern and central parts of Rahad irrigated scheme, and El Fau city within the locality is considered the headquarters of the scheme (ABDEL RAHMAN 2010). The locality was established in 2003 (ABDEL RAHMAN 2010). It is considered the western gate of Gedarif; most of the locality hosts the Rahad irrigated scheme, which gave it economic importance in agriculture and livestock keeping (ABDEL RAHMAN 2010). The space in the El Fau locality is estimated to be 3,744 km^2 (ABDEL RAHMAN 2010). The locality contains 20 villages within the irrigated Rahad scheme (dependent on farming inside the scheme besides livestock keeping), and 26 villages outside the Rahad scheme depend on rain-fed farming and livestock keeping (ABDEL RAHMAN 2010). It contains 63 primary schools, 16 secondary schools, and 23 kindergartens (ABDEL RAHMAN 2010). It has 20 local markets, 23 water networks inside villages of the scheme, 3 wells, one *hafeer* (surface well) and two manual pumps (ABDEL RAHMAN 2010). There are 2 hospitals in the El Fau locality, 3 medical centers, and 18 health points. There are 122 mosques, 6 churches, and 25 (khalawa) local Quran schools (ABDEL RAHMAN 2010). The locality contains the administration of the Rahad scheme, police section, security, Zakat Dewan, taxation institute, mechanics and electricity workshop, Irrigation Administration, and the El Fau Court (ABDEL RAHMAN 2010). Civil societies in El Fau are the National Service, Public Defense, Public Police, Women's Union, and National Union for Sudanese Youth, and the Students' Union (ABDEL RAHMAN 2010). However, there are no International Governmental Organizations in the El Fau locality (ABDEL RAHMAN 2010).

Topography and tribes in El Fau locality

El Fau is inhabited with different tribes due to the settlement of the population in villages of the Rahad scheme and the coming of laborers mainly originating from western Sudan to work on the scheme (ABDEL RAHMAN 2010). Population in the El Fau locality is estimated to be 205,272 (ABDEL RAHMAN 2010). Major tribes living within El Fau are Kawahla, Rikabia, Shukrya, Galeen, Shaygia, Bawadra, Musalamia, Fulani, and Funj (ABDEL RAHMAN 2010). The mentioned tribes are the resettled tribes in the Rahad scheme (ABDEL RAHMAN 2010). Tama, Bargo, Noair, Denka, Gawamaa, Mysairia, Nuba, Rezyagat are examples of tribes working as labor sharers within the Rahad scheme (ABDEL RAHMAN, 2010).

There are four pathways for pastoral movements in the El Fau locality, while the total numbers of pathways in the eastern states are eight (ABDEL RAHMAN 2010). Pastorals start moving from south to north, crossing the Butana plains in the autumn and returning back to the south by the end of autumn (ABDEL RAHMAN 2010). Butana refers to the arid zone of eastern Sudan, which occupies an area of approximately 120,000 km² and lies between Latitude 13º 40' N to 17º 50' N and longitude 32º to 36º E(ABU SIN 1970; EL HASSAN 1981),cited by(EL HAG, 2006)

The pathways are demarcated roads pastorals use to walk within during their movement for grazing (ABDEL RAHMAN 2010). These pathways do intersect in certain points inside farming areas of the Rahad scheme (ABDEL RAHMAN 2010). As a matter of organization, the El Fau locality has initiated checkpoints in order to stop pastorals from intruding on the farms of the scheme (ABDEL RAHMAN 2010). These pathways within the El Fau locality are also used by tenants or farmers with a considerable number of livestock who graze their animals in Butana (ABDEL RAHMAN 2010).

3.9.7 Production relations in the scheme

Since establishment of the scheme, tenants were allotted different farming units according to type of crop planted (RAHAD AGRCIULTURAL CORPORATION 2010). For field crops tenants were given 9.2 hectares each to plant with cotton or groundnuts. In addition to those units, tenants were assigned 2 hectares for horticulture crops and 2 hectares for fodder crops (RAHAD AGRICULTURAL CORPORATION 2010). This crop combination was the cropping pattern for the first years of the Rahad scheme; however, changes in crops have been made according to farmers' needs and changes in agriculture policy. Sorghum, sunflower, wheat, and sweet corn were later introduced in the scheme (RAHAD AGRICULTURAL CORPORATION 2010; BENEDICT et al. 1982). Horticulture crops (vegetables/fruits) are seasonally grown for local consumption, while fodders (legumes and grass) are annually grown for livestock feeding (RAHAD AGRICULTURAL CORPORATION 2010; BENEDICT et al. 1982) (table 2 illustrates crops planted in 2008/2009). In addition to agricultural crop planting, the Rahad scheme allocated 5% of its space (3,000 hectares) as forests; it is owned by the Rahad Agricultural Corporation and not for tenants (RAHAD AGRICULTURAL CORPORATION 2010).

The total number of tenants in the Rahad scheme is 15,420 divided into 13,200 field crop farmers, 1,570 horticultural crop farmers, and 650 fodder crop farmers (RAHAD

AGRICULTURAL CORPORATION 2010). These farmers are distributed in the 46 villages where farmers were settled (RAHAD AGRICULTURAL CORPORATION 2010).

The production system in the scheme was based on tenancy arrangements; the tenancy is a non-mortgage, non-transferable farming unit of 9.2 hectares registered in the name of a single responsible individual (BENEDICT et al. 1982).

The crop rotation in the Rahad scheme was changeable according to seasons but the main pattern of cropping was cotton, groundnuts and sorghum as summer crops and wheat and sunflower as winter crops in addition to horticultural and fodder crops (RAHAD AGRICULTURAL CORPORATION 2010). The majority of tenants in the Rahad scheme maintained considerable amounts of livestock as many were agro-pastorals before settling within the scheme (RAHAD AGRICULTURAL CORPORATION 2010; GALAL EL DIEN 1975). In the initial years of Rahad, the corporation planned for animal husbandry as a way of livestock integration in the Rahad scheme, but there was no explicit policy towards livestock integration in the scheme (BENEDICT et al. 1982).

As a result tenants created their own means to integrate animals into the cropping system by letting animals graze on crops' resediual or in grazing areas outside the scheme (RAHAD AGRICULTURAL CORPORATION 2010).

Crop	Space
Cotton	20 hectares
Groundnuts	25 "
Sorghum	29 "
Sunflower/wheat	30 "
Fodder	2 "
Horticultural crops	2 "
Total	108 "

Table 2**:** hectares of crops grown in the Rahad scheme
Season 2008/2009
Source: Rahad Agriculture Corporation, 2010.

From the table 2 we notice the small space planted in relation to the space of the project. This was due to the problem of irrigation water shortages lately in the scheme (RAHAD AGRICULTURAL CORPORATION 2010).

The corporation was responsible for providing agriculture inputs and assessing costs against profits (BENEDICT et al. 1982). Tenants who were recruited and settled were responsible for farming the land and would receive the profits of their production (BENEDICT et al. 1982). However, for major cash crops such as groundnuts and cotton, farming operations were mainly done by machinery; other operations were performed by laborers (BENEDICT et al. 1982). Therefore according to BENEDICT et al. (1982), tenants in the Rahad scheme were mainly considered employees rather than farmers.

Since the 1990s, banks were the financing institutions of agricultural inputs for farmers instead of the government (EL AMIN and EL MAK 1997). In line with this policy, the Rahad Agricultural Corporation and the Farmers' Union were coordinating the process of finance in the Rahad scheme; in cases where farmers failed to pay the banks, the Rahad Agricultural Corporation would become responsible for paying the farmers' loans (EL AMIN and EL MAK 1997).

3.9.8 Laborers in the Rahad scheme

Establishment of large-scale governmental agriculture schemes such as the Rahad scheme in under-populated rain-fed areas or irrigated areas has generated a high demand for rural labor (BENEDICT et al, 1982). The Rahad irrigated scheme was planned with 300 tenants and 300 resident laborers for each village (BENEDICT et al. 1982). In the initial years of Rahad (1977-1982), there were not enough resident laborers to fulfill this plan, forcing tenants to depend on seasonal labor (BENEDICT et al. 1982). Many tenants, particularly agro-pastorals, preferred not to work on their own fields due to a lack of prior agricultural experience and a dislike for particular field operations such as cotton picking. This generated extra demand for labor attracted around 50,000-60,000 seasonal laborers of whom 95% migrated from western regions of Kordofan and Darfur (BENEDICT et al. 1982). This fact had led to the assumption that the earnings of the Rahad scheme did benefit other impoverished populations elsewhere in Sudan (BENEDICT et al., 1982). Laborers in the Rahad scheme worked on picking cotton, weeding, and cleaning crop residues (BENEDICT et al. 1982).

Permanent resident laborers maintained more extensive relations with tenants, and many such laborers hoped to eventually obtain tenants (BENEDICT et al. 1982).

Over the course of several years, the laborers'situation within the Rahad agricultural scheme has drastically changed, forcing new realities (BENEDICT et al. 1982). Dynamics such as population increase and famines in other parts of the country resulted in growing laborers communities within tenant villages (ABDEL RAHMAN 2010). Therefore, laborers in the

Rahad irrigated scheme began competing for social services such as schooling, health facilities, potable drinking water, and other social services (ABDEL RAHMAN 2010).

3.9.9 Impact of government economic policies on the Rahad scheme's performance

In Sudan there have been many structural adjustment programs implemented by the government aiming to lift up the poorly performing economy (EL AMIN and EL MAK 1997). Amongst those programs were the Economic Recovery Program (ECRP) from 1978-1985 and the National Economic Salvation Program (NESP) from 1990-1993 (EL AMIN and EL MAK 1997). In the following part, we will discuss these two programs in relation to their significant impacts on agriculture, especially the irrigated sector.

The aim of the ECRP was to attain balanced payments, high rates of investment, and economic growth through the devaluation of the Sudanese pound, followed by attempts to adopt a high demand and management policy (EL AMIN and EL MAK 1997). The program policy measures in the irrigated sector were to introduce an individual account system of production relations (Gezira scheme), a general rehabilitation of major public agricultural schemes, and a reduction of export taxes from agricultural exports, thereby dismantling the monopoly of parastatal marketing corporations (EL AMIN and EL MAK 1997). The individual account system meant that each tenants paid a fixed land and water charge that varied from one crop to another (EL AMIN and EL MAK 1997). Costs of production were charged by unit areas, providing incentives to increase yields. Agricultural corporations such as the Rahad Agricultural Corporation continued to control irrigated schemes, and the government continued to control crop rotation and farm gate prices of cotton, wheat, and gum Arabic (EL AMIN and EL MAK 1997). Agricultural corporations also continued to recover land and water charges of all crops from cotton, because the government controlled cotton, while farmers managed the marketing of the other crops. This made cotton production relatively less profitable (EL AMIN and EL MAK 1997). Marketing of export crops, which was done by companies, was evaluated as less efficient, but little was done to improve the companies' marketing policies (EL AMIN and EL MAK 1997).

Companies disappointed producers by keeping prices of crops at a low level compared to international prices (EL AMIN and EL MAK 1997) . The Bank of Sudan provided production input credits for agricultural corporations, which was mostly regarded by farmers as subsidy from the government (EL AMIN and EL MAK 1997). This process resulted in an

accumulation of debt against agricultural corporations, a fact that significantly hindered their efficiency, including the Rahad Agricultural Corporation (EL AMIN and EL MAK 1997).

In a rescue attempt to counteract the effects of the ECRP, the government initiated the three programs of the National Economic Salvation Program from 1990-1993(EL AMIN and EL MAK 1997). The NESP aimed to liberalize the economy through deregulating commodity prices and removing administrative and legal barriers in order to stimulate agricultural exports (EL AMIN and EL MAK 1997).

The main NESP policy measures in the agricultural sector were to remove subsidies on goods and services provided by agricultural corporations, most of which were fertilizers, pesticides, land, and water. Shift the financing of agricultural corporations to commercial banks instead of the state represented by the Bank of Sudan, and reinforce the role of the private sector on agriculture (EL AMIN and EL MAK 1997). As a response, some agricultural corporations were identified as targets for privatization such as the Gezira scheme, the Rahad Agricultural Corporation, El Suki Agricultural Corporation, and New Halfa Agricultural Corporation (EL AMIN and EL MAK 1997). The board of directors of these corporations was reconstituted with the Farmers' Union given 50% of seats in order to enhance the farmers' role in decision making (EL AMIN and EL MAK 1997). In the study area of the Rahad scheme, the Rahad Agricultural Corporation was dissolved, and Kinana for Integrated Agricultural Solutions entered on a share with the Rahad scheme Farmers' Union and became responsible for managing the scheme (MINISTRY OF AGRICULTURE and NATIONAL FOREST CORPORATION2010).

3.9.10 Private sector in Rahad scheme

In 2006, the president of the Sudan announced a program of agricultural revival in Sudan (CEM 2009) (see 3.3.4) In the agricultural sector, this program was manifested through the privatization of ginning factories, agricultural machinery, and railways in the Gezira scheme and the privatization of other agricultural corporations (MINISTRY OF AGRICULTURE and NATIONAL FOREST CORPORATION2010). This privatization would be implemented by restructuring the administrations of agricultural corporations, rehabilitating the agricultural schemes managed by the corporations, and reallocating them to the private sector (MINISTRY OF AGRICULTURE and NATIONAL FOREST CORPORATION2010).

The federal Ministry of Agriculture and Forests asked the Kinana for Integrated Agricultural Solutions (KIAS) Company to participate in the management of the Rahad irrigated scheme (KSC 2009). This management would be practically achieved by making agreements with

landlords and farmers in order to make a substantial movement in farming and applying agricultural packages within these schemes (KSC 2009). So on September 13th, 2009, the Federal Ministry of Agriculture and Forests assigned a contract with KIAS to invest in a number of agricultural schemes including the Rahad agricultural scheme (KSC 2009). The Ministry of Finance and National Economy and the Ministry of Irrigation and Water Resources signed an agreement with KIAS on September 23rd, 2009, that enabled KIAS to manage irrigation operations in the Rahad agricultural scheme (KSC 2009).

Accordingly KIAS signed an agreement with the administration of the Rahad scheme (Rahad Agricultural Corporation) and the Rahad Farmers' Union that allowed KIAS to manage the Rahad irrigated scheme according to a detailed agreement with the Rahad Corporation and the farmers through the Farmers' Union (KSC 2009).

KIAS would farm 50% (almost 73,849 hectares) of farms in the Rahad scheme in the summer season. Farmers would farm the remaining 73,849 hectares (KSC 2009). In the winter season, KIAS would farm 100% of the Rahad scheme (KSC 2009). Cost and benefits would be divided at the scheme section level (KSC 2009). Profits of crops planned by the company and farmers would be divided after harvest and marketing into 50% for the farmers, 40% for the company, and 10% for social services in the area of the scheme (KSC 2009).

The timeframe of the agreement between the Kinana company, Farmers' Union, and Rahad Corporation is 20 years and can be renewed (KSC 2009).

The experience of KIAS in the 2010/2011 season was challenging, the company forced hard regulations on the farmers and followed different crop management operations, which generated a negative sense from farmers towards the company, although the Rahad Farmers' Union was the institution that represented farmers in the share. Moreover, KIAS production in the mentioned season was less than expected (120 kg per 1 hectare, the optimum is 4,000 kg per hectare) (FIELD DATA 2011).

The low production for the company in the first season led the Agricultural Bank to cease financing the 2011/2012 agricultural season. The company had to depend on its own capital to finance production. According to discussions with KIAS staff (interviewed in September, 2012), the financing from the company is weak compared to financing from the Agricultural Bank. The company withdrew from the Rahad irrigated scheme in June 2012 and removed all their equipment, machinery, and staff.

According to the interviewed KIAS staff, the Ministry of Agriculture has assigned a general manager for the Rahad irrigated scheme, and an administration council has been formed. The administration council has appointed personnel and managers of sections in addition to a farm

unit. Presently after KIAS quit the Rahad scheme, there is a problem on financing. The Agricultural Bank cannot finance after the loss with KIAS. Farmers individually planted half of their farm space with Sorghum and groundnuts but did not farm cotton. The situation in the Rahad scheme is now very uncertain; it is not exactly known whether private institutions would re-enter the Rahad scheme, and it is likewise unknown if the government will resume responsibility for financing the scheme. It can be said that the agricultural innovation in the Rahad scheme is open for many possibilities of change.

The existence of KIAS in the Rahad scheme during data collection (2010-2011) did not change the initial questions that rose from the RAAK study. Researchers tried to listen and sometimes go around critical questions raised by farmers about KIAS and what the future of the scheme would be.

4 Methodological framework of the study

4.1 Quantitative research, Qualitative research and mixed method research

Quantitative research is linked to the view that social research should adopt scientific methods including testing hypothesis by data that takes the form of quantitative measurements. These measurements include gathering, analysis, interpretation and presentation of numerical information (TEDDLIE and TASHAKKORI 2009).

Research hypothesis in quantitative research is a specified research questions on which researcher make prediction based on previous theory about the relation among social phenomenon before conducting the research (TEDDLIE and TASHAKKORI 2009). BRYMAN (2001) had mentioned that one of the main steps for quantitative research that the researcher would deduct a hypothesis from theory to test it.

Probability sampling is associated with quantitative research and indicates the selection of a large number of units from a population randomly (TEDDLIE and TASHAKKORI 2009). Sampling is also referred to as selection of research sites and selection of research subjects (BRYMAN 2001)

Quantitative statistical analysis is the analysis of the numerical data using techniques that include, simple description of the investigated phenomenon or looking for significant differences between groups or among variables (TEDDLIE and TASHAKKORI 2009) Once research findings are written and published BRYMAN(2001) thinks they become part of the stock knowledge or theory in their domain. Scholars such as Bryman, 2001 arguing that steps of quantitative research entails validity and reliability of quantitative research, specifically, testing of theories by translating concepts into measurements.

Qualitative research has been defined by DENZN and LINCOLIN (2008: 4) *as ''a situated activity that locate the observer in the world, it consists of a set of interpretive material practices that make the world visible''.*

BRYMAN (2001) argues that in qualitative research, instead of testing a theory, it's an assumed that we know very little about the situation which we want to study. Therefore, the researcher would raise general questions about the situation or the phenomenon needed to study. In this regard qualitative research is raising exploratory questions about the unknown phenomenon studied by the researcher (TEDDLIE and TASHAKKORI 2009). Qualitative research could be ethnographical research, and case studies (TEDDLIE and TASHAKKORI 2009).DENZIN and LINCOLIN (2008) have added to qualitative research, personal

experience, life story, introspection, artifacts, and cultural texts and productions, observational, historical, interactional, and visual texts.

After research questions being raised, the next step in qualitative research is selecting relevant research sites and collecting relevant data (BRYMAN 2001) Purposive sampling is typical in qualitative research which is selecting a relatively small number of units that provides valuable information related to research question (TEDDLIE and TASHAKKORI 2009).

Ways of data collecting in qualitative research include field notes, interviews, photographs, recording, memo to the self, and conversations (DENZIN and LINCOLIN2008). The data need to be examined and interpreted (CORBIN and STRAUSS 2008). To interpret the data the researcher will develop his/her own analytical tools, although some scholars have set some check lists for coding data (CORBIN and STRAUSS 2008). In qualitative research, if the data collected elicited no new insides researcher can narrow down his s research questions and collect more data (BRYMAN 2001)

By writing up research findings, the researcher would be able to develop his grounded theory from the analyzed data (BRYMAN 2001; TEDDLIE and TASHAKKORI 2009). Grounded theory is methodology connected to qualitative research mean building theory from a narrative data that has been intuitively analyzed (CORBIN and STRAUSS 2004; TEDDLIE and TASHAKKORI 2009).

A mixed research can be use to address confirmatory and exploratory questions (TEDDLIE and TASHAKKORI 2009). Confirmatory questions are related to quantitative research where a theory or theoretical framework is being tested in the ground to assure its validity within the tested setting where exploratory questions are related to qualitative research (TEDDLIE and TASHAKKORI 2009). Therefore deductive and inductive logic is used in mixed method research which means researcher is arguing depending on theory (TEDDLIE and TASHAKKORI 2009). Quantitative and qualitative studies can occur parallel either simultaneously or with some times laps (TEDDLIE and TASHAKKORI 2009) BRYMAN (2001) is arguing that qualitative research and quantitative research should not be looked at as contradictory disciplines but as complementary ones. In other words quantitative research results can be used to analyze qualitative research and vise versa

Mixed method research can be used to address the same research questions (TEDDLIE and TASHAKKORI 2009). Purposive sampling and probability sampling is used in mixed research (TEDDLIE and TASHAKKORI 2009). Probability sampling is associated with quantitative research and indicates the selection of a large number of units from a population randomly (TEDDLIE and TASHAKKORI 2009).

Accordingly data analysis in mixed research is an integration of statistical and thematically techniques besides triangulation and data conversion (TEDDLIE and TASHAKKORI 2009). Triangulation is the comparison and combination of multiple information sources, data collection, and data analysis procedures (TEDDLIE and TASHAKKORI 2009). Data conversion is converting qualitative data to numeric ones, and converting quantitative data to narratives (TEDDLIE and TASHAKKORI 2009).

According to the mentioned characteristics it is possible in mixed method research that the researcher can move from concluding certain grounded theory using intuitive analysis (TEDDLIE and TASHAKKORI 2009) .Then the researcher can test this theory or predict its performance in the particular setting using deductive analysis (TEDDLIE and TASHAKKORI 2009).

4.2. Knowledge and information system perspectives to view agricultural innovations

The knowledge and information system is a perspective developed by Röling and others at Wagenningen University (cf. RÖLING 1986, 1988,) cited by (ENGEL 1997, 23).

The perspective views the performance of social organizations of innovations as relationships interplayed by different actors more than seeing innovations as a technological process that requires certain materialistic inputs and outputs. It is the relationships and integrations of actors that ease the performance of the innovations or constrain them (cf. RÖLING, 1986, and 1988) cited by ENGEL 1997, 23).

Reasons for choosing the knowledge and information system perspective by social scientists to study innovations are many. First, the system has the potential to diagnose the innovation configuration at macro- and micro-levels in other word human actions or relations towards innovations are studied at different levels; perspectives can range from the relationship of two farmers to relationships between agro-business institutions (ENGEL 1997).

Second, it focuses on sharing knowledge among relevant stakeholders and not only on extension as the source of information; policy makers, education, and research institutes are also responsible for disseminating information and ideas so that innovations can bring better technological and social outcomes (ENGEL 1997).

Third, the knowledge and information system perspective has managed to raise radical questions about the classical definition of individuals within agricultural innovations as innovators, adopters, laggards, or worse. Instead, a more comprehensive understanding of

human agency through the system perspective is provided, *"What people know and do is intrinsically related."* (ENGEL 1997, 23)

Since certain farmers or groups of farmers reject applying certain technologies, there is a need for us to look to surrounding institutions, circumstances, and how the farmers are related to them. Moreover, in this regard, issuing of local knowledge and how farmers are deeply related is also vital, and the knowledge and information perspective can be realistically considered (ENGEL 1997). .

Finally, according to the knowledge and information perspective, agricultural innovations are *"social efforts that require joint competence of interrelated actors rather than the sum of individual competences"* (ENGEL 1997, 23). Since the system can provide a diagnostic framework for analysis and design management of interventions, we thought the perspective can be very useful for approaching our research question; it can first help us study the relationships of actors in the study area and how they communicate information with each other. Furthermore, it can help us suggest a basis for developing approaches to improve the performance of actors in the Rahad irrigated agricultural scheme.

4.3 System thinking and soft system thinking to facilitate innovation

System thinking is an approach developed by scientists to study the world and how to intervene in it; system thinking may not be the only valid way to do so but it has been adopted widely by many disciplines (ENGEL 1997). Although there is no agreed definition on what system thinking is in literature, it is referred to as the thinking that *"establishes one or more constructed abstract wholes or systemic imgages, which can be set against the precieved world to help us to study it"* (SCHECKLAND and SCHOLES 1990) cited by (ENGEL 1997,24). Scientists who developed system thinking view the natural or social phenomena as an adaptive whole in order to study the system; they develop abstract constructs or system images that are believed to represent the real world in order to help study it.

The aim of such thinking of the world around us will be either to implement adequate interventions or learn more about the world (ENGEL 1997).

In accordance with this development of system thinking, there are two traditions: hard system thinking and soft system thinking.

Hard system thinking understands the world to be systemic; in other words hard system thinkers takes their systemic images to be models and images to create a system that is supposed to represent the real world (ENGEL 1997) . Those images are representations of the system to be investigated. The more closely the outcomes predicted by the images to the

observed events in the system, the better the supply of knowledge and better function of the system (ENGEL 1997). Another character of hard system thinking is its emphasis on the process of transformation; the function of the system happens through transformation of inputs to outputs captured in systemic images (FRESCO 1986) cited by (ENGEL 1997, 25). In this case of system function, the systemic images are called black boxes that specify only incoming and outgoing relations (KRAMER and DE SMIT 1987) cited by ENGEL 1997, 25). To explain this, in our opinion, the household farm model developed and adopted by many economists, is actually a systemic image that represents farm relations as inputs of farm labor, land, capital, and outputs of production units and expenses. Finally in hard system thinking, *"a system is a limited part of reality with well-defined boundaries"* (RÖLING 1994) cited by Engel 1997, 25).

However, soft system thinkers do not understand the world as systemic; neither is systemic images representations of the real world, but instead, systemic images in soft system thinking are used to build instruments of enquiring the system (ENGEL 1997). They are windows to the real world. In this case system images are constructed to develop different perspectives of the studied world. The system images are constructed to reflect different worldviews, which means the methodology of inquiry within soft system thinking could be a learning process (ENGEL 1997). This led to the fact that soft system thinking usually does not provide a methodological approach to intervention as in hard systems, but it provides a basis for the development of approach for interventions (SCHECKLAND and SCHOLES 1990) cited by (ENGEL 1997,25-26).

In contrast to hard system thinking, soft system thinkers believe that the system they are studying is not a limited part of reality that has defined boundaries, but the system *"is a construct with arbitrary boundaries for discourse about complex phenomena to emphasize wholeness, interrelationships, and emergent properties"* (RÖLING 1994) cited by (ENGEL 1997,25).

Therefore soft system thinking could be a useful perspective to understand complex situations in which stakeholders may hold different views of their problems, goals, and options to achieve the goals. Concerning these characteristics, scientists found soft system thinking to be a useful methodology for studying the situations of social organization of agricultural innovation (RÖLING 1989; ENGEL 1997).

Accordingly, we choose soft system thinking methodology to understand the roles, objectives, and knowledge sharing among social actors within the Rahad irrigated scheme. Furthermore,

we use the same methodology to suggest approach/es that can improve relations and knowledge networking among social actors of the scheme.

However, soft system thinking has been criticized for its inability to solve conflicting views of social actors in order to achieve innovation objectives (ENGEL 1997). In other words, soft system thinkers when studying systems do seek harmonizing among social actors, while harmonizing in agricultural innovations could be one situation among many. Therefore soft system thinking is a very simple approach to power struggles and conflict among actors. However, soft system thinking can provide opportunities for conflicting actors to negotiate their convergent and accommodating ideas if actors of innovation are basically involved in a continuous probe of conflicting ideas (ENGEL 1997).

4.4 Why RAAKS is used as a methodology

Beyond farmers first concept assumes that communities are formed by actors (local and non local people) who have different interests, goals, and access to resources (SCOONES and THOMPSON 1994). Therefore those actors would inter into different relations and networks to utilize the resources (SCOONES and THOMPSON 1994). Through discursive networks, different kind of information and process are communicated and legitimatized (SCOONES and THOMPSON 1994). As a result a diffuse and fragmented knowledge is shared through discontinuous and inequitable interactions between the competing actors (SCOONES and THOMPSON 1994). On this line ENGEL (1997) have discussed the notion of social organization of innovations that actors of agriculture innovations would enter into different relation network to communicate information and ideas to go about innovations. On the contrary communities were viewed by farmers' first populists as complex, diverse, and risk prone environment who shares common interest, goals and access to resources (SCOONES and THOMPSON 1994). Knowledge of local communities according to this view was understood as unitary, systemized and easily to assimilation and incorporates with outsiders' (SCOONES and THOMPSON1994).Therefore types of investigating communities or innovations settings would differ according to the investigator's idea about how information and knowledge and information are processed within communities (SCOONES and THOMPSON1994).

Researcher identity as a positivist or constructionists can also play a role on type of questioning innovations settings (ENGEL 1997).

Hard system methodologies such as standard questionnaires could be useful to find solutions for already identified problems on the ground where development activities or projects can be

designed (SCOONES and THOMPSON 1994). Standard questionnaires would be improper to investigate communities if investigator aims to understand network of relations among actors' settings such as farming communities (SCOONES and THOMPSON 1994). Improving or developing of communities according to soft system thinking is a transaction process involves negotiations by different actors over divergent goals (SCOONES and THOMPSON 1994). Soft system methodologies such as RAAKS can be a learning process to plan bridging or connecting actors of innovations (SCOONES and THOMPSON 1994). RAAKS would not put answers for questioned situations but it would help to develop approaches for changes or improving the network of actors or performance of actors (ENGEL 1997). According to this logic the researcher chose not to use a positivist or quantitative approach to investigate knowledge networking within Rahad scheme in Sudan. On this research performance of Rahad scheme is believed to be depending on how knowledge and information are shared between actors of the scheme. So in order to improve the innovation or the outcome agriculture systems, we need to question the roles, and relations of different actors who are interacting to realize that innovation which is settlement of agropastorlaists to practice irrigated farming.

If we need to improve the performance of actors of Rahad scheme we need to go into participatory enquiring proccess during which the researchers would discuss actors' roles and network of relations. The result of the enquiry would be approaches or actions believed to improve Rahad scheme actors' network.

4.5 RAAKS as an empirical methodology of soft system thinking

RAAKS or rapid agricultural appraisal knowledge system is a tested participatory action research methodology used to enquire about knowledge systems including agricultural innovations (SCHECKLAND and SCHOLES 1990) cited by (ENGEL 1997, 164). It evolved and was developed by social scientists at the University of Wageningen, and was tested in many developing countries, e.g., Tanzania and the Philippines (ENGEL 1997).

RAAKS is a methodology that facilitates the understanding of complex situations such as social organizations of innovations, meaning RAAKS is used to approach agricultural innovations with change but does not give direct answers to innovation problems (SALOMON and ENGEL 1997). This approach to change begins by forming a team to diagnose the social organization of a certain innovation. Members of the team are usually resource persons, 'experts on RAAKS,' and actors of the innovation. According to SALOMON and ENGEL (1997), the team of RAAKS in the process of investigation will be

aiming to better the organization, conduct decision making, exchange information among actors in order to increase awareness among actors with respect to opportunities and constraints that affect their performance, and finally identify actors and potential actors who do or could act effectively to remove constraints and use opportunities to improve innovative performance and encourage their commitment to such changes.

To achieve the mentioned objectives of RAAKS in a certain innovation setting, there is a need to design a RAAKS study; the study would be implemented in phases, and each phase would have its constructed images or windows to diagnose and better organize innovative performance of studied actors. Those windows are analytical tools or perspectives designed to approach the system under investigation and set it in accordance to RAAKS objectives.

In the following part RAAKS phases are procedurally discussed.

4.5.1 Phases of RAAKS

Phase A: definition of the innovation problem

The aim of this phase is to identify opportunities to improve the knowledge and information system; accordingly facilitators define the boundaries of the system to be studied and the actors to be included. Secondary data and brainstorming are among the windows to be used in this phase in order to have more specifications about the problem.

During this phase, actors have different views on the problem defined, so it is possible that many windows can be used to try to narrow down different perspectives of actors in this stage. By the end of the phase, there should be '*a first approximation of the knowledge system and the way relevant actors act and interact in their search of information that can lead to innovation in their practice*' (SALOMON and ENGEL 1997,31)

Phase B: analysis constraints and opportunities of innovation

In this phase, RAAKS team members will get more details on how actors organize themselves or interact within the innovations. To do so members will go to fields to do key informant interviews; key persons will be interviewed since their opinions will reflect those of actors in the innovation. Windows used in this phase are to know the impacts of actors, their performance of tasks, their characteristics, their linkages, communication, coordination, and the knowledge network. Windows of the phase are numbered B1 to B8. It is worth noting that the team is not obligated to use all the windows, but the choice depends on the situation and apparent priorities. The phase results in *'a more detailed picture of how different networks of actors interact, what issues are dominating their discussions, and how they coordinate their activities or fail to do so'* (SALOMON and ENGEL 1997,32).

Phase C: strategy to improve the performance of the innovation

Strategies or plans of action to improve actors' coordination or communication within the innovation are formulated and discussed. This can be achievable when a comprehensive analysis for the constraints and opportunities identified in the second phase is done using the three windows of this phase. Windows in this phase are used to analyze the potentials of actors to carry out the specific strategies needed to change actors' communicative behavior. RAAKS developers think '*involving some or all representatives of actors in all phases of RAAKS will stimulate actors' commitment to put plans into reality*' (SALOMON and ENGEL1997, 33).

It worth noticing that the phases of RAAKS need not be implemented in order or as it is constructed; the phases can be interchangeably implemented. For example during implementation of phase A, the team can go to the field and interview some key informants as well. Moreover, the time frame between phases of RAAKS is flexible and can be decided according to the aim of the study; usually the last phase will need more time to be accomplished, maybe 5-6 months. In some studies seen in literature, the first phase of RAAKS is done in one day, second phase in four days; however, the third phase is finished in five to six months (HULESBOSCH 2001).

Prior to conducting the RAAKS study, an orientation on the methodology needs to be made for actors participating in the study, especially the ones on the RAAKS team.

How RAAKS was used by the researcher in the Rahad agricultural scheme

In the following sketch (see figure 6), we thought that within the Rahad agricultural scheme, information flows among and between different social actors within the innovation. This flow of information materializes in certain communications and relations among the actors. This networking characterizes actors' performance in the innovation over time. Knowing that the Rahad scheme is an innovation that has been implemented by formal institutions to practice irrigated farming, the situation by necessity poses an interesting question of how communication and coordination have been taking place between those different actors in order to realize the Rahad scheme. Conducting a RAAKS study by interviewing actors at administration level of the scheme and actors on villages will help us understand how actors have been networking in order to facilitate the innovation, and then we can eventually formulate proper strategies for improving actors' networking.
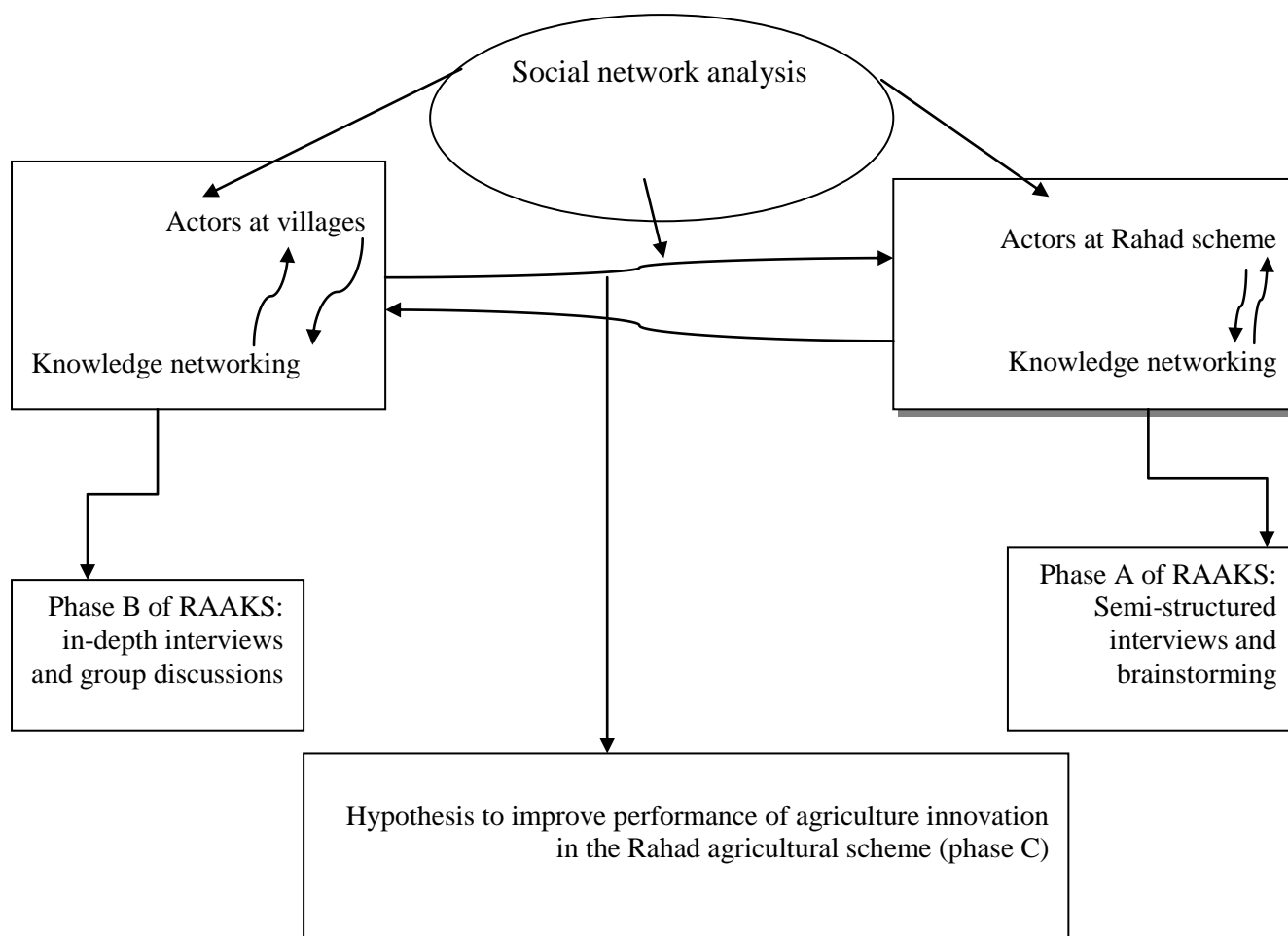
Figure 6: Sketch for research design
Source: own preparation

Figure 6 is a diagram showing how researchers conducted RAAKS in the Rahad agricultural scheme; l actors at Rahad scheme means the Rahad scheme administration, ministries, research institutes, education institutes, investment, and the private sector actors at villages scheme are individuals and associations of agro-pastoralsthose were settled to practice irrigated farming. Understanding the flow of information within and among both actors will improve the performance of agricultural innovation. Social network analysis is used to analyze part of the RAAKS research study.

Actors at the level of the Rahad scheme are institutions whose members represent the Rahad scheme management, government, extension, research, education, investment, and the private sector; those institutions have to be concerned with agricultural innovation in Rahad. This imagined picture allowed us to include wide categories of actors within the scheme.

Actors at the level of villages are the individuals and associations that are identified as the agro-pastorals, who were the focus during implementation of the Rahad agricultural scheme.

This imagined picture of local actors in Rahad allowed us to include wide categories of those actors within the scheme: farmers and their associations, women groups, youth groups, and elderly people.

4.5.2 Preparing for RAAKS in the Rahad scheme

Prior to using the analytical tools of RAAKS, the researcher introduced the research problem to one of the farm managers in the Rahad scheme, who welcomed the presence of the researcher and volunteered to participate in the study, (he was the first actor to be identified). There researcher was directed to select RAAKS team members from agricultural extensionists who worked for the Ministry of Agriculture within the El Fau Locality where the Rahad scheme is geographically situated. One female extension worker and one male volunteered to be on the RAAKS team.

It was hard to find members from the Rahad scheme management to be included in our RAAKS research. The reason given to us was that the staff was preoccupied by the incoming KIAS private company that was entitled to share the Rahad scheme with the farmers. This fact actually interrupted us further along in our study because our actors would always bring the issue of sharing with this private company in interviews and discussions. However, the RAAKS team tried to be flexible and listen.

A one-day workshop was conducted at the El Fau locality building to orient RAAKS members about the methodology. This was not fully understood, but the researcher hoped that application of the phases would improve the team's perception of RAAKS. To be honest, the researcher herself did not get proper training on RAAKS (only two meetings with one of the founders of RAAKS) but the research itself was a learning process to her and day by day she could get more insights into the methodology.

Phase A

To get a general understanding of knowledge networking among social actors in the Rahad scheme, or to clarify our problems on how the relationship and communication between formal actors and local actors in Rahad are taking place, we used most windows of phase A and selected windows of phase B (see pages 305,306); that is to say we investigated who were actors in the Rahad scheme, what are their roles, objectives, and tasks (what they actually do), how they perceive the performance of the scheme within the given social, political, and ecological environment surrounding the scheme, what sources of information are available to them, and what cultural communication problems exist between them. The team managed to

interview 15 relevant actors within the Rahad scheme in the first phase of RAAKS, and did one brainstorming session with eight actors who managed to show up.

Phase B

To get a more precise picture of Rahad actors networking, we conducted key informant interviews and a group discussion with local actors in the Rahad scheme (see pages 307,308, 309). The team did 32 individual interviews, and 11 group discussions. The reason to have this number of interviews in qualitative research is due to the geographical and social combination of the Rahad scheme. The scheme is divided into three areas: north, middle, and south, and populated with different ethnic groups (see literature section).

Phase C

In order to improve the performance of the Rahad scheme, the researcher suggests that actors need to manage their knowledge on farming and livestock keeping within the scheme. Knowledge management is the "initiation, direction, and control of purposeful activities" (VAN HACK cited by ENGEL 1997). Knowledge management can be the future activity for actors of the Rahad Irrigated Scheme. It can be implemented in two stages. First they need to conduct training workshop where actors can decide the need to categorize their knowledge management tasks, find out which of the actors are policy makers, which are projects designer, etc. (ENGEL 1997) (. Actors need to define whom each actor needs to contact in order to do the task and why (ENGEL 1997). Then actors at the scheme level need to define which of the actors at the village level are their respective contacts or beneficiaries (ENGEL 1997). The next step of phase C, extension in the Rahad scheme, is suggested to weave connections and create relations at different levels within the scheme (KREBS and HOLLEY 2004).

4.5.3 Sampling

Firstly, the researcher had categorized tow levels of respondents to conduct the research study; actors at level of Rahad Scheme and actors at level of villages. Actors at level of Rahad scheme means representative of government institutions and representative of farmers' organizations at administration of Rahad scheme (phase A& B). Actors at level of Rahad scheme were interviewed in El Fau city, head quarter of Rahad scheme Actors at level of villages are individual farmers, representative of farmer's organization at village levels, youth groups, women's associations, and elder people such as local sheikhs, teachers and traditional medicine men (some of phase B). Rahad scheme is administratively divided into northern

scheme includes 15 villages central of the scheme includes 15 villages and southern of the scheme contains 16 villages (RAHAD AGRICULTURE CORPORATION 2010) To interview actors at level of villages researcher selected tow villages from every sections of the scheme making 6 villages interviewed out of 64 villages.

Purposive sampling is the main sampling technique used by the researchers using semi structured interviews (BRYMAN2001).Snow ball technique was also used to include more actors defined by the first interviewed actors at village levels and scheme level (BRYMAN2001).

To fill gaps of missing information researcher did key informant interviews with actors concerned with Rahad scheme but located outside the scheme area. Ex, Khartoum, capital of Sudan.

4.6 Social network analysis

In order to analyze the research study data, social network analysis measurements were used. Social network analysis is a methodological perspective that has been developed within the social sciences domain. According to WASSERMANNand FAUST (1994), social network analysis stems from the importance of the relations connecting interacting entities. Therefore the analysis does not view the individual entities as the unit of analysis, but it considers individual entities and the relations connecting them as the unit of analysis (WASSERMANN and FAUST 1994). Those individual entities could be individuals, groups of the same type or identity, or they could be of different types. Entities in social network analysis are called actors, who are individual entities connected to others with relationships (WASSERMANN and FAUST 1994). Relationships connecting actors are known as relational ties; there could be different kinds of relationships connecting actors, i.e. biological relations, affiliations, behavioral interactions and others (WASSERMANN and FAUST 1994). In social network analysis, the focus is on the dyads, which are the pairs of actors connected with relationships, triads, or three actors connected with relationships, and subgroups of any set of actors and all relations defining them (WASSERMANN and FAUST 1994). In social network analysis, certain measurements are performed; a group is the set of actors on which network measurements can be calculated (WASSERMANN and FAUST 1994). In order to give a complete picture of what social network analysis is, it is defined as the network that consists of a finite set or sets of actors and the relationship or relationships defined in them (WASSERMANN and FAUST 1994). Hence our research is concerned with understanding how information is being communicated between actors of the Rahad scheme; it is important

to see how actors are related to each other in the scheme. Therefore, social network analysis is a suitable analytical perspective to approach answering some of the research questions. Measurements of social network analysis are presenting in the following section (WASSERMANN and FAUST 1994).

4.6.1 Measurements of social network analysis

In this section, some of the measurements that are used in social network analysis will be presented, stressing the measurements that were used by the researcher.

Socio-gram or a graph is one way of representing relational matrix data, where some elements, represented as points in the graphs, are connected by lines. The lines are representatives of different types of relationships that connect the elements (SCOTT 2000).

In graphs the pattern of connections matters, but not the size or the position of the points in the graph. Therefore, graphs are always used to express directed relationships, undirected relationships, and valued relationships. In the directed graphs, the pattern of relation can be traced from one point to another. *"The directed graph is represented in a drawn form; attaching an arrow head to each line direction of the arrow indicates the direction of relation"* (SCOTT 2000, 65). In undirected graphs, one point can be a receiver or sender of relation to corresponding point. If the intensity of the relationships is important, it can be represented in a numerical value, so a graph can be constructed based on which numerical values are indicating the relationship (SCOTT 2000).

In multiplicity, more than one type of relationship exists between points, and frequencies of contacts between elements are examples of relationships that can be expressed in valued graphs (SCOTT 2000).

In the Rahad scheme formal network, graphs have been used by researchers to indicate the direction of relations between defined actors and the strength of actors' relationships was expressed in valued graphs using Netdraw software techniques (BORGATTI and FREEMAN 2002).

Geodesic distances

In graphs, two points connected by lines are adjacent to one another; points can be connected directly by line, or indirectly by sequences of lines, or a "walk" (Scott, 2000). When points in a walk are connected by distinct lines, the walk will be called a path, and the lines making up the path are called the length of the path. Therefore, the distance between two points

connected by a line is actually the length of the shortest path connecting them or the geodesic distance between the two points (SCOTT 2000).

Geodesic distance also means the number of relations in the shortest possible walk from one actor to another. The most optimal connection between two actors is called the geodesic path. Therefore, geodesic distance between two actors can also be the count of the number of links in the shortest path between them (BORGATTI et al. 1999).

To calculate geodesic distances in Rahad, we ran UCINET 06 software (BORGATTI et al. 1999). Our aim was to describe the connectedness and cohesion of the Rahad network generally rather than explaining geodesic paths or distances between actors separately.

Knowing the connectedness of actors in the network will help us know how easy or difficult the communication and flow of information among the actors in the network are. Then our intended strategies to improve the information network in Rahad can be logically worked out.

Density

Density of a graph is the general level of linkages or lines among the points of the graph. A complete graph is one where all points are adjacent to one another, which rarely happens in reality. Studying graph density is a way to understand how far the graph is from completion by measuring the overall distribution of the graph's lines (SCOTT 2000).

Measuring the density of a graph is comparing the actual number of lines present in a graph with the total number of lines that would be presents if the graph were complete (SCOTT 2000).

Densities of graphs are calculated according to the direction of relationships in graph; in directed graphs, the direction of relationships from A to B will not involve a reciprocal relation from B to A. Moreover, every point is connected to another point except for itself, which means the number of connections in a directed graph is n (n-1). Therefore, the density of a directed graph is calculated as J/n (n-1), where in undirected graphs the number of lines that connect the points is half of the connections in directed graphs or n (n-1)/2. Accordingly, density in undirected graph is J/n (n-1)/2 (SCOTT 2000).

Scholars such as MITCHELL (1989) argue that in order to get concrete measurements of density, it is important not only to calculate the overall connections in the graph but to measure the linkages surrounding certain elements or points in the graph, the "eco-centric density." Others such as BARNES (1974) mentioned that the graph's "socio-centric density" is a distinctive contribution of social network analysis (SCOTT 2000, 71-72).

Density can be calculated according to different types of graphs: directed, binary, or valued graphs (HANNEMAN and RIDDLE 2005). However, SCOTT (2000) argued that it is

difficult to calculate density of valued graphs because no simple calculation formula is fixed; for example, the relationships of three types between two points in a graph are considered to be three lines connecting the points; the same has to be done for the rest of the relationships in the graph. Thus, a considerable loss of information can occur when density is calculated. Moreover, it is difficult to calculate the density of valued graphs based on the strength of relations. For these reasons, the density of a valued graph in the Rahad scheme network was not calculated.

The researcher chose the density in the Rahad scheme network to be the proportion of ties divided by number of possible ties that exist between the set of actors (WASSERMAN and FAUST 1994).

Density in Rahad was calculated as $J/n(n-1)/2$, where J is number of undirected ties in the network and n is the number of individuals in the network (SCOTT 2000). Density is measured between 0-1, where one is the highest density, nearly zero means a weakly tied network, and nearly one is a strongly tied network (WASSERMANN and FAUST 1994; SCOTT 2000).

Centrality

The concept of graph centrality was defined by the works of BAVELAS (1950) and MORENO (1937) as the star shape when a person or actor gets nominated by others, so in the star graph, there will be a point connected by lines with other points in the graph (SCOTT 2000, 82). Then following this initial idea, other concepts connected to centrality evolved. Point centrality, also called "local centrality" (NIEMINEN 1974), corresponds to the intuitive notion of how well-connected a point is with its neighboring points or its neighborhood (SCOTT 2000, 83). Apparently there is global centrality (FREEMAN 1979, 1980), which concerns the prominence of points within the whole graph (SCOTT 2000, 85). Betweenness centrality is a concept introduced by FREEMAN in 1979 that sees point centrality as the extent to which a particular point lies between various other points in the graph. Finally, FREEMAN (1979) added centralization as the overall cohesion or integration of the graph; usually graphs can be more or less centralized around certain points (SCOTT 2000, 90).

Computation for centrality can be made in accordance with these different notions; degree centrality based on local centrality can be computed in directed graphs as in-degree and out-degree centrality: the number of lines sent by a point to other points and the number of lines received by the point from other points in the graph (SCOTT 2000). In directed graphs, the values of in-degrees and out-degrees will be different, so researchers have to distinguish between in-centrality and out-centrality (SCOTT 2000). In calculating degree centrality, there

will be a number of points that are centrals in the graph and not just one point (SCOTT 2000). Global centrality is computed based on the closeness of points in the graph. A point is globally central when it lies at the shortest distance from the most points (SCOTT 2000). SABIDUSSI (1966) suggested that by summing the geodesic distances to all other points in the graph global, centrality will be achieved (SCOTT 2000, 86).

In order to measure centrality in the Rahad network, researchers used closeness centrality for the Rahad scheme network, since it gives an idea of the distance among actors in the whole network (SCOTT 2000). The formula for closeness centrality is n-1/∑dij where n is network size; dij is the number of ties in the geodesic distance between i and j (FREEMAN 1979) cited by (VALENTE 1995, 52). Geodesic distance means the number of relationships in the shortest possible walk from one actor to another (BORGATTI et al. 1999; SCOTT 2000).

FREEMAN (1979) uses relative measure for calculating centrality as he assumes that absolute measurements of centralities cannot be compared along through different graphs of different sizes (SCOTT 2000, 87).

4.6.2 Relations between actors

At level of Rahad scheme relations measured between actors were the communication of codified information on irrigated farming management, livestock keeping, credits managements, irrigation water management, forests conserving and management, environmental health management, and other social and administrative issues within the scheme area. In other words the researcher questioned the transaction network among actors at level of Rahad scheme (BORGATTI 2009). Researcher examined existence, regularity and irregularity of this relation between actors. Monthly contact between actors to communicate information is considered by researcher as strong relation, yearly contact is considered next strong relation, and irregular contact between actors to communicate information is considered weak relation. No relation between actors exists when tow actors have no official contact to communicate information on the mentioned categories.

At level of villages connections between actors could be connection or ties to peruse different social activities, funerals, wedding, joining illiteracy classes, religious classes, cleaning of villages, sports, donation of finance for rehabilitation of schools, health centers and etc. such connections in network had been defined as social exchange networks (CONWAY and STEWARD 1998). The researcher examined contacts between villagers on farming such as work together on farming, share information on farming, joining training on farming, and etc. this type of connections in network had been defined as discrete connections (BORGATTI

2009). Existence of relation between farmers on farming is indicating strong connections while no relation on farming is considered weak connections between villagers.

The third level of relation examined is the relation between actors at level of villages and actors at Rahad scheme. Ties between actors at tow levels can be financial support, exchange of information on farming, and social services within Rahad Scheme. In other words the transaction networks and discrete networks those involve flows of information and services on farming and livestock keeping between actors at level of Rahad Scheme and actors at level of villages (CONWAY and STEWARD 1998; BORGATTI 2009). Connections between the two different levels of actors had been studied based on the weakness and strength of the connection. Two actors are strongly connected if they are connected together with more than one tie or a relationship; if they are connected through one tie they are considered weakly connected. If actors expressed less emotional intensity between them, they are considered weakly connected and vise versa (GRANOVETTER 1973; BAER; 2010). In Rahad Scheme network, valued graphs have been used by researchers to indicate strength and weaknesses of actors' relations using Netdraw software program techniques (BORGATTI and FREEMAN 2002).

4.6.3 Maxqda 10 and coding strategy

The researcher used Maxqda 10, which is a software method to analyze and interpret textual data (IVERB 2007).

Maxqda helped the researcher process content analysis (CORBIN and STRAUSS 2008) for data collected using semi-structured interviews and group discussions (BRYMAN 2001).

Maxqda 10 was used to analyze data on the roles of the 15 relevant actors in the Rahad scheme (RAAKS phase A). The researcher developed codes and sub-codes as the raw data from interviews was divided into different conceptual levels so that meanings could be inferred out of the textual content (CORBIN and STRAUSS 2008).Meanings of texts were merged and compared using the technique of retrieved codes in Maxqda 10 (IVERB 2007). Finally, concluding points or summaries of actors' roles were drawn by the researcher's consensus and thoughts.

Codes of 15 actors' roles at administration level of Rahad scheme were the sources of actors' knowledge, and the type of knowledge. The sources of actors' knowledge were divided into sub-codes of formal source of knowledge and informal source of knowledge.

The type of knowledge was divided into knowledge of cropping, knowledge of livestock keeping, and organizational knowledge.

At level of villages (RAAKS phase B).Codes were developed to understand activities performed by actors in villages; sub-codes were used to understand connections among villages' actors

For total network of Rahad scheme, sub-codes were developed to analyze the opinions of villages' actors about how they relate to actors at administration of Rahad scheme.

Maxqda 10 was also used to analyze interviews and group discussions with villages'actors On the other hand, the social network analyzed connections and strength of connections among all actors of the scheme including both actors at scheme level and actors at villages' level.

Strategies to improve actors' connections and performance in regards to knowledge and information exchange (RAAKS phase C) are suggested in accordance with outcomes of the thesis result discussions.

5 Rahad scheme actors and connections at scheme level

Diffusion research depending on social network theory would consider the role of actors and their interactions in the setting of innovations that are essential for the performance of the innovations (VALENTE 1995; SPIELMAN et al. 2010). Therefore, the roles of Rahad scheme actors are presented in this chapter. Interactions or relations of actors at level of Rahad scheme are also discussed in this chapter.

5.1 Actors at the Rahad scheme level

5.1.1 Rahad scheme administration

Rahad scheme admninstrations consisits of several actors mentioned in figure at chapter 3, the administration includes, Farm Management Section,Technology Transfer and Extension Investment Section, Agriculture Engineer,Spinning Section, Planning and Research Administration, Finance and Supply Section (PLANNING and RESEARCH ADMINISTRATION 2010).The actor represents the Technology Transfer and Extension, which follows the agricultural administration in the Rahad scheme (PLANNING and RESEARCH ADMINISTRATION 2010). The roles of this actor are explained through the development or changing of different extensional approaches used in the Rahad scheme.

Conventional approach: agriculture extension services were introduced in the first production season for the Rahad scheme in 1977. The extension services operated according to the existing inspectoral system, where the field inspectors were asked to shoulder an additional educational extension function besides their original regulatory duties (EL HASSAN 2004).

Extension services during the conventional approach in the Rahad scheme was described as an activity that started with noticing; farmers were watching the machines, which were picking the cotton and harvesting the groundnuts (interview 1, paragraph 11).

According to the actor, in first years of Rahad (1977- 1984), orders and regulations were the main relationship between farmers and the scheme (interview 1, paragraph 23), meaning that farmers had to blueprint orders that were produced by scheme administers. From interviewing of other extensionists in the Rahad scheme, we learned that this approach was known as the field inspector approach and was first introduced in the Gezira scheme in the 1920s (interview 17, paragraph 10) (see also DORAN 1980; EL HASSAN 2004). Reviewed literature on the field inspector approach or commodity approach proved that instruction on agriculture practices resulted in poor feedback from farmers, since farmers have no way to just to adopt agricultural packages. The approach in the Rahad scheme also led to no formal linkages with

research (EL HASSAN 2004). However, the tenancy system in Rahad allowed the governing authority of the approach to survive (DORAN 1980).

An important extensional approach that was followed in the Rahad scheme is the training & visit system (HUSSAIN et al. 1994; EL HASSAN 2004). This system, funded by the International Development Agency (IDA), was introduced through the Agricultural Research, Extension, and Training Project (ARETP) (EL HASSAN 2004). Extension services reached farmers through the mechanism of the T&V system (i.e field days and home visits); feedback was channeled to the research station for needed recommendations and further research. The duration of the project was eight years (1986-1994) (EL HASSAN 2004).

In the training and visit approach, the extensionist would conduct training every day on the farm; a normal day for the extensionist would entail coming and deciding to meet farmers in a certain place at a certain time and discussing with *contact farmers* a certain subject such as cotton planting. The environment of that meeting was usually informal. Then on a farm of a certain farmer, the extensionist would conduct an experiment or farm trial of what had been said during cotton planting. Farmers would attend and compare what they heard and what they saw in the experiment. There was also a field day; it was one day each month to see a certain event such as the introduction of a new harvesting machine, or cleaning of a canal, or going to visit a certain area (interview 22, paragraphs 7, 8).

The training and visit approach also contained animal production compounds such as artificial insemination and poultry production; extensionists used to visit farmers and demonstrate AI (interview 1, paragraph 17).

During the training and visit approach, the subject matter experts were found at the section level, and at the village level were the extensionists. The two extensionists were connected with the research station of Rahad in the beginning; the scheme did not initially have this system (interview 22, paragraph 7). EL HASSAN (2004) argued that the T & V approach improved linkages between research and extension.

The training and visit approach was going but faced opposition from managers, because extensionists were given privileges and facilities such as cars and training outside Sudan; the old managers and field inspectors felt jealous and wanted this program not to work. They therefore isolated the extensions and put down their work. In 1989, the revolution of Engaz came, and the government enacted certain policies that led to the withdrawal of funding by the World Bank, meaning the government could not finish the program (interview 22, paragraph 9). According to EL HASSAN (2004), withdrawal of the training and visit approach in Rahad was due to a shortage of facilities.

Then in 1994, the Farmers' Field Schools approach (FFS) was established in the Rahad scheme (EL HASSAN 2004). FFS was a model for participatory research and extension established through the integrated pest management project (IPM) (ABDEL RAHMAN 2003). The approach is considered an alternative to conventional pest control measures for wheat and vegetable production. Each FFS consists of 25-40 farmers, lectured and trained by extension workers in weekly meetings (ABDEL RAHMAN 2003; EL HASSN 2004). AHMED and KAWTHER (1997) cited by EL HASSAN 2004) mentioned that FFS held in the Rahad scheme were characterized by poor attendance of farmers and a low number of training sessions. Shortages of irrigation water and a lack of financing at the time could have discouraged farmers from attendance.

The Department of Technology Transfer and Extension of the Rahad scheme is staffed with 45 extension workers (BSc holders) who are formally trained for their position. Each section in the Rahad scheme has five extension workers, and the ratio of farmers to extension workers approximately is 300:1 (IBRAHIM 2006).

According to EL HASSAN (2004), extension in the Rahad irrigated scheme returned to performing according to the commodity approach, where extension work is a part of the administrative and managerial work of field inspectors.

During data collection in 2010/2011, there were no extension activities being directed to the farmers of the scheme. This situation was due to the presence of the Kenana Integrated Agriculture Solution (KIAS) Company. Here a working staff was involved in addressing technical managerial duties enforced by the company.

5.1.2 Rahad research station

The actor interviewed is the administrator of the Rahad research station. The interviewee explains the activities of the station, and their relationship to the Rahad scheme. The Rahad research station was constructed to serve the project with research and to serve people in the area ever since the 1970s. EL HASSAN (2004, 82) commented that "the mandate of the Rahad research station calls for experimentation on the relationship of crops for the Rahad Agricultural Corporation both as field crops and vegetable crops."

The Rahad research station follows the agricultural research corporation in [1]Medani (BEINTEMA et al. 1995). It has many options: plant protection, specializing in researching

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Medani is a city situated in the Gezira agricultural scheme 176 km south of Khartoum and the research corporation in Medani was chosen to be the headquarters of all research stations in Sudan (ARC, 2007).

all diseases related to the plant or the crops within the scheme; soil and water studies, which was established in 1997 and aims to research soils within the scheme and then make recommendations about proper fertilizers, crops, and land preparation; agricultural engineering, which is responsible for searching out proper land preparations and machines used for soil in the scheme, integrates with soil research and is responsible for searching out which machines will be used in such a soil (interview 3, paragraphs 2, 4); another option of the station is plant pathology, which searches for different bacterial and fungal diseases that infect the crops; finally there agronomy, which is supposed to study crop management in order to produce farming operations in the field. Crop management includes the time of sowing, spacing between plants, and the number of seeds. It also includes plant mass, applying fertilizers, weeding, and intervals of irrigation. All these crop management measures are practiced at the same time and should be taken together to produce high yields (interview 3, paragraph 5).

The station right now is running research on cotton breeding. Crops have different species that the breeders can cross-breed, and in this case they deal with the genes in order to select the best ones. Invented species are sometimes named after the researcher (interview 3, paragraph 5).

Approval of research results takes place at the agricultural corporation in Medani; it is a series of three meetings to approve the technical work by all scientists in Sudan (ARC 2007). The research will be presented and discussed until it is approved (ARC 2007). One meeting is to prove plant protection inventions and agronomy inventions, which usually follow each other (interview 5, paragraph 6; see also ARC 2007).

Then there is a committee for approving species; it meets once a year in Khartoum to pass the invention (ARC 2007). The researcher will present his invention; it is discussed until the committee agrees to pass the species (interview 5, paragraph 6; ARC2007).

Research subjects conducted by the Rahad research station represent agricultural research policies in Sudan (BEINTEMA et al. 1995). Most research policies there since independence in 1956 focused on irrigated crops such as cotton and wheat, in addition to horticultural crops (BEINTEMA et al. 1995). On the other hand, little research work was directed at traditional farming sectors (BEINTEMA et al. 1995).

Administratively, the Rahad research station followed the research corporation in Medani, but the research station technically followed the Rahad scheme. The manager of the Rahad scheme used to form technical committees; the committee would be a mix of Rahad staff and the station staff but headed by a researcher (interview 5, paragraph 8).

The technical committees would go touring on fields, observing land preparation, plant diseases, etc., and then the committees were supposed to report their findings and recommendations to the manager of the scheme (interview 5, paragraph 8). According to EL HASSAN (2004), the organizational structure of the T & V approach in the Rahad scheme contained the technical committees. This would imply that the existence of the technical committee is referred to in the implementation of the T & V approach in the Rahad scheme.

However, according to the interviewed actor, recently due to the deterioration of the scheme, the performance of the committees was not sufficient (number of committee members decreased; one group would include only two researchers) (interview 3, paragraph 8).

Therefore, the research station was technically cooperating with the Rahad scheme until the KIAS company over took management of the Rahad scheme (interview 3, paragraph 8).

At the time of data collection, the Rahad research station was not involved in the work of KIAS. However, the station was engaged with its research on cotton breeding (interview 3, paragraph 5).

Staff of the Rahad research station represents the agricultural research corporation in Medani, and the research corporation officially follows the Ministry of Agriculture in Khartoum (BEINTEMA et al. 1995) figure 6 represnet symbols (green boxes) used to domenstrate Rahad scheme administration and Rahad research station.
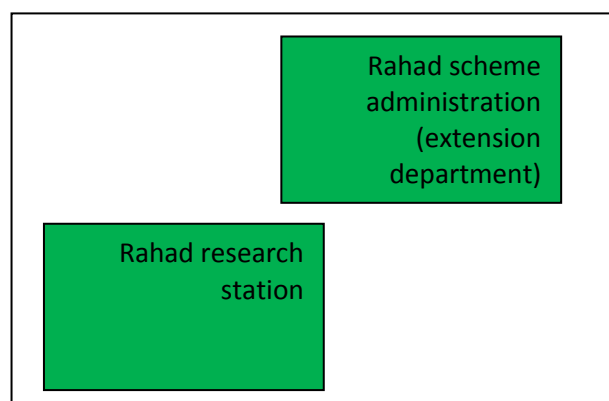
Figure 7: Rahad Scheme institutions
Source: own preparation

5.1.3 El Fau locality (executive unit)

The role of the executive unit in the El Fau locality is to give a general viewing on the activities and responsibilities of El Fau in the area, since the unit accumulates and processes performance reports of different sections and ministries in the locality (interview 7, paragraph 5).

The executive unit in El Fau is responsible for the managerial work; it performs its activities according to the direction of polices that are produced from the center (Khartoum) and directed to states and localities (interview 7, paragraph 5).

The El Fau executive unit is entitled to assembly and reproduces performance reports for every section throughout the year: monthly, quarterly, or annually (interview 7, paragraph 5).

According to an actor of the El Fau locality, *"Since the law of local role in 2006 was formed, we are entitled to serve many things, we offer work in health through the health office, and we serve the youth with sports"* (interview 7, paragraph 7). Local ruling is the act that was first released in 1970. This act gave authority to educated persons who were allocated in different councils and localities to represent the government. These people were responsible for resuming all administrative and executive authorities of the native administration (ALNEM 2010; SAAD 2010). According to this reviewing, the El Fau locality officially performs responsibilities that were previously entitled to the institution of the native administration.

The executive unit is also entitled to release licenses for individuals or entrepreneurs to create enterprises and commercial work. These include licenses for crop transportation and licenses for opening shops, pharmacies, etc. The section also provides information for people on how they can administratively communicate with the locality (interview 7, paragraph 5).

The locality represents the government by collecting taxes from economic sector activities in the locality including taxes on animal herds, taxes on transporting crops (produced by the scheme or on rain-fed farms), and taxes on other private enterprises (interview 78, paragraph 8).

The locality generally is concerned with presenting political views of the main ruling party (National Congress) (interview 7, paragraph 12).

The source of knowledge for the locality is the legislative council, which consists of 33 people representing political and educated elites in the area; this legislative council is elected yearly (interview 7, paragraph 41, 43). During data collection we failed to find out what criteria is used to select members of the legislative council and what decisions can be made by this council.

There is no systematic connection between the locality and the Rahad scheme when it comes to the farming sector (interview 7, paragraph 12).

The locality is responsible for rain-fed farming areas through the supervision of Ministry of Agriculture; the representative of the ministry is entitled to hands-on performance reports four times annually and one financial plan for the year. Finance would be supported by the Ministry of Finance in Gedarif state and handed to the financial office in the locality, which is

supposed to deliver the money to the Ministry of Agriculture. The same procedure would apply for the rest of the ministries and administrations (interview 75, paragraphs 13, 19, 37, 50).

The locality deals with locals in villages through local organizations called public committees (interview 7, paragraph 18) (see 5.2.1 page 121).

The locality is also responsible for official appointing local leaders (sheikhs), who are basically appointed by their tribe (interview 7, paragraph 34) (see 5.2.5 page 125)

Tribes in Sudan had sheikhs who ruled or controlled members of tribe with a consensus formed by harmonies of a non-written customs and traditions or *al aurf* (ALNAEM 2010).

The colonial rulers had considered the tribal system in Sudan to be a cheap tool to rule and control the massive land of the Sudan and renamed the system the native administration (ALNAEM 2010; SAAD 2010). In addition to their roles as tribal leaders, sheikhs were responsible for tax collection from crops and livestock for the authorities (ALNAEM 2010; SAAD 2010). The native administration was abolished by the central government in the 1970s and then returned again in 1980-1990s (ALNAEM 2010; SAAD 2010). Reviewed literature have noted many challenges faces local sheikhs as they attempted to resume their roles in the changing social, economic, and political environment in Sudan (ALNAEM 2010).

The locality is responsible for forming technical committees to solve emergencies or crisis situations within the El Fau locality. For example, there is a safety committee; it is headed by the mayor of the locality. There is also a law consultant, a manager of police in the locality, a manager of security in the locality, and a manager of the eastern military area (interview 7, paragraph 22).

The committee is called the safety committee of locality. Any issue of safety is handled by them, they meet monthly and then report the situation to the locality administers and the eastern state (interview 7, paragraph 22).

For agricultural emergencies, there is a technical committee that estimates the problem or the damage. This committee consists of a manager of the agricultural office, representatives from the pastoral union and farmers' union, police, security officers, and a locality representative (interview 7, paragraph 22). The committee was formed to evaluate damage as animals enter a farm or when a pathway is planted by a farmer (interview 7, paragraph 22). In such cases, the animal owner or the farmer will complain to the agricultural office in the locality, and then the locality will ask the committee to estimate the damage (interview 7, paragraph 23).

For construction of markets or new villages, there is a planning committee directed by the locality (the mayor) (interview 7, paragraph 23). In natural disasters such as floods or disease

outbreaks, an emergency committee will be formed and can contain different actors in the area such as the manager of Rahad scheme, a representative of the Ministry of Livestock, the manager of the Health Administration. There is no sheikh to decide or evaluate the damage (interview 7, paragraph 24).

The total staff working in the El Fau locality is about 400 persons who are paid by government of Gedarif state (interview 7, paragraph 9).

5.1.4 Ministry of Agriculture (El Fau locality)

The actor we interviewed is the administrative head of the agriculture office, which represents the Ministry of Agriculture in the El Fau locality. The Ministry of Agriculture is represented by an office responsible for monitoring and following agricultural activities for rain-fed farming areas within the El Fau locality.

 The sector of rain-fed farming is characterized by small farms ranging from 2-30 or 10-50 hectares relying on labor-intensive use of hand tools (UNEP 2006; CFSAM 2011).

Traditional rain-fed farming in Sudan was practiced for years and proved to be sustainable when the population was low; however, demographic, political, and technical changes are distorting the sector (UNEP 2006).

The rain-fed farming area is around 416,666 hectares located in northwest, south, and central El Fau and southwest Butana (interview 2, paragraph 30).

Rain-fed farming or traditional rain-fed farming in the mentioned areas is to some degree mechanized where farmers use tractors for plowing but use manual labor for the rest of the farming practices (CFSAM 2011).

Activities of the office are mainly to conduct extension activities and apply pest control; the office has sections for plant protection, which is responsible for controlling national pests or any other horticultural pests (ESMAEL 2010).

The actor mentioned that the extension staff is responsible for implementing field days, demonstrations, meetings with farmers, and distributing leaflets and posters (interview 2, paragraphs 29, 30) (ESMAEL 2010).

According to the actor, the 26 agricultural engineers in his opinion are considered extensionists and can get involved in training farmers, but the staff who had an agricultural extension degree consisted of 9 extensionists (interview 2, paragraph 29).

The Agricultural Office contacts farmers during meetings; in these meetings representatives of the rain-fed farmers' union will attend (interview 2, paragraph 19).

The rain-fed farmers' union in the El Fau locality is a volunteer organization representing farmers within the rain-fed area in El Fau (ESMAEL 2010). The union represents the geographic sections of rain-fed areas in El Fau (northwest El Fau, south El Fau, central El Fau, and southwest Butana) (interview 2, paragraph 50).

According to the actor, every union contains a farmers' committee, which is the simple representative of the union at the village level (interview 2, paragraph 50). Another organization related to the farmers' union in rain-fed areas is the cooperative association (per every district union there will be 3-4 cooperative associations; the total number of associations is 16) (interview 2, paragraph 50) (ESMAEL 2010).

The idea of this organization is to organize farmers, especially poor ones, in groups so as to be able to contact funding and aid agencies within the area and get support for production inputs (interview 2, paragraph 50). The Agricultural Bank in the El Fau locality is one of the main funding agencies dealing with these committees (interview 74, paragraphs 55, 57).

In every season the rain-fed farmers' union is responsible for distributing seeds to farmers free of charge; the source of seeds is the research center in Gedarif state (interview 2, paragraph 50; interview 27, paragraph 79).

The Agricultural Ministry in El Fau distributes leaflets (during meetings) to farmers, and then the office continues its responsibility by following farmers during farming (interview 2, paragraph 50) (ESMAEL 2010).

The actor mentioned there is also a union of vegetables and fruits, a new union that has not been registered yet, but later it is expected to be effective (interview 2, paragrpah 50).

The Ministry of Agriculture in El Fau is also responsible for supervising horticultural fields (nurseries) there are around, 4, 1666 hectares (ESMAEL 2010). The ministry is also responsible for supervising farming activities of Rahad River Banks (quick growing vegetables) (ESMAEL 2010).

People in rain-fed areas raise animals in addition to farming (interview 2, paragraph 30). Herding and farming activities within the locality would include some tensions. Especially during rain shortages, herders would graze closer to or inside farms. In this case, farmers usually would report it to the Ministry of Agriculture, and the latter would tell farmers to report to law enforcement (interview 2, paragraph 21).

The animals would then be kept on a fence belong to the locality, and a fine for the owner would be decided by a committee. The committee would do so according to an evaluation of the damage made by the animal, but sometimes the problem would be solved locally without involvement of the police or the locality (interview 2, paragraph 21).

The damage committee consists of a representative of the farmers' union, an administrative officer (rep. locality), a police officer, a representative of the pastoral union, and a security unit. Both the pastoral and farmers' union members will be selected according to the geographical section within the rain-fed area where the damage occurred (interview 2, paragraph 58).

The actor reported that the source of information on farming for the Ministry of Agriculture is the research corporation in Gedarif, which responds to the needs of the rain-fed areas within the eastern state (interview 2 paragraph 38) (ARC, 2007). Also there is Gedarif Centre, a company in Gedarif (interview 2, paragraph 42).

Last year Gedarif Centre invited staff from the Ministry of Agriculture in El Fau to attend a workshop on the topic of zero tillage and another workshop on fertilizer usage in rain-fed farming (interview 2, paragraph 42).

The actor mentioned that there used to be *thrips* (*Thripidae sp*) infection in okra; the Ministry of Agriculture contacted the section for plant protection at the Rahad research station. They helped the Ministry know how to control the insect (interview 2, paragraph 42).

The actor also mentioned that the Rahad scheme would hire staff from the office to work in the scheme (interview 2, paragraph 6). Moreover, in the case of pest invasions, the plant protection office in the ministry and the plant protection section in the scheme would work together. Then a report would be handed to the Ministry of Agriculture in the state (interview 2, paragraph 42).

According to the actor, the Agriculture Office is staffed with 26 agricultural engineers distributed in different options: plant protection, horticulture, and extension (interview 2, paragraph 34). The Ministry of Agriculture has one vehicle to cover their work and receives from Gedarif state 5,000 Sudanese pounds shared with the Ministry of Livestock for annual budgeting (interview 2, paragraph 34).

5.1.5 Ministry of Livestock (El Fau locality)

The RAAKS team interviewed two people representing the Ministry of Livestock in the El Fau locality (manager of the office and another officer responsible for animal production in the ministry). The Ministry of Livestockin El Fau institutionally follows the Ministry of Livestockin Gadarif state (interview 15, paragraphs 13, 15).

According to the manager of the ministry's office, the role of the Ministry of Livestockin El Fau mainly is to monitor animal health for cattle within the locality (interview 15, paragraph 4), while the animal production officer thinks the ministry is also responsible for applying

animal production activities or making use of the economic viability of animal stock in the area (interview 6, paragraph 17; interview 15, paragraph 21). Therefore, it became clear during our field work that a conflict in views or mission is hidden within the staff of the ministry.

Hence, curing animals was the main mission reflected to us by the office manager; he continued explaining how the ministry applies health monitoring activities. Local people are the ones who report for diseases, and they bring their animals to the ministry (interview 15, paragraph 10). In the case of a disease outbreak, there would be cooperation and communication between the animal wealth office and other institutes in El Fau, for example the locality might help with vehicles (interview 15, paragraph 10).

Every year the ministry is responsible for conducting one compulsory vaccination campaign, meaning that all animal owners within the El Fau locality should have access to cattle vaccines. The ministry would also conduct one optional vaccination campaign for cattle every two months (interview 15, paragraph 10).

Owners of animals (pastorals) would pay for the vaccination. During the second data collection in October 2011 we knew that the ruler of the eastern state had exempted pastorals from paying for vaccinations (interview 59, paragraph 19).

According to the office manager, the Ministry of Livestock is responsible for inspecting daily slaughtering in the El Fau locality (interview 70, paragraphs 15, 48).

The ministry is also responsible for participating technically with related organizations whenever micro-projects on animal raising are launched (interview 15, paragraph 3).

The Ministry of Livestocksupports and adopts scientific methods for animal production, but the pastorals still retain their cultural way of raising animals (interview 6, paragraph 19).

General policies for animal health are formulated at the state level (Gadara) (interview 15, paragraph 15). In spite of this fact, the manager of the ministry office follows research updates personally from other institutions (interview 15, paragraph 15).

Reviewed literature proved that research conducted within the Ministry of Livestockor other research institutions focuses mainly on animal diseases (BEINTEMAet al. 1995). This research focus actually explains actors' interests in having healthy stock within the El Fau locality. Others scholars have exaggerated this research interest and have categorized it as a biased policy in Sudan that aimed to enhance animal production at the expenses of pastoral development (SALIH 1990; AHMED et al. 2012).

The Ministry of Livestockis committed to developing monthly and annual performance reports for the El Fau Locality. The locality would approve the reports and launch annual budgeting for the ministry (interview 15, paragraph 4; interview 75, paragraph 19).

The unit of animal production within the Ministry of Livestock is responsible for milk inspection (interview 6, paragraph 12). It is also responsible tfollow up local cheese factories within the locality made by pastorals (interview 6, paragraph 19). The ministry is also responsible for informing farmers about artificial insemination (interview 6, paragraph 33).

5.1.6 Irrigation Administration

The Irrigation Administration works to facilitate provision of required irrigation water which is (800,000,000 m^3) per year (interview 12, paragraph 7) (MINISTRY OF IRRIGATION, 2007). The calculated water runs through channels with a length of 192 km from the source, the Rosaries Dam (MINISTRY OF IRRIGATION 2007). The channels need management operations such as siltation (removal of silt), and the removal of plants growing in the channels (MINISTRY OF IRRIGATION 2007). (Accordingly, the Irrigation Administration is also responsible for the aforementioned operations as well as drainage of canals inside and outside the Rahad scheme (interview 12, paragraph 7).

The administration is also responsible for maintenance work in canals and irrigation assets inside the scheme in addition to administrational work within the administration (interview 12, paragraph 7).

Among the concerns within the Irrigation Administration is how to provide enough water to animals and humans besides plant irrigation. It can be said that the scheme irrigates all animal wealth in Butana; when wells in Butana become dry in winter and summer season, nomads with animals would come to the scheme to water them (interview 12, paragraph 5). Rich nomads who have huge numbers of animals would also come and fill tankers from canals in order to water animals at the scheme boarders. We were told that in the Rahad scheme water has been calculated for animal drinking, and some parts of canals had been adjusted to be suitable for animal watering (interview 12, paragraph 5).

There is also a surveillance section within the locality. The Ministry of Irrigation is connected with it. If the surveillance section surveys new established horticulture farms[2] within the

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[2] Those farms are vegetable farms that were planned outside the scheme farms to cover the needs of the area for vegetables and to produce for neighboring markets. They are outside the scheme in order to keep the scheme farms away from insects that might infect the scheme farms. The Rahad scheme used to irrigate those farms as well. The locality (surveillance section) is the one who decides on planning for those farms.

locality, the Ministry of Irrigation has to be contacted in order to plan channels and calculate water requirements (interview 12, paragraph 9).

According to the actor, the Irrigation Administration gives room for local people to participate in providing water requirements for the scheme farms (interview 12, paragraph 12). This participation is achieved by units or sections established inside the scheme (interview 12, paragraph 12). The combination of sections into one staff from local people: a water guard, water engineer, and water technician (interview 12, paragraph 12). Regulations on water use at the farm level will be given to extensions through regular seminars held by Irrigation Administration (interview 12, paragraph 18).

These series of responsibilities went on until KIAS took over responsibility for managing the Rahad scheme. The company maintained the irrigation assets in the scheme and asked for the responsibility for providing water requirements for the scheme (interview 76, paragraph 7). Therefore management of water requirements in the Rahad scheme has been shifted to the company. By June 2012, KIAS cancelled its contract to manage the Rahad scheme, and there is no information available on the exact responsibilities of the Irrigation Administration in the Rahad scheme.

5.1.7 Health Administration

When we collected data in October 2010, Health Administration was an office within the El Fau locality, but in June 2011 the health office in El Fau was reorganized and evolved into the Health Administration (interview 61, paragraph 46). The administration is guided by a manager and supervises five units; these units are primary health care, health environment, health enforcement, integrated control of diseases, and child health (interview 61, paragraph 46) (FEDERAL MINISTRY OF HEALTH 2010).

Changes are mainly in administrational and technical guidelines, but the main objective of the administration has remained the same as when it was an office. The Health Administration is responsible for providing health services, health education, and controlling health problems within the El Fau locality (interview 13, paragraph 3). Providing health services includes services of primary health care such as treatment and vaccination for children and mothers, services of environmental health including spraying insects, condemning dead animals, supervision of village cleaning, and drying canals (interview 23, paragraphs 3, 10). Control of diseases includes control of waterborne diseases and communal diseases such malaria and AIDS (interview 13, paragraph 35). In implementing these services, the office applies health education methods that include training courses and workshops for staff and volunteers from

the local community (interview 13, paragraph 35) (FEDERAL MINISTRY OF HEALTH 2010). According to the actor from the Health Administration, its connection is with local people who come for complaints or ask for services. Moreover the actor also considers community and mosque leaders in implementing education programs (they will be invited to attend debates or lectures) (interview 13, paragraph 21). However, the actor mainly depends on contacting schools, women, and youth for conducting education programs (interview 13, paragraph 32).

Volunteers who work with the Health Administration are working women and youth, especially girls who belong to a society called youth for malaria; it was formed by the administration and is located in El Fau (interview 13, paragraph 35).

Another society of youth working with the Health Administration called Aids Control includes youth from village 10, village 13, and village 3 (interview 13, paragraph 35). Moreover, among the staff of the Health Administration, there are local people who are appointed by the Ministry of Health who can directly contact people in villages (interview 13, paragraph 42).

These volunteer students were trained by the administration, but the Health Administration still does not offer training to all villages; they concentrate on villages in the head of sections (interview 3, paragraph 35).

According to the actor, there are some institutions in the El Fau locality whose work is connected to the Health Administration such as the Ministry of Livestock, because there are common diseases shared between animals and humans (interview 13, paragraph 10).

According to the new changes in the Health Administration, the success of the health system can be measured with how closely the work is connected to related institutions (interview 61, paragraph 47).

The Ministry of Health in Gedarif represents the main source of information for the Health Administration in the El Fau locality (interview 13, paragraphs 5, 13).

5.1.8 National Forest Corporation- El Fau

The National Forest Corporation is a para-state organization established in 1989 following the Ministry of Agriculture and Forestry. The National Forest Corporation was established in 1989 to assume technical supervision over forest reserves in the Sudan (NATIONAL FOREST CORPORATION 2007). The corporation is also entitled to take measures to protect and manage reserved areas across the country (NATIONAL FOREST CORPORATION

2007). The National Forest Corporation in El Fau represents the Ministry of Agriculture and National Forest Corporationin Gedarif state (interview 9, paragraph 2).

The National Forest Corporation is divided into sections for planning, extension, field work, and information (interview 9, paragraph 24). This categorizing was initiated to serve the role of the corporation, which can be limited to include protection of natural forests in the area by conserving and reforestation of natural forests, planting seedling trees in public institutions including schools, government buildings, mosques, etc. Implementation of corporation roles is accomplished by involving local people and conducting extension work (interview 9, paragraphs 4, 6, 10).

According to the actor, the Rahad research station is a source of information for the corporation, especially information on the soil and climate (interview 9, paragraph 25). The corporation also considers itself the source of information; the corporation conducts research on the soil, grows and tests its own seedlings, and might import seeds from outside Sudan (interview 9, paragraph 26). In plantation activities, the corporation produces seedlings monthly and sells them with relatively low costs for beneficiaries falling within the El Fau area up to the boundaries of the other state (Kassala) (interview 9, paragraph 6).

There are laws that regulate the use of forests by locals including entering of animals in the forests (interview 9, paragraph 36).

According to the actor, society has not departed from the forest (interview 9, paragraph 36), so the corporation is responsible for educating people about how to use the forest, how to plant inside the forest, and how animals can properly graze from the forest (interview 9, paragraph 36). Anyone who allows the animals to feed from the trees themselves will be punished (interview 9, paragraph 36).

The corporation is also responsible for conducting surveys to know which seedlings are suitable for a certain area (interview 9, paragraph 11). The corporation contacts public committees and youth associations when it comes to plantations on public lands such as schools, mosques, etc. (interview 9, paragraphs 8, 13). When planting at schools, the Ministry of Education is also consulted by the corporation (interview 9, paragraph 22).

Among official institutions or actors connected to the corporation is the locality, especially the office of the Ministry of Agriculture (interview 9, paragraph 16); the office is involved in evaluating forest activities (interview 9, paragraph 16). The Rahad agricultural scheme is a partner with the corporation (interview 9, paragraph 17). The Rahad scheme planted 5% of its space with forests; forests of the scheme belong to the scheme administration but not to the farmers (RAHAD AGRCULTURAL CORPORATION 2010).

Forests planted by the scheme are protected by regulations of the National Forest Corporation (NATIONAL FOREST CORPORATION 2007) This relationship was explained to the new company of KIAS, and the actor expects that the same technical role of the National Forest Corporation with the new company will continue in the same way (interview 9 , paragraph 20).

5.1.9 El Fau Agricultural Secondary School

El Fau Agricultural Higher Secondary School follows the Ministry of Education in the state of Gedarif (interview 10, paragraph 2) (MINISTRY OF EDUCATION 2006). Syllabus is designed by the Ministry of Education and contains agricultural engineering, animal production, horticulture, plant protection, agricultural economics, food manufacturing, and crop production. Moreover, students of the school study the basic fields of mathematics, chemistry, biology, Arabic, English, physics, and Islamic studies (MINISTRY OF EDUCATION 2006). Students are accepted from the El Fau locality as well as other localities within Gedarif (interview 9, paragraph 10). The students of the school are expected to continue higher education in agricultural universities or join the labor market in the agricultural domain (agricultural technicians) (interview 10, paragraph 2).

El Fau Agricultural School is missing qualifications such as practical labs, experimental fields for animal production, workshops for agricultural engineering (interview 10, paragraph 15).

The school has no training programs for students with the Rahad agricultural scheme, National National Forest CorporationCorporation, Ministry of Agriculture, or any training agency (interview 10, paragraphs 4, 6).

According to an actor of the Agricultural School, students there can conduct training for farmers on farming, but there is no connection between the school and the union (interview 10, paragraph 9)

El Fau Agricultural School managed to implement only one training for the Women's Association in poultry in village 10 (interview 10, paragraph 9).

The Agricultural School is located near a storage facility for chemicals that belongs to the Rahad scheme (interview 10, paragraph 16). The chemicals in this storage site are volatile and could be a health hazard for the school, teachers, and students. This situation was not mentioned by the headmaster of the school as a problem (interview 10, paragraph 15).

5.1.10 Zakat Dewan

The main fundamental Quranic principles relating to the law and institution of *zakat* is that *zakat* is a tax that a Muslim state may impose on its Muslim citizens (Kaslam, 2007). There are two types of *zakat* in Islam: a flat fee imposed on each individual Muslim person called *zakat al fitr*, and a tax on wealth called *zakat al mal*. *Zakat al mal* is levied only on Muslims whose taxable wealth exceeds a threshold called *nisab*. The *nisab* is calculated based on the amount of wealth held for one year (KALSAM 2007). *Zakat el mal* in the El Fau locality is deducted from farm production and animal herds yearly. The institution of *zakat* is governed by *zakat* officials, and these officials must possess a thorough knowledge of the law of *zakat* (KALSAM 2007). In the Quran, there are specified schemes for the distribution of *zakat* funds, and it is the duty of *zakat* officials to be aware of those who deserve receiving the *zakat* funds (KALSAM 2007). Therefore at the end, the *zakat* should be regarded as an instrument to improve the social well-being of the communities (KALSAM 2007). Zakat Dewan in El Fau is the institution responsible for levying *zakat al mal* from farmers in the locality, either within the rain-fed area or the irrigated Rahad scheme (interview 14, paragraph 3).

After collecting the *zakat*, Zakat Dewan redistributes it either directly to needy people or invests it in micro-projects for the poor. These projects can be food security or vocational projects (interview 62, paragraph 49; interview14, paragraph 19). According to the actor from Zakat Dewan, by distributing the *zakat*, Dewan provides aid to poor families and individuals in the community, but Dewan also provides aid to institutes that work to deliver Islamic education such as mosques, and Quran schools, or *khalwa* (interview 14, paragraph 3).

Zakat Dewan has representatives in the villages to assist in collecting the *zakat* and identifying individuals who need aid from *zakat* projects or money (interview 14, paragraph 5).

Representatives of Zakat Dewan at the village level are called based committees and are headed by an imam of a mosque. Membership includes a public committee, women's union youth, and Zakat payers (interview 14, parargraph 5). Women include the divorced and widows (interview 14, paragraph 7), youth assist Zakat Dewan in delivering money for *dawaa* activities and in identifying students of universities and schools who are supported by Dewan (interview 14, paragraph 7).

At the locality level, the council of *zakat* coordinators aim to decide how and to which sectors the *zakat* money should be delivered. *Zakat* coordinators are headed by *Mutamad* (the mayor

of El Fau), and membership includes the head of Zakat Dewan, *zakat* payers (rich men), and religious men (interview 14, paragraph 5).

Food security projects funded from *zakat* are individual projects distributed to individuals or families (for example projects for raising chicken, cows, and sheep and vocational projects for poor men, women, and widows such as kiosks, carts, or cutting wood (interview 14, paragraph 19). Food security projects can also be group projects given to a group of families together (distribution of goats or chicken for a group of families) (interview 14, paragraph 25).

Projects for agricultural associations within the rain-fed sector possess tractors and harvesters for these associations (interview 14, paragraph 25; interview 27, paragraphs 13, 15). Zakat Dewan is involved at the level of managing and monitoring these projects (interview 14, paragraph 20).

For either individual projects or group projects, Dewan distributes the project without asking for back payment, and then Dewan supervises and trains the individual or the association that received the project (interview 14, paragraphs 21, 22).

Misuse of projects such as selling the goats has been mentioned as a problem facing food security projects for individuals. Group members would disagree on the procedures or the ways the project should be managed (interview 14, paragraphs 40, 38). The Zakat Dewan actor further mentioned that local people are less skilled in dealing with some projects such as poultry (interview 14, paragraph 41).

In total there are seven projects for agricultural associations and four groups of families raising goats, but there are many more individual projects (interview 14, paragraph 41). Most of these projects cover farmers within rain-fed areas in El Fau (interview 14, paragraph 32).

Staff in Zakat Dewan in El Fau are appointed and paid by Zakat Dewan in Gedarif (interview 14, paragraph 3). Figure 8 is presenting symbols for actors that are administratively following El Fau locality but interacting with scheme administration and actors at village levels within Rahad scheme
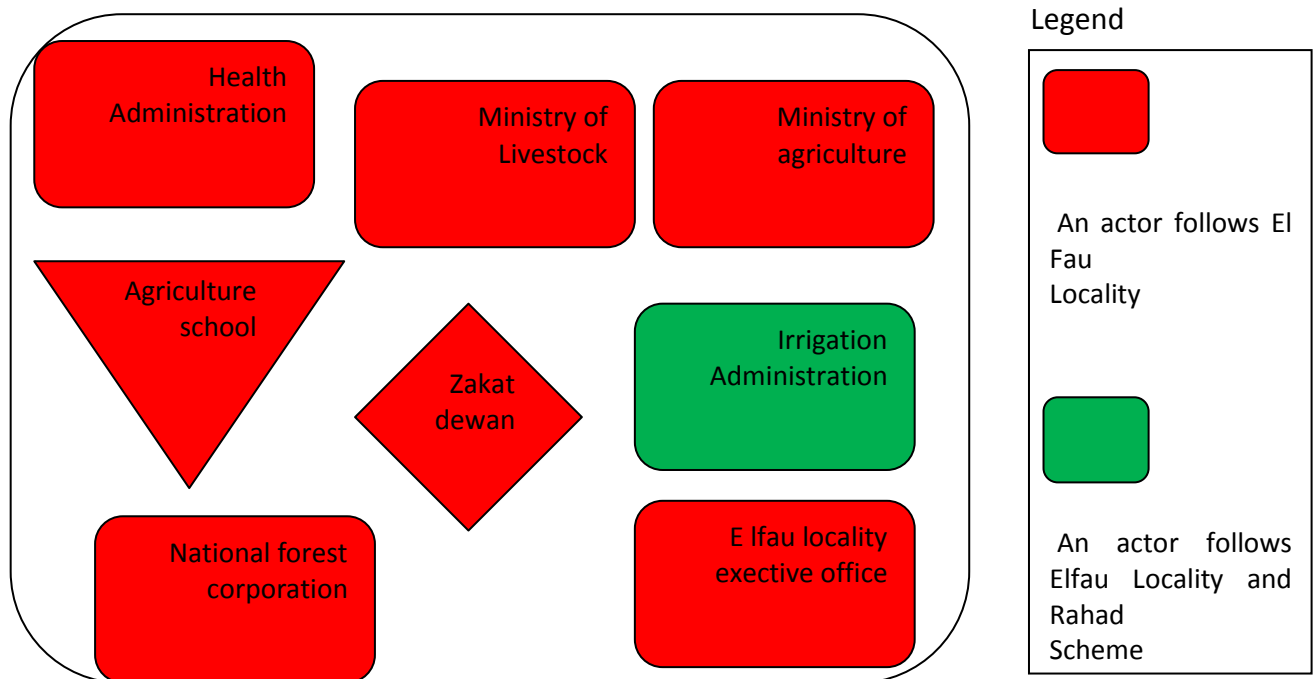
Figure 8: Government institutions at El Fau locality
Source: own preparation

5.1.11 Sudanese Agricultural Bank

Since the establishment of the Rahad scheme, the Bank of Sudan has provided credits or loans to the Rahad Agricultural Corporation and other agricultural corporations to finance farming operations every season (EL AMIN and EL MAK 1997). The Rahad Corporation would recover land and water charges from farmers for cotton only, and other crops were freely charged (EL AMIN and EL MAK 1997). Farmers recognized this process as farming by subsidy from the government, but officially this economic policy was known as the Economic Recovery Program (EL AMIN and EL MAK 1997). The ERCP resulted in an accumulation of debt in agricultural corporations including the Rahad Agricultural Corporation (EL AMIN and EL MAK 1997). The government of Sudan enacted the National Economic Salvation Program; its policy measures in the agricultural sector were to remove subsidies on fertilizers, pesticides, land, and water provided by the agricultural corporations (EL AMIN and EL MAK 1997). Financing production costs was shifted to commercial banks instead of the state-run Bank of Sudan (EL AMIN and EL MAK 1997). According to the Agricultural Bank actor, when the government stopped financing, farmers came to the bank (interview 4, paragraph 13).

The Sudanese Agricultural Bank is a developmental bank uses its human and technical resources to achieve agricultural and animal development (SUDANESE SUDANESE

AGRICULTURAL BANK 2009). This aim is achieved through the presence of bank branches within producing sectors that offer financial, extensional, and banking services (SUDANESE SUDANESE AGRICULTURAL BANK 2009)

Since 1991, the Sudanese Agricultural Bank has financed irrigated scheme farmers and rain-fed farmers in all type of crops (EL AMIN and EL MAK 1997). For example, for cotton crops the bank would finance all farming operations by supporting inputs of seeds, fertilizer, and the cost of spraying the cotton with chemicals (interview 4, paragraphs 2, 3).

The bank will monitor this financing through control groups (farmers would be divided into groups; every group will be headed by a farmer, usually a member in the farmer's committee; the farmer would receive the inputs on behalf of his group and hand it to members). The bankers in the finance section would report the costs of finance for every group, and then the head of the group would be the contact person (interview 4, paragraph 2). The bank would decide the amount of money needed from the head of the group. Money would be collected from the groups of the farmers, while the bank calculates the cost. If farmers managed to pay their input costs and make a profit from their produce, the bank would return their profits. Farmers who produce amounts that fail to make profits must repay the cost of inputs (interview 4, paragraph 2). In some cases farmers produced amounts that did not allow them to pay the production costs. Usually, the Rahad scheme administration would be responsible for the farmers and would pay the finance costs if farmers failed to pay (interview 4, paragraph 2).

Financing farmers at the scheme level is considered a micro-finance that benefits many people with relatively little money (interview 4, paragraph 3). The other type of financing banks practice is macro-finance (interview 4, paragraph 3). This type of financing is approached with farmers in rain-fed areas within the El Fau locality. Farmers who apply for financing at this sector usually have a massive piece of land (farmer can own 410-1,255 hectare) (interview 4, pargraph5). Reports on rain-fed farming stated that individuals own around 50 hectares on average (UNEP 2006; CFSAM 2011). Therefore, this type of finance is directed to large-scale farmers within rain-fed farming areas. In macro-financing the farmer would be asked to open a running account; his land would be checked; he would be given fuel, the cost of land preparation, the cost of seeds, and fertilizer (interview 4, paragraph 5). On the other hand, farmers should mortgage their land to cover 70% of the cost in case they failed to pay the bank input costs (interview 4, paragraph 5).

The Agricultural Bank is expanding its financing from the farming sector to include other social domains (interview 4, paragraph 3). For example, the bank is financing livestock for

families. This activity was called the finance of producing families and first approached families working within the Rahad scheme, teachers, or health officers in El Fau city (interview 4, paragraph 3).

The family will be asked to open account, then be given two cows, and be asked to pay back in two years with low monthly payments (interview 4, paragraph 3). Another project was to buy male goats to improve the breed; the family would borrow the goat and pay 20 cents per month for one year (interview 4, paragraph 3).

The bank introduced oil grinding in villages (small machines locally manufactured to grind oil seeds such as groundnuts); in every village there would be 3-4 local grinders (interview 4, pargraph 3). Financing small enterprises such as biscuit machines and sewing machines was also practiced by the bank (interview 4, paragraph 3). Trade was also financed, for example, merchants to buy sugar and flour (interview 4, paragraph 3). They also financed construction materials for building houses (interview 4, paragraph 3).

Women are among those who are financed by the bank, but they are financed individually, meaning that the bank up until now has not financed women groups (interview 4, paragraph 9). According to the actor, in 90% of cases where women were financed, women would pay the cost of inputs back (interview 4, paragraph 9). The actor further mentioned that women are interested in getting financed for building houses and establishing kindergartens; therefore, the bank finances these categories for women (interview 4, paragraph 9).

After the arrival of KIAS and its sharing with farmers, the bank financed the space farmed by the company (interview 4, paragraph 17). KIAS production in the mentioned season was less than expected (120 kg per hectare; the optimum is 4,000 kg per hectare) (primary data, 2011). The low production for the company in the first season, led the Agricultural Bank to cease financing the agricultural season of 2011/2012. In June 2012, KIAS quit managing the Rahad irrigated scheme (FIELD DATA 2012).

5.1.12 Savings and Social Development Bank

The aim of the Saving and Social Development Bank is to finance a limited slice of people or families with limited income whom are also called small producers by the bank (interview 4, paragraph 22) (Savings and Social Development Bank, 2012). According to the actor, the individual has a limited income, and he or she gets not more than five Euros per day (interview 4, paragraph 26).

The bank uses micro-finance policy to increase people's income, which will reflect on the economic growth of the community in the area (interview 4, paragraph 22) (Savings and

Social Development Bank, 2012). The common activities for people within El Fau are farming and animal rising (interview 4, paragraph 31), so the bank mainly finances these two activities (interview 4, paragraph 31).

However, financing is also limited to active people who are well-experienced in farming and animal keeping (interview 4, paragraph 22). Before launching the project for an agent, the bank will collect information on the agent's income or financial status, what activity the agent is doing, and the relevance of the agent's activity with project intended to be financed (interview 4, paragraph 22). The bank finances projects either run by individuals or groups (interview 4, paragraph 42) (SAVING AND SOCIAL DEVELOPMENT BANK 2012).

Financing of groups takes place as follows: members of the association elect members of the executive office, usually three; the three will deal with the bank and sign papers (interview 4, paragraph 47) (SAVING AND SOCIAL DEVELOPMENT BANK 2012).

Most of the associations financed are pastoral associations and women's associations; there are around seven pastoral associations (interview 4, paragraph 44) and only one association for working women called Amna Eltyeb (interview 4, paragraph 53). In our second field work, we found out that there were around 10 new women's associations in addition to the women's union that were registered and financed with different projects by the bank (livestock, trading projects, and electric products) (interview 77, paragraph 31). The actor said the aim was to have 60% of finance projects go to women, (interview 4, and paragraph 53) (SAVING AND SOCIAL DEVELOPMENT BANK 2012).

After financing a certain project, the bank would follow the payment through executives of the association (interview 4, paragraph 47).

The actor considers itself as a pioneer and specializes in micro-financing in the area (interview 4, paragraph 23).

About the actor's relation to the Rahad agricultural scheme, the actor is not directly linked with the corporation, but the bank is directly connected with farmers and families that directly benefit from the scheme, farmers, and the staff of the scheme (interview 4, paragraph 33). The following figure 9 domenstrates finance inistitutions within Rahad scheme and El Fau locality
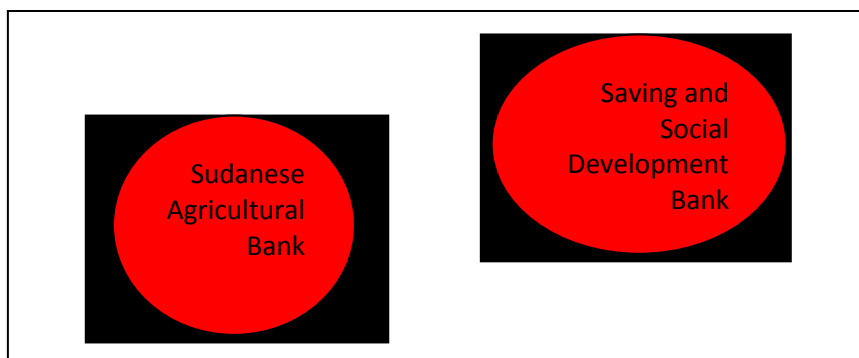
Figure 9: Finance institutions at Rahad scheme
Source: own preparation

5.1.13 Rahad scheme Farmers' Union

The Rahad scheme Farmers' Union was first established in the south part of the scheme in the form of a starting committee. Then when the establishment of the scheme finished in 1982, a comprehensive union representing the geographical expansion of the scheme was formed (interview 11, paragraph 3).

The composition of the union is as follows: the base of the union is the general assembly, every village has a general assembly, and every village will select a production committee of 10 persons called the production council for the village. The 10 members of the production council of the village are divided into a four-person central committee and a six-person production committee; the village council has president, secretary, treasurer, and members (interview 11, paragraph 3).

All farmers in the scheme (minimum should be around 500 persons) will meet to form a central committee. This committee is formed as follows: every village will select four people; the total will be 184 persons (4 x 46 villages). This number will select 24 people as the executive office; this office should be representative for all villages in the scheme (interview 11, paragraph 3).

Members of the executive committee in the union have authority to instruct services to the section committees (interview 11, paragraph 4). The section committee is a committee consisting of 10 persons selected at the level of the section and headed by the head of the section (interview 11, paragraph 4). The section committees instruct farmer committees at the village level.

These executives will hold a meeting with the central committee to select the president secretary and the general secretary of the whole union (interview 11, paragraph 3). There are also committees formed within the executive council of the union called the service committees such as the electricity committee, personnel committee, union building

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committee, and water committee. These committees are formed to respond to the needs of villagers in the scheme (interview 11, paragraph 3). Three members of the executive council are members on the administrative council of the scheme. Usually they are the general secretary, the treasurer, and the head of the union (interview 11, paragraph 4).

According to the Farmers' Union actor, the executives of the union attend meetings with the administrative council of the scheme (interview 11, paragraph 4). In these meetings, the union representative is able to supervise input supply to the farmers and money circulation within the scheme (interview 11, paragraph 4).

Every village has one extensionist, so at the section level there are five extensionists. This type of structure existed during the administration of the Rahad Corporation (RAHAD AGRICULTURAL CORPORATION 2010).

The Farmers' Union in the Rahad scheme has been among the decision makers for the privatization of the scheme; the secretary of the Farmers' Union is a member of the High Council of Agricultural Development, which a political body containing politicians at the presidential level (interview 11, paragraph 15). This council suggested private companies as alternatives for managing national schemes, among of them the Rahad scheme (interview 11, paragraph 15). Involvement of the Farmers' Union in this decision indicates the polytypical role of the union in the Rahad scheme (ABD ELRAHIM 2010). At the state level, the Rahad scheme Farmers' Union and the rain-fed Farmers' Union represent the General Union of Sudanese Farmers (ABD ELRAHIM 2010).

The Rahad Farmers' Union finances social services for scheme villages by deducting a certain share from farm production 2% (interview 11, paragraph 6). Coordination of these finances goes through a share with the Department of Social Services and development in the Rahad scheme (see other part) and a share with the El Fau locality (interview 11, paragraph 6). The Department of Social Services provides its technical views in implementing the services (interview 46, paragraph 4), and the El Fau locality provides the administrational side of implementing the services along with funds from the state (interview 11, paragraph 6). Involvement of the Rahad Farmers' Union in social services goes through the services committees in the administrative council and the section committees (who are the representatives of farmers' committees at the section level).

The section committee has the right to suggest programs according to the needs of the section and specifically hands the administrative council their proposals (interview 11, paragraph 4).

The administrative council discusses with the Department of Social Development and develops the proposals in the Rahad scheme[3] (interview 11, paragraph 4).

The Farmers' Union was also responsible for providing social services even before establishing the El Fau locality in 2006. After that the union continued its role in financing social services through the Department of Social Services in the scheme (interview 11, paragraph 6). The share of the Farmer's Union was used to build schools, clinics, water services, and electricity (interview 11, paragraph 6).

The Farmers' Union worked to provide electricity for some villages (mainly in the head of sections). It collected share money from farmers and contacted the government in order to facilitate electricity provision.

Involvement of the Farmers' Union in providing such social services in the Rahad scheme villages is actually a part of the objectives and roles attributed to the Sudanese National Farmers' Union (ABD ELRAHIM 2010). See Figure 10 to follow representation of Rahad scheme Farmers' Union from village level to administration level.
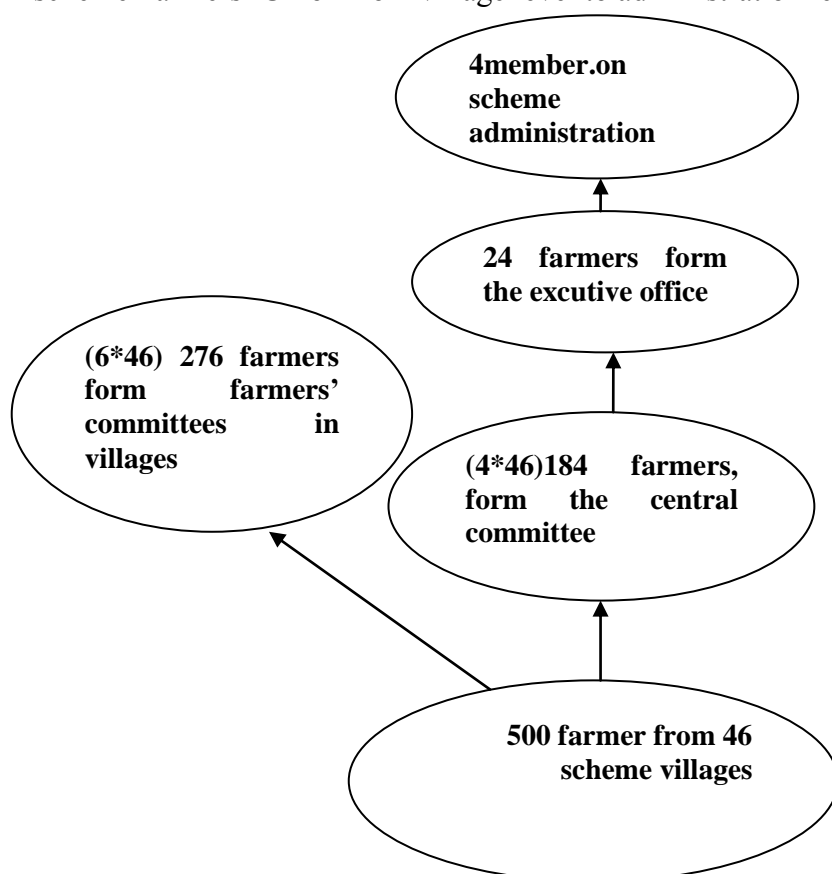
Figure 10: Composition of the Rahad scheme Farmers' Union
Source: field data 2010

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[3]From interviews at the field level, we understood that within the Rahad scheme there is an administration for social development that conducts technical assistance with the section committee. They coordinate with the Farmers' Union to suggest proposals for rehabilitation or to establish social services in the villages of the scheme.

5.1.14 Pastoral Union

The researcher interviewed the general secretary of the National Pastoral Union and representatives of the Pastoral Union in the El Fau area. Views in this section represent both representatives. The Pastoral Union in El Fau is a part of the National Pastoral Union, which was established in 1992 and is situated in Khartoum (interview 45, paragraph 4) (BARAKA 2012). The National Pastoral Union consists of unions in different states, at the state level there will be a Pastoral Union representing unions from different localities, and the Pastoral Union at the locality level consists of members of pastorals in villages (interview 5, paragraph 7) (BARAKA 2012). In El Fau, the pastoral union consists of 12 members: four of them will be representatives in Gedarif state and around 38 members at the state level will represent the state in the center (interview 5, paragraph 15) (see figure11). Moreover, the Pastoral Union in the El Fau locality deals with problems or issues within rain-fed farms and Rahad scheme farms (according to geographical sections of the El Fau locality, there are representatives of the Pastoral Union who represent pastorals in rain-fed farms and scheme farms) (interview 2, paragraph 58). The head of the Pastoral Union in Khartom mentioned that the union is an organization that aims to improve human beings (the pastorals), animals, and pastures. This main goal will be achieved by providing social services for pastorals (health and education), improving access to pathways, providing proper veterinary services and water points for pastorals (interview 45, paragraphs 5-8).

The actor from the Pastoral Union in El Fau reflected many problems as *status quo* that the actor is looking forward to change (interview 5, paragraph 8). Changing this problematic situation so far represents the current perceived role the union is responsible for.

Problems mentioned by the Pastoral Union in El Fau include encroachment of private farms on grazing space within Butana (interview 5, paragraph 8). This problem has been complained about widely by interviewees, and there is a need to demarcate pathways. Irregular water sources in Butana have been mentioned as a problem that obligates more digging of *hafair* in the area (interview 5, paragraph 8). *Hafair* are reservoirs for surface water (KIRK 1993). According to a pastoral representative in El Fau, the Pastoral Union started to decide suitable areas for the *hafair* (interview 5, paragraph 8).

Animals theft is among the problems threatening animals and pastoral safety in the El Fau locality, because thieves mostly are armed now (interview 5, paragraph 8).

Imposing different kind of taxes paid to the government at different localities has been mentioned as a problem facing pastorals, so there is a need for a reasonable way to cut off or limit taxes (interview 45, paragraph 8).
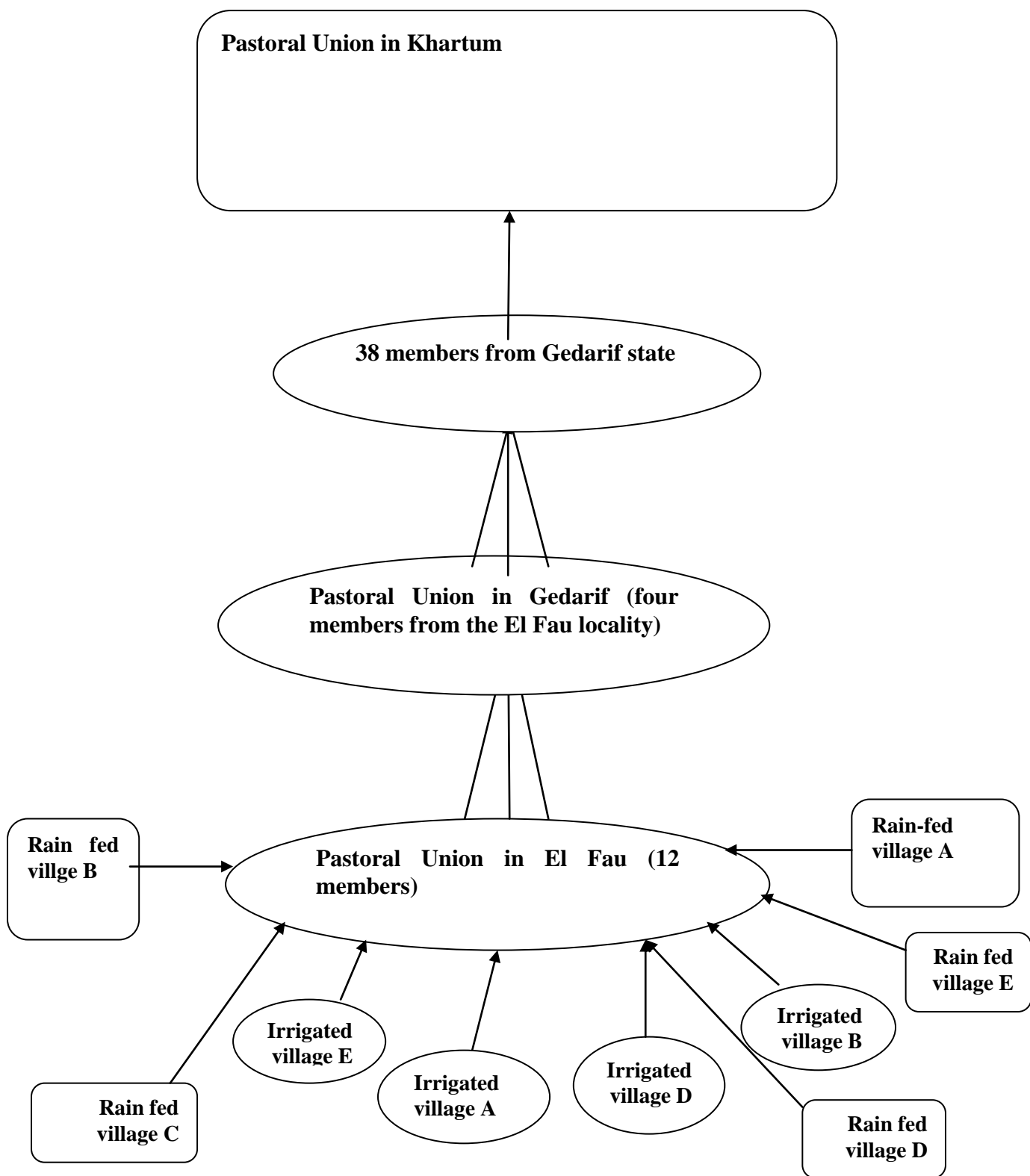
The actor views pastorals as a crucial economic sector in Sudan, because livestock export is one of the main components of the national economy in Sudan (Ahmed et al., 2012). In spite of this fact, pastorals continue traditional grazing and retain their traditional way of animal rising within the accessable natural grazing (interview 5, paragraph 10) (SALIH 1990; AHMED et al.2012). Therefore, the actor expresses a need for proper services of artificial insemination for cattle, establishing proper milk and meat production factories in the area, and programs of capacity building for pastorals in fodder production and processing (interview 5, paragraphs 10, 11).

In 2010, a law was launched to organize the production of farming and animal grazing in Sudan's Ministry of Justice (MINISTRY OF JUSTICE 2011). This law is known as the law of owners of agriculture and animal production (MINISTRY OF JUSTICE 2011). According to this law, farmers and pastorals are considered one sector of economic production (MINISTRY OF JUSTICE 2011). For example, the Pastoral Union and Rahad Farmers' Union is one unit of production. The regularities of this law are in its developing stages and there are no cultivated experiences on the ground yet.

Pastoral Union could be considered as a collective action organization. Collective action is an action taken by a group (either directly or on its behalf through an organization) (NGAIDO and KIRK 2000, 13). Collective action organizations usually perform democratic decision process; it can also enforce sanctions and good group behavior (NGAIDO and KIRK 2000). Pastoral union similar to other pastoral organizations in Africa had the tendency to pritorize economic productivitiy of pastoral sector.

Research recommends that pastoral organizations should not depend only on state formal mechanisms of sanctions or excultions where as indeginous knowledge of local community need to be sourced for such regulations (NGAIDO and KIRK 2000).

 In our views the open access system which charectrize land tenure in Sudan can obstacle developed rules or rights of access to pastures developed by Pastoral Union (NGAIDO and KIRK 2000). The scaling nature of Pastoral Union allows including heterogenous groups over extended pastures, therefore, it is necessary that Pastoral Union integrate possible or existing workable elements of local collective actions (NGAIDO and KIRK 2000). This research is trying to prove that this integration can come through networking of relations with different Rahad scheme actors

Pastoral Union in Khartum

38 members from Gedarif state

Pastoral Union in Gedarif (four members from the El Fau locality)

Rain fed villge B

Pastoral Union in El Fau (12 members)

Rain-fed village A

Rain fed village E

Irrigated village E

Rain fed village C

Irrigated village A

Irrigated village D

Irrigated village B

Rain fed village D

Figure 11: Composition of the Pastoral Union from village level to federal level
Source: field data 2010

5.1.15 Women's Union

The RAAKS team interviewed the head of the Sudanese Women's Union in El Fau and the Women's Union in village 10. The roles of the Women's Union in El Fau represent objectives of the General Sudanese Women's Union (SWGU 2010) (figure 12 represents compination of Sudanese Women's Union in El Fau locality). The Women's Unions at the state and locality levels consist of the following: an executive office containing a president, deputy, economic secretary, political secretary, training secretary, health secretary, secretary of rural women, and secretary of labor women (interview 8, paragraph 2). This system also applies to villages; in every village there is executive office consisting of a secretary of the union and its deputies. If they have a program, they deliver it to the village. They get programs from higher and deliver them to the branches (interview 8, paragraph 2).

The union implements programs that are designed by the state and then presents them to localities, meaning that the activities of the Women's Union cover villages within the scheme area and outside the scheme (interview 8, paragraph 5) (SWGU 2010).

Investment activities implemented through the economic unit and aim to increase the income of women; women will pay membership, and can then get training in food manufacturing such as sweets and biscuits (interview 8, paragraph 3) (SWGU 2010).

The health secretary of the union deals with the health visitor in the hospital to train women in child and maternal health. The health secretary contains a health committee who supervise the activities of village cleaning (interview 8, paragraph 3) (SWGU 2010).

The training secretary trains women leaders at the locality or state level and advocates women with their role in politics and what they do in society. Women attend sessions where papers on law issues are presented, and women are supposed to reflect what they learned to villages (interview 8, paragraph 3) (SWGU 2010).

The women's labor secretary is responsible for assessing the needs of working women such as teachers, nurses, women who do administrational jobs, and even tea sellers and for knowing and then reporting to the responsible agencies (interview 8, paragraph 3) (SWGU 2010).

According to the actor, a survey was made for working women in the El Fau locality, but no results were given yet (interview 8, paragraph 3). The political secretary's mission is to receive signs or political orientation from the center (Women's Union in Khartoum) such as how to explain the culture of unity for southern women and why it is important (that was an activity prior to South Sudan secession) (interview 8, paragraph 3).

The Women's Union has also initiated associations for female laborers working on farms (interview 8, paragraph 8). Women pay a membership fee of 50 cents monthly, and the union has to officially register the association. According to the actor, this membership can be used as a revolving fund for financing women's farming (interview 8, paragraph 7).

The Women's Union is connected to the El Fau locality, but the actor expressed weak financial support from the locality for the Women's Union's activities (interview 8, paragraph 12).

The RAAKS team interviewed one branch of the Women's Union in village 10 (south of the scheme), and the following activities were mentioned: participation in village cleaning annually, participation with youth clubs, participation in fighting harmful practices (interview 43, paragraph 8). The Women's Union participates in education committees in schools in order to know and understand the problems of students (interview 43, paragraph 8). The Women's Union participates in political work in a big way (participating with the national conference, which is the biggest power of women here in village 10) (interview 43, paragraph 8). Finally, the Women's Union participates in social events, helping poor families by donating money (interview 43, paragraph 8).

The Women's Union in villages also expressed shortages of funds to run activities. In order to solve it, sometimes they would collect share money from members to pay for transportation or the running cost of activities (interview 43, paragraph 59). The Women's Union in village 10 expressed future hopes of having a university in El Fau city (interview 43, paragraph 59). The union also expressed an improvement in health clinics, drinking water, and local roads to El Fau (interview 43, paragraph 72).
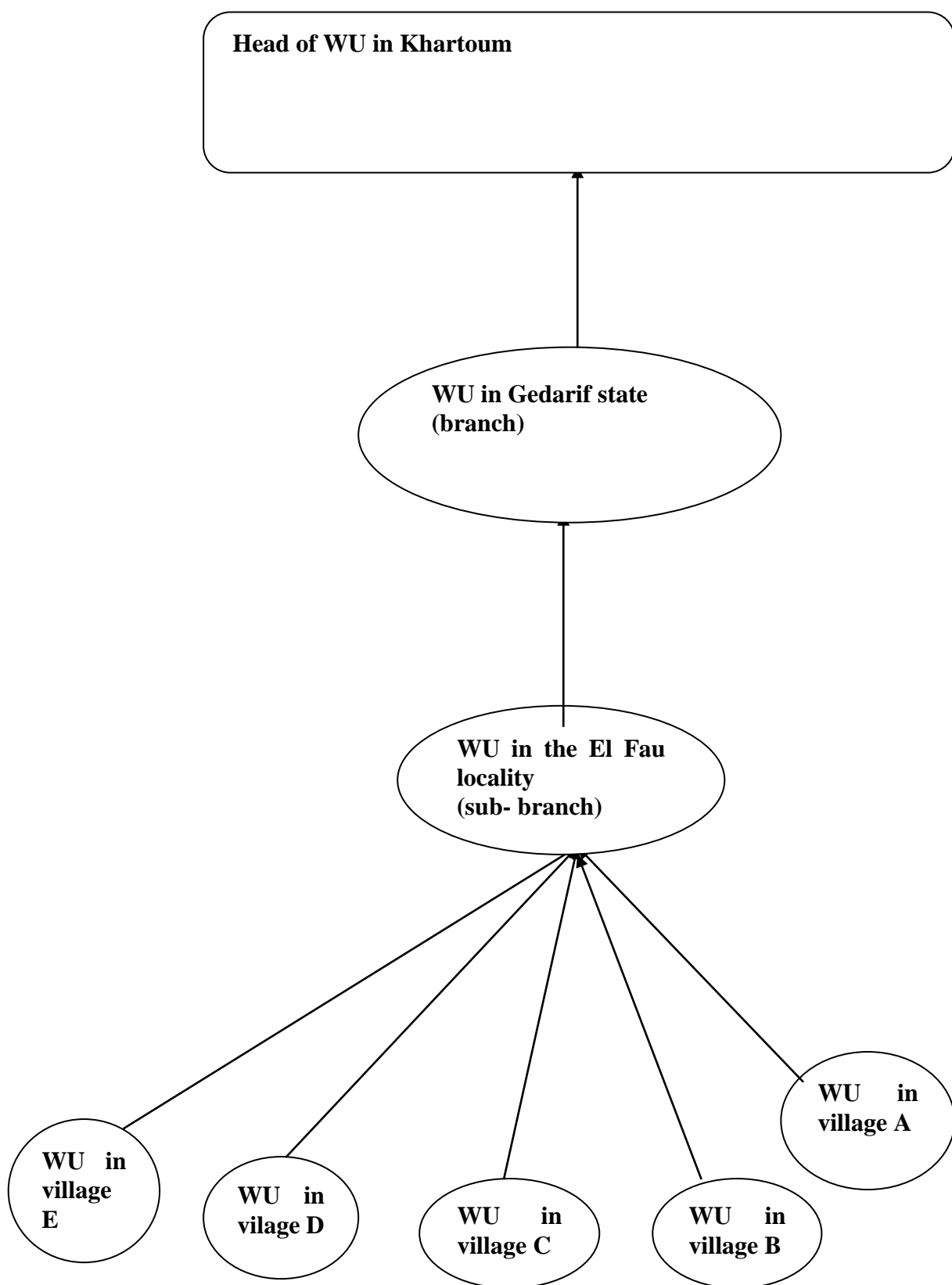
Figure 12: Composition of the Women's Union from village to federal level
Source: field data 2010
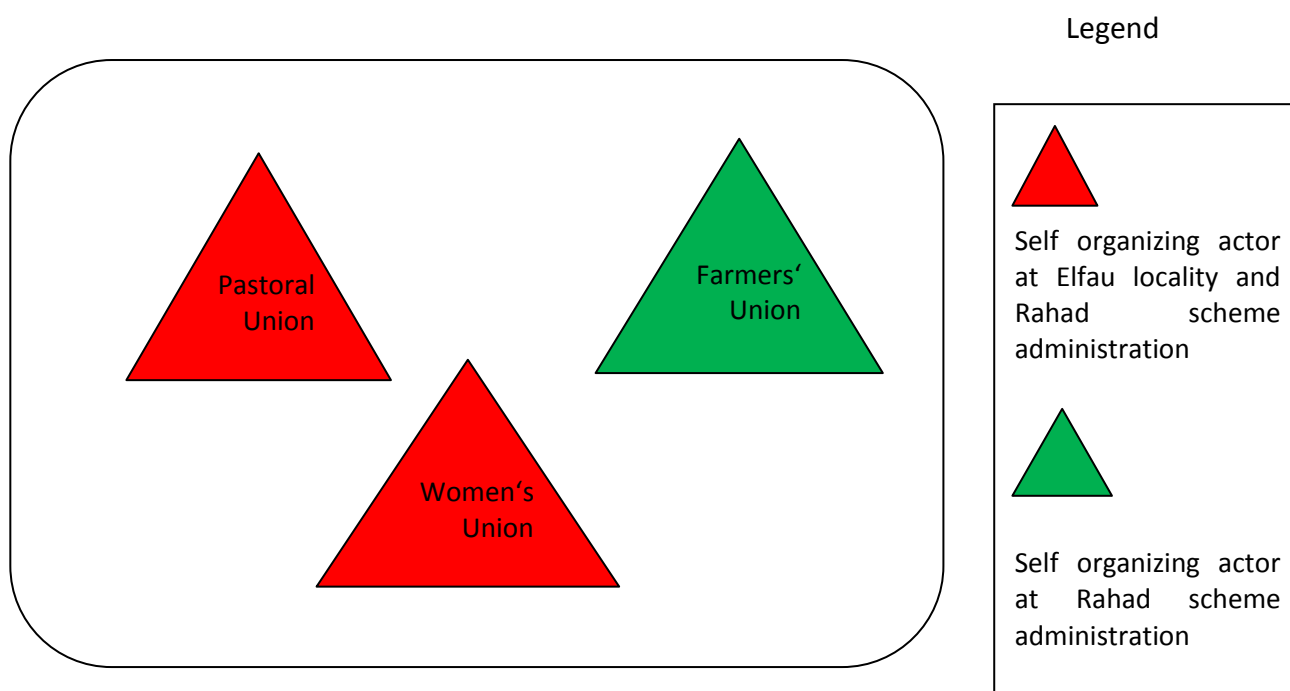
Figure 13: Self organization actors at level of Rahad Scheme
Source: own preparation

5.2 Actors at the village level

5.2.1 Public committees

Public committees represent the government authority in different districts and rural areas (HIGH COUNCIL FOR DECENTERALIZED RULING 2012). (See figure 14 which domenstrates symbols of actors at level of villages)

The public committee has a head, a deputy, and someone responsible for planning housing and financing (interview 28, paragraph 4). Public committees are also known as the public committees for control and services. They resemble a micro-government and are entitled to control any illegal or intruding problems (interview 28, paragraph 4) (HIGH COUNCIL FOR DECENTERALIZED RULING 2012)

Public committees in El Fau are responsible for representing the locality by monitoring social services including education, health, and security (interview 7, paragraph 18) (HIGH COUNCIL FOR DECENETRALIZED RULING 2012) .Public committees are also supposed to estimate village needs for the above services, collect taxes from villagers (interview 7, paragraph 18). Regulations on the work for public committees are developed at the locality level (HIGH COUNCIL FOR DECENTERALIZED RULING 2012) .Therefore, there would be some differences in the activities of public committees from one locality to another (HIGH

COUNCIL FOR DECENTERALIZED RULING 2012) Actually appointing of the public committee is decided by the legislative committee. The legislative council is an institute formed by political aliegned, wiser and rich people in El Fau locality (interview 7, paragraph 41) the council will call for dissolving the public committee. This decision would be written to the locality, and then the locality would inform the public committee in the village that they are dissolved (interview 7, paragraph 41) (HIGH COUNCIL FOR DECENTERALIZED RULING 2012) .The public committee is formed by election; a certain village can be informed that they need to form their public committee, resulting in a meeting (50 people can represent the village). In the meeting the village should select 15 members and then from that number an exclusive office of 5 people will be selected (interview 7, paragraph 41) (The RAAKS team interviewed two representatives of public committees, one in south of the scheme and the other in the north). The following responsibilities were mentioned: They are supposed to report problems to the executive institutions (police) (interview 28, paragraph 4) (HIGH COUNCIL FOR DECENTERALIZED RULING 2012) It is a service committee because it is the delegates of the villages with the government (localities) that seek services such as the provision of drinking water, electricity, schooling services, health services, etc. (interview 28, paragraph 4).

Some of the finances for public committees to provide the mentioned social services are taken from villagers by deducting from their production. The rest should be provided by the government (interview 78, paragraph 14). However, if the committee were not serious in planning to improve the services of its villages, the government would not care to help (interview 78, paragraph 14). However, reviewed files of the High Council for Decentralized Ruling indicate that public committees should not collect money from local people (HIGH COUNCIL FOR DECENTERALIZED RULING 2012). In the Rahad scheme, farmer committees, of whom some could be members in a public committee, deduct money from farmers' produce (interview 11, paragraph 6). This would indicate power to take decesions in villages is on the hands of public committees

5.2.2 Women's associations

Unofficially registered, informal associations for women are found within the scheme villages. These types of associations have invented their own activities according to their needs. One distinguished women's association we found in one village is an officially registered association and follows a network of nongovernmental organizations in Gedarif state. The main focuses of this association are increasing the income of women through

income generation activities and conducting capacity building for women. Those two types of women association categories expressed no relationship with the defined actors within the Rahad agricultural scheme; however, some of these associations have expressed a kind of relationship with the Women's Union, youth associations, El Fau locality, and others such as religious associations (see chapter 5).

The RAAKS team managed to interview six women's associations in the Rahad agricultural scheme; two in the north of the scheme, two in the middle of the scheme, and two in the south of the scheme.

In the following section, women's associations are described, first starting with unofficially registered associations.

Some of the activities run by these associations are collecting share money (2 Euros per month) for buying utensils such as cups, trays, pots, and plates, and using it for social occasions; the individuals of the associations alternate borrowing these utensils and using them for weddings or funerals. Non-members of the associations would be allowed to rent these utensils (interview 49, paragraph 5; interview 30, paragraph 3). Another activity is gathering for education in the Quran, Islamic lessons, and conducting illiteracy classes (interview 48, paragraph 16; interview 49, paragraph 130). There would be either a teacher who can be a member in the association to teach the rest, or the association would approach religious men in villages to teach them (interview 48, paragraph 2; interview 49, paragraph 132).

Only one of the interviewed associations could express ideas to develop their work. There is a weak vision among members to develop the work of those associations. Trading activities for women to be financed from banks was mentioned, and a need of land for women of the association to farm (interview 30, paragraph 40). Improvement in drinking water and rehabilitation of main roads to El Fau city were mentioned by women as ambitions for a better life within the scheme (interview 30, paragraph 46).

An officially registered women's association (women's development association in village 10) follows the network for women's development in Gedarif state. This network consists of four societies, and the network is funded by an organization called Practical Action (interview 33, paragraph 13). The network helps facilitate contact with funding agencies in order to fund activities of the association, especially training (interview 33, paragraph 13). Activities of this association are training in food manufacturing, micro-finance activities after training (possessing production materials with payment), training in sewing and handmade products, revolving fund activities (selling some food products for members with pay back) (interview

33, paragraphs 5-10). Members of this group expressed that shortages of money constrain them from achieving their ideas; training courses in software in order to start computer and copy machine services were expressed as future plans (interview 33, paragraph 57). There were branches in 2002 at villages 8 and 7, *Abuishosh*, and villages 11-15; some of these branches have deteriorated, but the active ones are associations in villages 8 and 7 and *Dar Elmoeminat* (interview 33, paragraph 13).

The *Dar Elmoeminat* association complained that the main association organizes some activities without informing them as a branch, so they do not trust their main association (Women's Development Association) (interview 48, paragraph 76). Discussion of women's associations as local actors in the Rahad agricultural scheme is in chapter 5.

5.2.3 Youth clubs

The RAAKS team managed to interview six youth clubs: four in the southern Rahad scheme, two in the northern Rahad scheme

Youth in the Rahad scheme form social clubs through which they mainly form football teams, (interview 42, paragraph 5; interview 41, paragraph 11; interview 39, paragraph 12; interview 38, paragraph 6). The total number of clubs is almost 60 (RAHAD AGRICULTURE CORPORATION 2006). Youth clubs also include social activities such as training in first aid, vocational training, painting, mechanics, and cleaning campaigns for villages (interview 41, paragraph 12). Some clubs offered adult education classes with the help of women teachers in the village (interview 39, paragraph 14).

Some youth made their clubs places to gather and start socializing in the village. They would meet in the club and agree to go help farmers with the harvest; they would meet there and collect shares of money to assist poor families with funerals or weddings (interview 38, paragraph 6). The clubs can also be used to host kindergartens for village kids (interview 38, paragraph 6). They can be places for all villagers to meet and socialize; examples are graduates of schools and universities. Some evening extension debates used to be conducted in youth clubs (interview 31, paragraph 4)

Youth clubs within the scheme area get financial support from the Rahad scheme through the section of social development; however, this support is not regular and is sometimes shifted to another service in the villages (interview 42, paragraph 12; interview 31, paragraph 12). However, youth clubs do not get regular financial support from the locality, and some interviewed youth admitted that the clubs were built by youth from their own funds (interview 31, paragraph 18; interview 39, paragraph 12; interview 38, paragraph 62). Tribalism and

political differences among the youth was mentioned as a reason for the lack of coordination between them (interview 41, paragraphs 30, 31).

5.2.4 Farmers' committees

The Farmers' Union is connected to farmers through farmers' committees. The composition of the farmers' committee is as follows: the base of the Farmers' Union is the general assembly, every village has a general assembly, and every village will select a committee of ten persons who are called the village council. The ten-person village council is divided into four people as a central committee and six as the farmers' committee, sometimes called the production committee of the village. The village council has a president, secretary, treasurer, and members (interview 11, paragraph 3).

Farmers' committees are responsible for linking farmers with the extensionists. Some information is communicated from extensionists to the farmers' committee and then to the farmers (interview 23, paragraph 8).

Agricultural policies are formed at the level of the High Council of Agricultural Development, and the Federal Farmers' Union in Khartoum. These institutions decide which crops will be planted and discuss the types of financial resources to be used for farming. Then the decisions are handed to the section committees, then tofarmers' committees, and then to the farmers (interview 23, paragraph 8) (CEM 2009; ABD ELRAHIM 2010).

The section committee is a committee of ten persons selected at the section level and led by the section's head. In the Rahad scheme there are 10 sections (RAHAD AGRCIULTURE CORPORATION 2010) (interview 11, paragraph 4).

5.2.5 Local leaders (sheikhs)

Prior to explaining who the local leaders are, we need to briefly introduce the ruling system through which local leaders were given authority to lead their tribes.

The native administration is a body of administrative rules that was introduced by the Anglo-Egyptian Condominium to regulate grazing and farming activities within the Butana area (Sorbo 2003). The native administration system was also introduced to regulate grazing activities of other nomadic tribes in Sudan (ASAD 1970; ALNAEM 2010; SAAD 2010). The legitimacy of the native administration has been exposed to many challenges due to changes in political decisions and development planning (KIRK 1993; ASAD 1970; ALNAEM 2010; SAAD 2010). Some of these changes include the decision to totally abolish the native administration in 1972, and then to return to a native administration in the late 1980s

(ALNAEM 2010; SAAD 2010). According to the act of abolition of the native administration, authority granted by this system of local rule was withdrawn, and some scholars have expressed that a vacuum in leadership of local people in Sudan was created (ALNAEM 2010; SAAD 2010).

The administrative rules of the native administration were applied through a certain diagram consisting of persons who were delegated judiciary authority to solve disputes between individuals and to help the government collect taxes on farm produce and animal stock (ALNAEM 2010; SAAD 2010). The native administration also enabled leaders to give individuals of a community access to farming lands and grazing pastures (KIRK 1993; ALNAEM 2010; SAAD 2010).

In the Butana area, this system starts with the Nazir who is the top of the tribe. The Nazir is followed by the Shiekh Khat, who has Omdas following him, and Omdas are followed by sheikhs, who are the smallest unit of the diagram and are represented at the village level (KIRK 1993; ALNAEM 2010; SAAD 2010). One example of the responsibilities given to a sheikh during the native administration was to deal with conflict over land or murder. The sheikh would work on it, and if he could not solve the case, it would be referred to the Omda. The Omda would refer it to the Sheikh Khat, and then to the Nazir. Sheikhs in villages were also responsible for leading villagers in communal work such as digging wells (interview 57, paragraph 5). If someone in a village needed land to farm he would come to the sheikh and ask for it. The sheikh with two consultants would go with the man and give him a specific tract of land, and later the sheikh would be responsible for solving any disputes related to this land and refer it to the others in the system if he could not manage the problem (interview 37, paragraph 6).

Collecting taxes in the native administration was the responsibility of the Sheikh Khat. He would collect it with assistant of Omdas and sheikhs and bring it to the governmental authorities (interview 37, paragraph 5).

Although the native administration was dissolved in 1972, tribal leaders were still unofficially involved in keeping peace and stability in communities, especially by reducing conflicts between tribes in different areas in Sudan (ALNAEM 2010; SAAD 2010). Lately in 1987, the government of Sudan decided to return to the native administration but with some limitations (ALNAEM 2010; SAAD 2010). In nomadic and semi-nomadic areas, leaders are given *de facto* judiciary authority, and in settled areas they are given administrative and security authority (ALNAEM 2010; SAAD 2010). Within the Rahad scheme, sheikhs and Omdas for different tribes in the scheme area are appointed by the El Fau locality (interview 7,

paragaraph 34). The tribe would meet and nominate a certain number of people for Omda, and then a letter is released by the tribe and brought to the locality. The locality will appoint people to survey the candidates for Omda; they would enquire about his ethics, his loyalty to political parties, whether he was involved in previous crimes, or any other misbehavior (interview 7, paragraph 34).

NGAIDO and KIRK (2000) proved that Native Administration is a type of a local institution that was functioning in producing a stable and successful utilization of pastures by different groups in eastern part of the Sudan. Institutions are defined as human devised constrains that shape human interaction (NORTH 1990 Cited by NGAIDO and KIRK 2000, 7).   Building and strenthening of local institutions is necessary for devolution the management of rangeland (NGAIDO and KIRK 2000). However, changes on land uses and conflict within group interests are necessary to be considered if local institutions to be enhanced for   better management of pastures. As presented above, the Native Administration had been reconsidered by Sudanese authorities (sheikhs and Nazirate of tribes are appointed by government and assigned certain roles) however, this study is not emphazising on whether this consideration has been efficient or not, rather the research tried to see the present connections of local sheikhs with the rest of scheme's ; whether these connections have been fruitful in producing knowledge for the agriculture innovation in Rahad scheme.

The RAAKS team interviewed some local shiekhs in the Rahad scheme (four sheikhs and one Sheikh Khat in the south of the scheme, one head of court in the north of the scheme). In the interviews, the leaders were asked to describe their roles in the past and present and how they are related to decisions on farming within the Rahad scheme. The RAAKS team also asked questions about how local leaders are related to public committees.

The present roles of local leaders in the Rahad scheme are mainly to keep security and solve problems between members of tribes. Solving disputes takes place by forming local courts (interview7, paragraph19). If the locality needs to subpoena someone, they will contact the head of the public committee, who will ask the local leader to bring the man to the locality or to law enforcement (interview 7, paragraph 19). Local sheikhs in the Rahad scheme were previously involved in settling agro-pastorals within the scheme villages (interview 11, paragraph 10). Presently, some local sheikhs participate in farmers' committees and public committees within the Rahad scheme (interview 57, paragraph 3; interview 35, paragraph 92).

### 5.2.6 Western Sudan laborers communities in the Rahad scheme
In villages of the Rahad scheme, laborers that do the farm work, mainly crop weeding, watering, and harvesting, are settled in village suburbs (BENEDICT et al. 1982). Laborers

form a notable identity in the Rahad scheme (ABDEL RAHMAN 2010). During fieldwork RAAKS was able to interview actors within this community, namely local sheikhs, women groups, and youth clubs. Laborers in Rahad scheme also perform share cropping with tenants. Share cropping is a phenomenon historically traced back in the United States after freeing of African American origins(WHAYNE 2006).Prices of cotton were declining and planters were not able to pay laborers in cash. According to WHAYNE (2006, 1), wage laborers were given half of cotton and corn they grew in exchange of their labor. In Rahad scheme, laborers will do all the farm work and the produce of the farm will be divided in half between the sharer and the tenants (interview 23, paragraph 17; interview 58, paragraph 8). The phenomenon of sharecropping can be traced back to the 1990s (according to the Rahad staff). The RAAKS team asked for reports that document this phenomenon, but we did not find any. Rahad staff and some farmers estimated that 60% or 50% of tenants in Rahad share crop with laborers (interview 23, paragraph 17).

The RAAKS team discussed reasons for sharing farm crops. Many were given, some of them connected with tenants themselves such as growing old, having another source of off-farm income, or being unable to work on farms. Other reasons were connected to the deterioration of machinery work on farms and changing finance policy in the scheme (interview 23, paragraph 17; interview 58, paragraph 8).

At first glance on the laborers' communities, one might notice that the community laborer's has parallel societies or organizations that are found within settled agro-pastoralist tenants in the Rahad scheme. They have members on public committees in every village, they have their own youth clubs, and they have their own mosques and religious leaders, their own sheikhs, their own women groups. This trend of having separate organizations is self-explanatory because the settled tenants and community laborers are two extremely different ethnic groups (El Fau locality, 2010). The researcher is more concerned with showing network communication between formal actors and local actors but not concerned with showing or comparing ethnic differences in the Rahad scheme. Generally it can be said that laborers' political and social representation in villages improved since laborers' communities who became non-Arab suburbs within the village are represented in public committees in each village. Laborers' communities demand their own schools, mosques, and social clubs in the villages. Moreover, they also obey and pay respect to their own local leaderships or sheikhs ABDEL RAHMAN 2010).

Views and opinions of aborers and settled tenants were merged and analyzed as one category of local actors. However, interesting communication patterns within laborers' communities and settled pastoralists have been presented in another chapter.

Legend
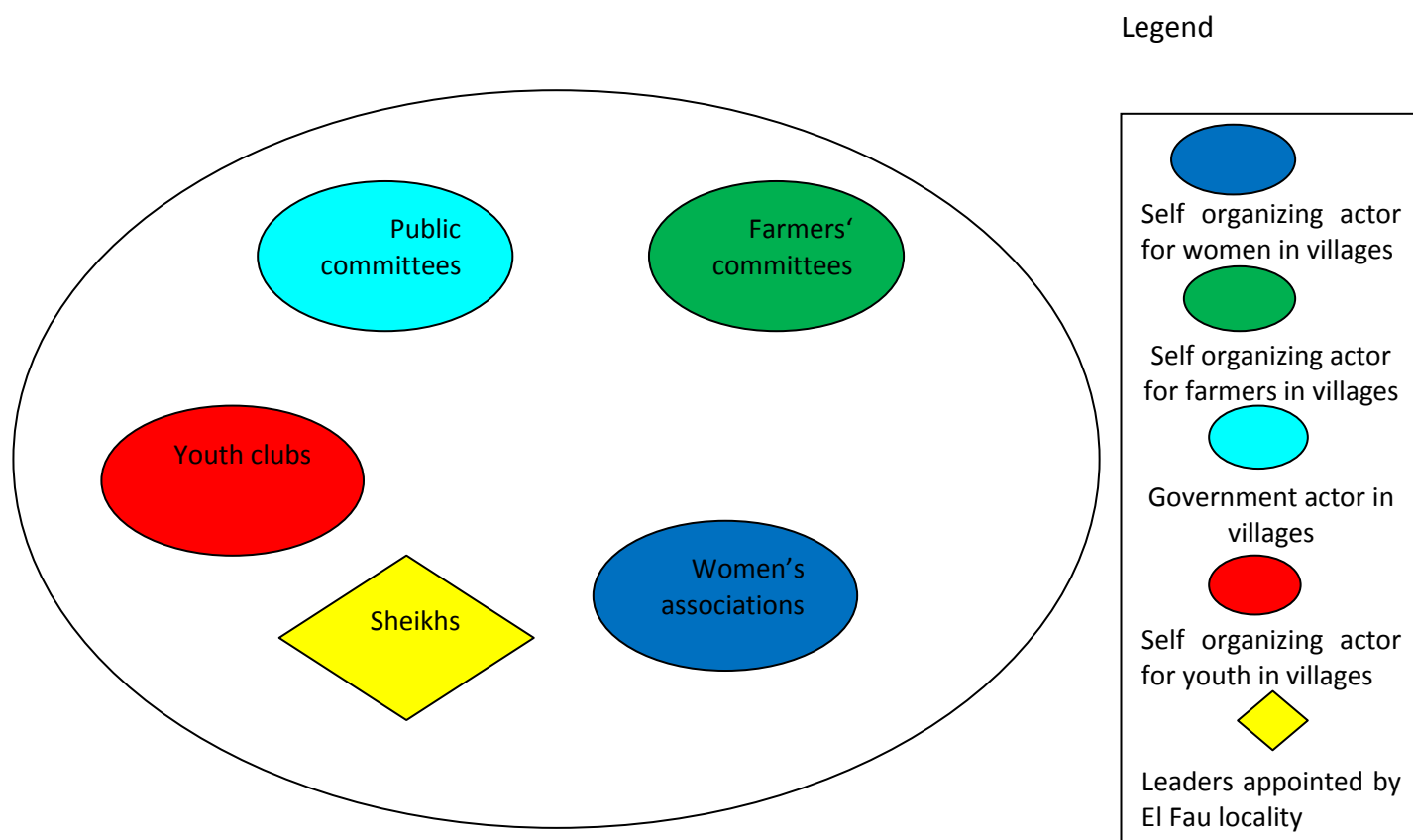
Figure 14: Actors at village level
Source: own preparation
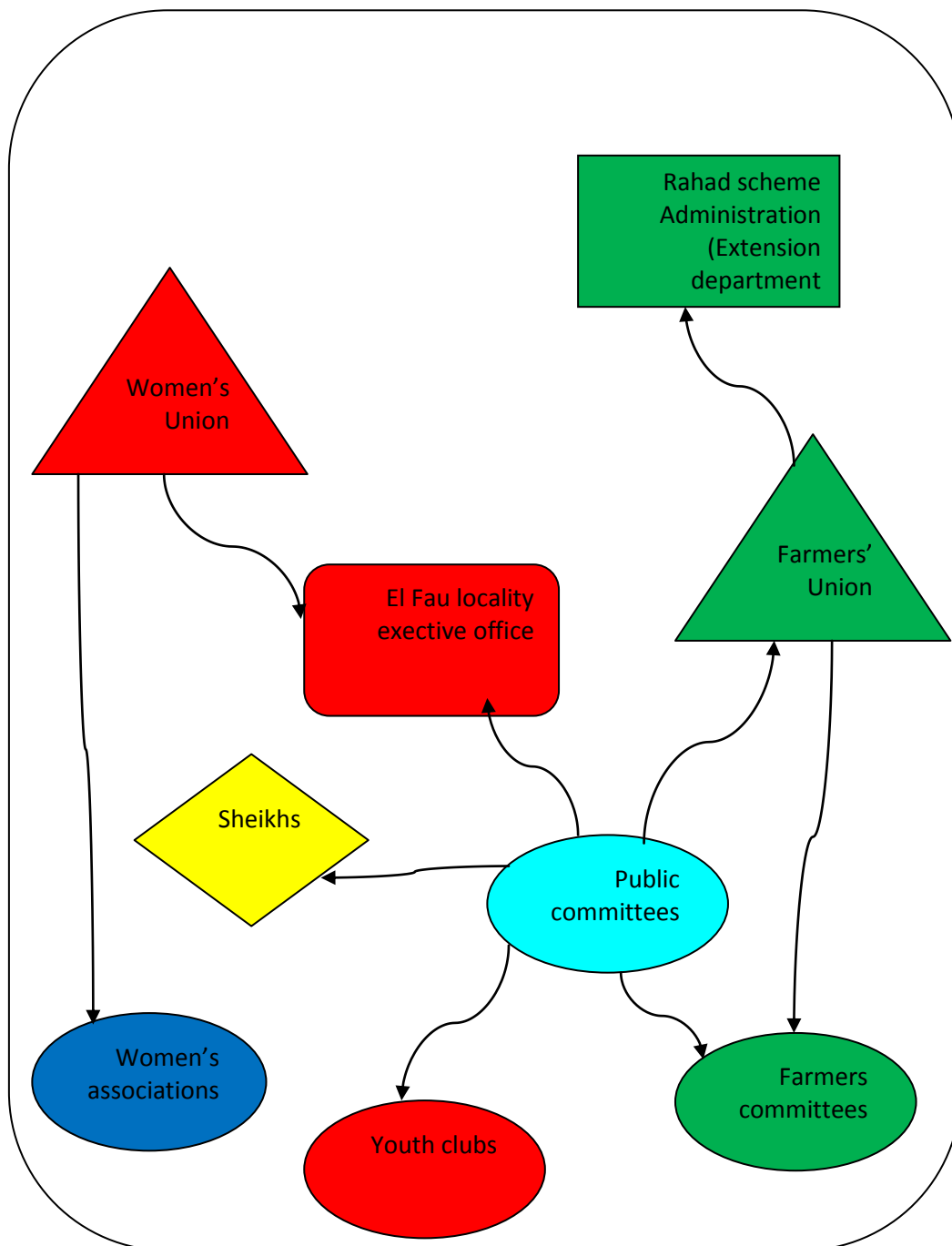
Figure 15: Trajectory of actors at the village level and their connections
Source: own preparation

The trajectory shows the connections of actors at the irrigated village level within the Rahad scheme. Their connection to the Rahad administration and the El Fau locality is also shown. Public committees are the actor connecting villages' actor to El Fau locality office, while Farmers' Union connectingfarmers' committees to Extension in Rahad scheme

Rahad adminstration(extension department)

Rahad research station

Irrigation Adminisitration

Farmers' Union

Zakat dewan

Agriculture bank

Saving and Social Development Bank

National forest corporation

Pastoral union

Women's Union

Ministry of Livestock

Ministry of agriculture

Health Administration

Agriculture shool

Elfau executive office
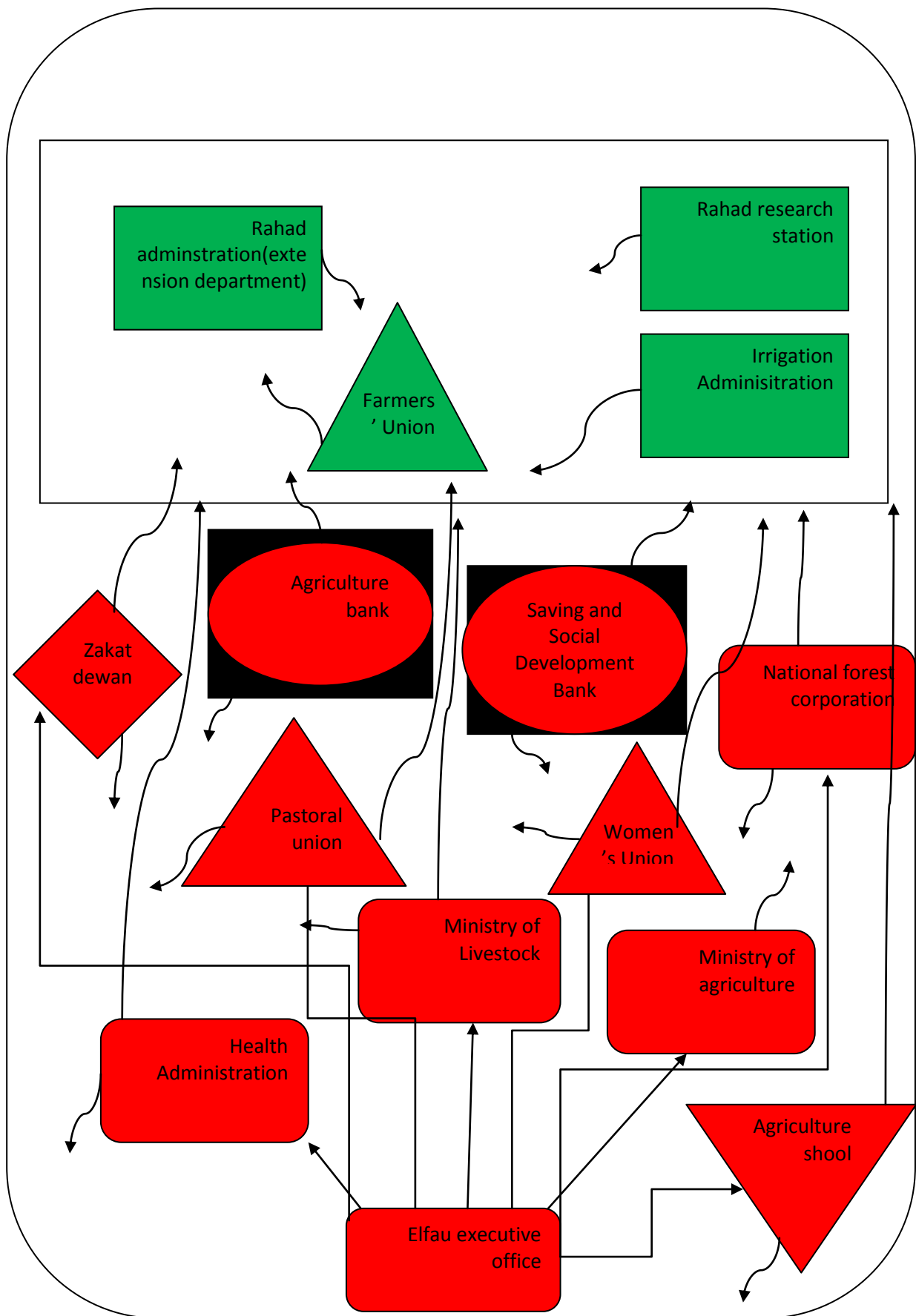
Figure 16: Trajectory of actors at the level of the Rahad scheme
Source: own preparation

The above trajectory shows the location of actors within the Rahad scheme and El Fau locality and their connections. Actors within the Rahad scheme follow the administration of the Rahad scheme and mainly function within the irrigated farms. Most actors within the El Fau locality function also within the administration of the scheme. The Ministry of Agriculture is the only actor that functions within rain-fed areas in the El Fau locality.

5.3 Connections of actors at level of the Rahad scheme

In this section the researcher is reporting communication of each actor at the level of the scheme and then a summary of the communication is presented. This section is an intorductry to the following section where the values (strength and weakness) of these communications are discussed. Firstly short definistions of actors at level of Rahad scheme are given in table 3.

Rahad scheme	■	The administration of the agriculture scheme that was established to settle agro-pastorals within Gedarif state and Gezira state – headquartered in El Fau city
Rahad research station	■	A governmental research station to conduct agriculture research and specifically provide research findings to the Rahad scheme
Ministry of Agriculture	■	Ministry of Agriculture responsible to manage farming activities for rain-fed farmers within the El Fau area
Ministry of Livestock	■	Ministry of Livestockresponsible for health services and production activities of animal stocks in El Fau
El Fau locality	■	El Fau locality executive office that represents government authority in El Fau
Irrigation Administration	■	Governmental inistitute responsible for managing water requirements for irrigation of the Rahad scheme
Farmers' Union	▲	A voluntary organization representing Rahad scheme's farmers
Pastoral Union	▲	A voluntary organization representing owners of livestock in El Fau
Women's Union	▲	A voluntary organization representing women in El Fau
Saving and Social Development Bank	◼	Savings and Social Development Bank, private financial bank providing micro-financial projects for farming society in El Fau
Sudanese Agricultural Bank	◼	Sudanese Agriculture Bank, a governmental financial bank responsible for financing production inputs for farmers in El Fau
Heath Administration	■	Health Administration in El Fau locality responsible for monitoring environmental health in El Fau
Zakat Dewan	◆	An Islamic governmental institution responsible for managing donations from rich to needy people in El Fau
National Forest Corporation	■	National Forest Corporation: a governmental institution responsible for conserving and managing forest resources in El Fau
Agricultural School	▼	A governmental high school responsible for providing a formal education in farming in El Fau

Table 3: Actors at the Rahad scheme level
Source: field data 2010

Rahad scheme administration's netowrk

The Rahad scheme administration is the technical body managing farming operations in the scheme area. There are two ways contacts between the scheme administration and the Agricultural Bank to facilitate credits for farmers, (see figure 17 to study scheme's network). Irrigation Administration contact Rahad scheme administration to organize provision of irrigation water and canals maintenance. The Research station provides the Rahad scheme administration with technical knowledge on crops, soil, plant diseases, and land preperations. Rahad scheme administration has contacts with almost all actors at the level of the scheme with exception of Women's Union and saving and social development bank who are peripheral actors in this network
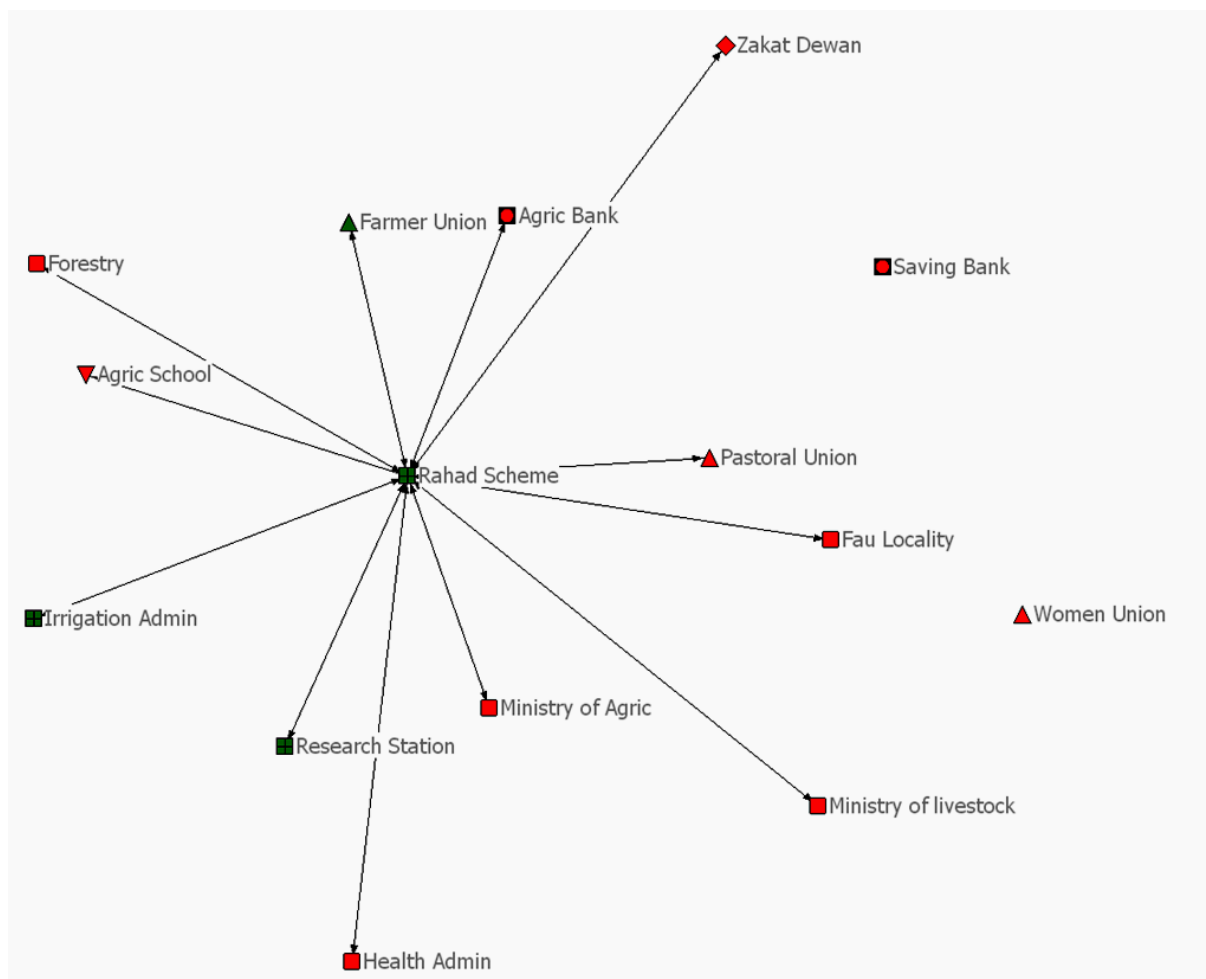
Figure 17: Rahad scheme administration's network
Source field data: 2010

| | Tow way connection |
| | One way connection |

Rahad scheme administration symboled as green box connects to most actors in the network. Women's Union and Saving and social development Bank are peripheral in this network

Rahad research station's network

The Rahad research station represents the source of agricultural research outputs for the Rahad scheme administration; both actors communicate with each other, (see figure 18 to study station's network). The Rahad research station contacts Irrigation Administration to facilitate water requirements for experiemental fields managed by the station. Heads of Farmers' Union and Pastoral Union contact research administration to get advice on technical problems on farming. Rahad research station would contact Sudanese Agricultural Bank on regards of the certified seeds that need to be provided by the Bank to farmers. Zakat Dewan and El Fau locality are not involved on technical performance on Rahad research station
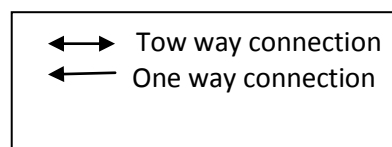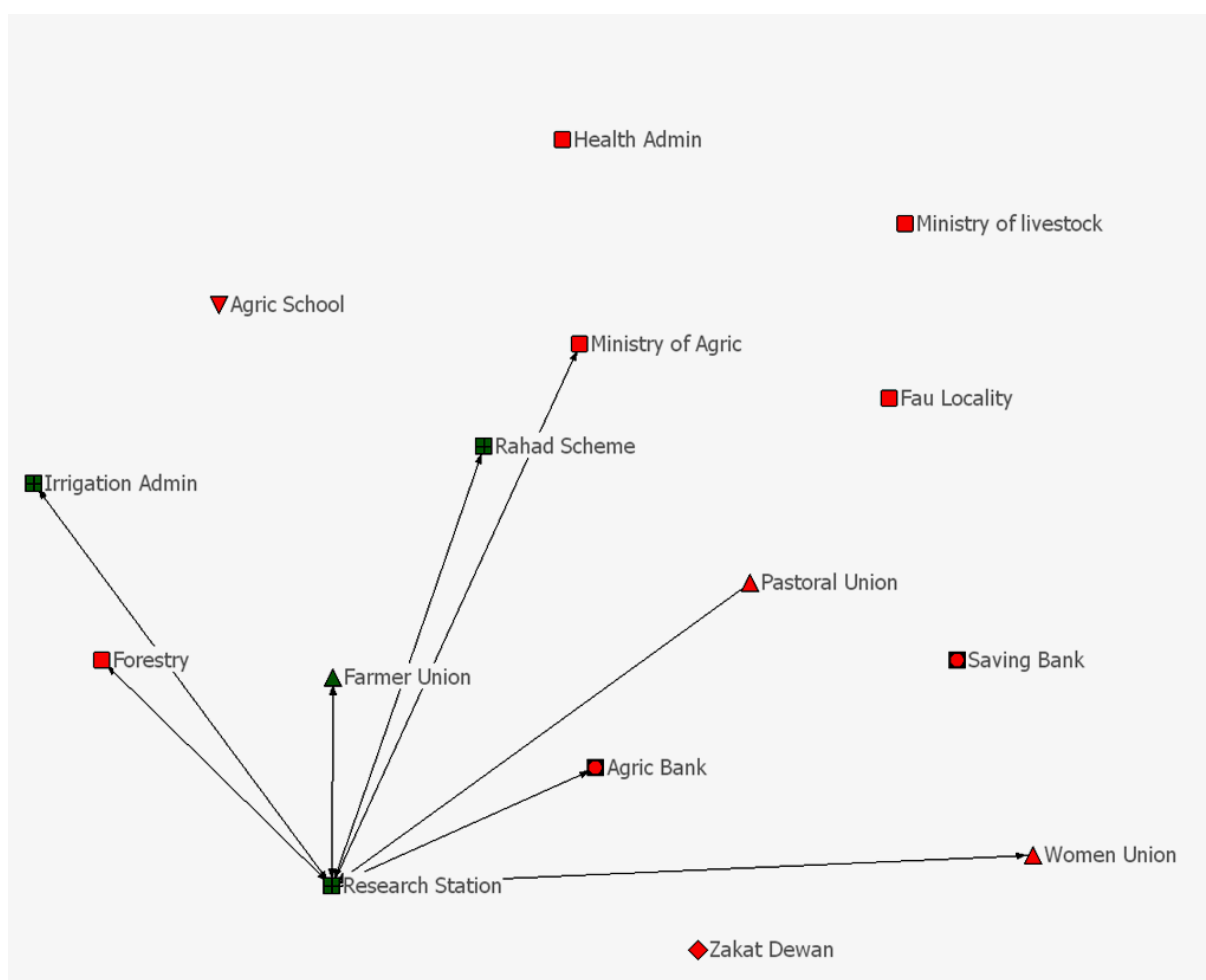
Figure 18: Rahad research station's network
Source field data: 2010

Rahad research station symobled as green box contacts Rahad scheme administration to provide the scheme with technical knowedge on farming

Irrigation Administration's network

The Irrigation Administration and the Rahad scheme administration communicate in order to facilitate irrigation water requirements for farming. Farmers' Union is involved on the meetings of this process, (note figure 19 to see administration's network). Irrigation Administration would contact Ministry of Agriculture on planning of any additional farming activities within the locality (privately owned farms). Irrigation Administration admitted providing of drinking water for herds within El Fau locality during summer season (either by water tankers or animals would be brought to canals); Pastoral Union would be awared of this issue. Communication between Agricultural School and Irrigation Administration was intiated to construct water pumb to irrigate experimental farm in the school
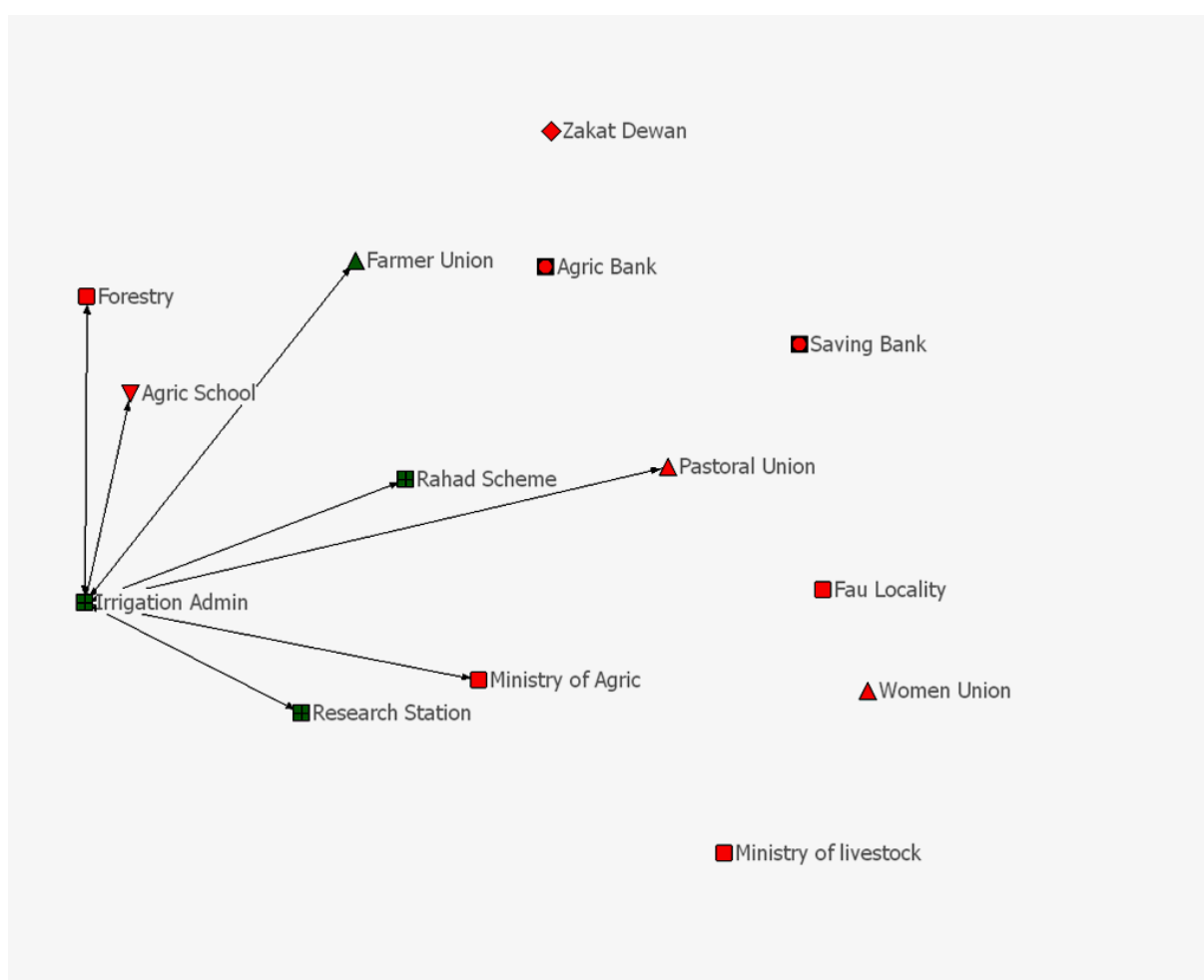
Figure 19: Irrigation Administration's network
Source field data: 2010

Irrigation Administration symobled as green box contacts Rahad scheme administration and Ministry of Agriculture in regard to provision of irrigation water

Ministry of Agriculture's network

The Ministry of Agriculture, which is the technical supervisor for rain-fed farming (outside the scheme area), contacts the El Fau locality executive office and the Agricultural Bank in order to facilitate input funding and other administrative issues concerning rain-fed farming in the El Fau locality. Though Zakat Dewan and Ministry of Agriculture are establishing farmers associations for securing credits on rain fed areas, however, there is no coordination between these tow actors on managing and serving of these associations. Actor of Ministry of Agriculture contacts with Women's Union to discuss what proper activites for women should be palnned in the area (see figure 20 to note connections)
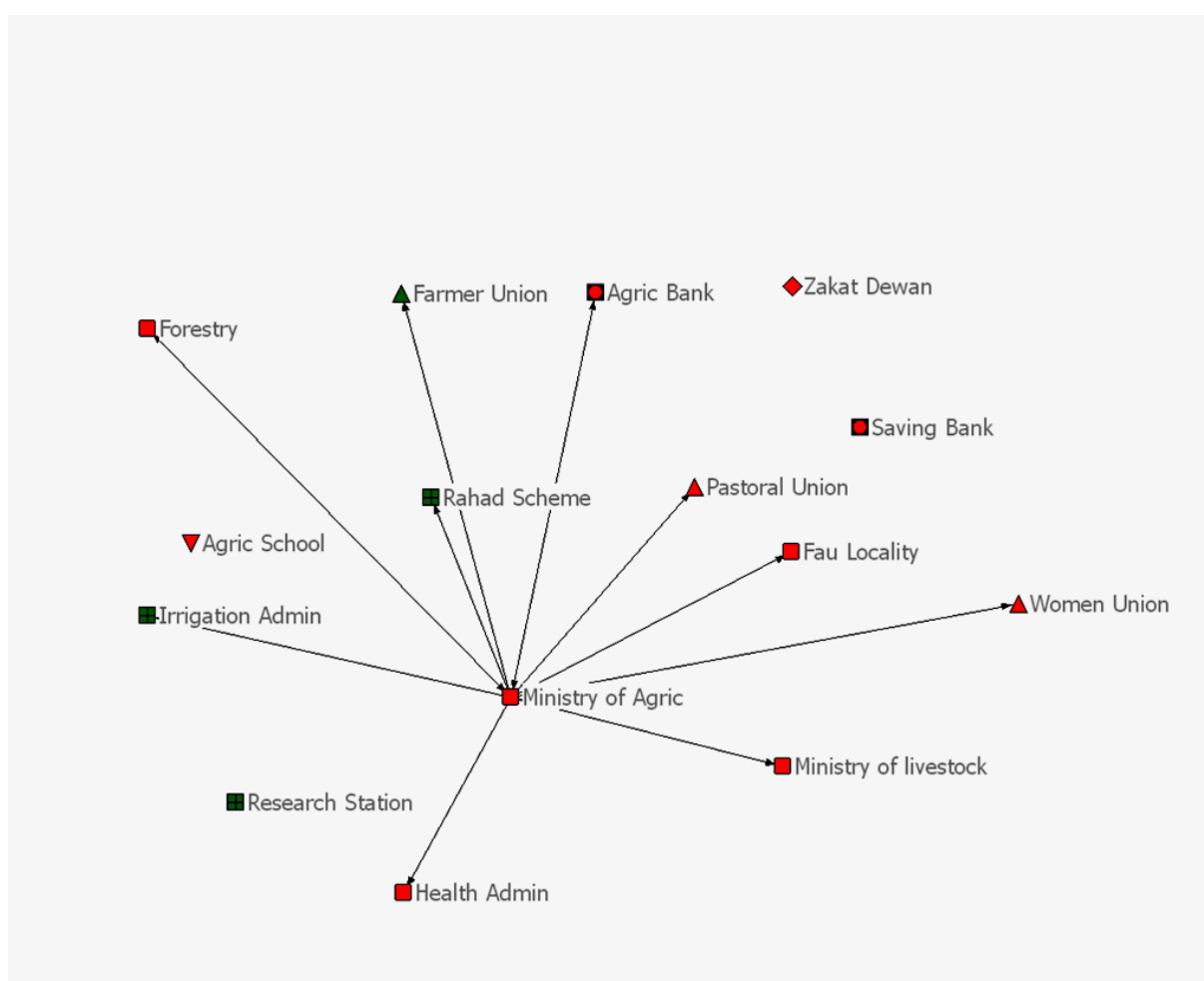
Figure 20: Ministry of Agriculture's network
Source field data: 2010

Ministry of Agriculture symobled as red rounded box is connected with El Fau locality Executive Office to report activities.

Ministry of Livestock's network

The Ministry of Livestock contacts the El Fau locality executive office in order to work on monitoring and supervising livestock health within the locality, (see figure 21 to study theMinistry' network). There are contacts between Ministry of Livestock and Health Administration on coordination of public health services in El Fau locality. Actor of Ministry of Livestock has personal communication with Saving and Social Development Bank to seek information on micro finance projects. As it is noticed Ministry of Livestock has no communication with most of the actors in the network.

Figure 21: Ministry of Livestock's network
Source field data: 2010
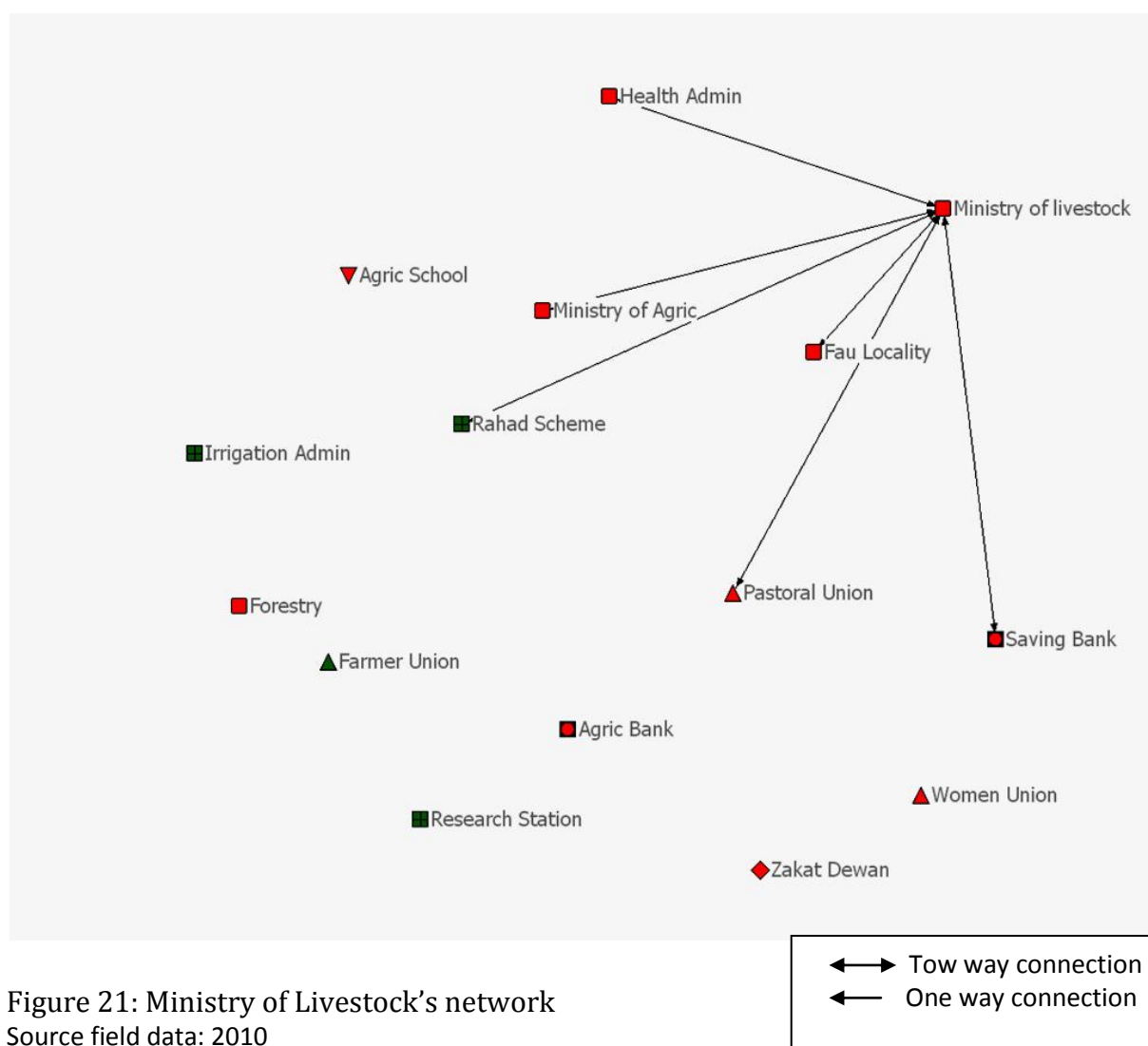
Ministry of Livestock symboled as red rounded box is communicating with El Fau locality Exectutive office and Pastoral Union

Farmers'Union's Network

The Rahad Farmers' Union represents farmers' contacts both with the scheme administration and the Agricultural Bank in order to facilitate technical supervision and access to credits for the farmers (see figure 22 to note the union's network). The Farmers' Union members also work as farmer extensionists, on this regard the union contact extension and technology transfer department within Rahad scheme administration. Pastoral Union and Women's Union are peripheral actors within Farmer Union network although both actors admit the necessity of communication with Farmers' Union. The Farmers' Union is reaching most of actors in the network at level of Rahad scheme.
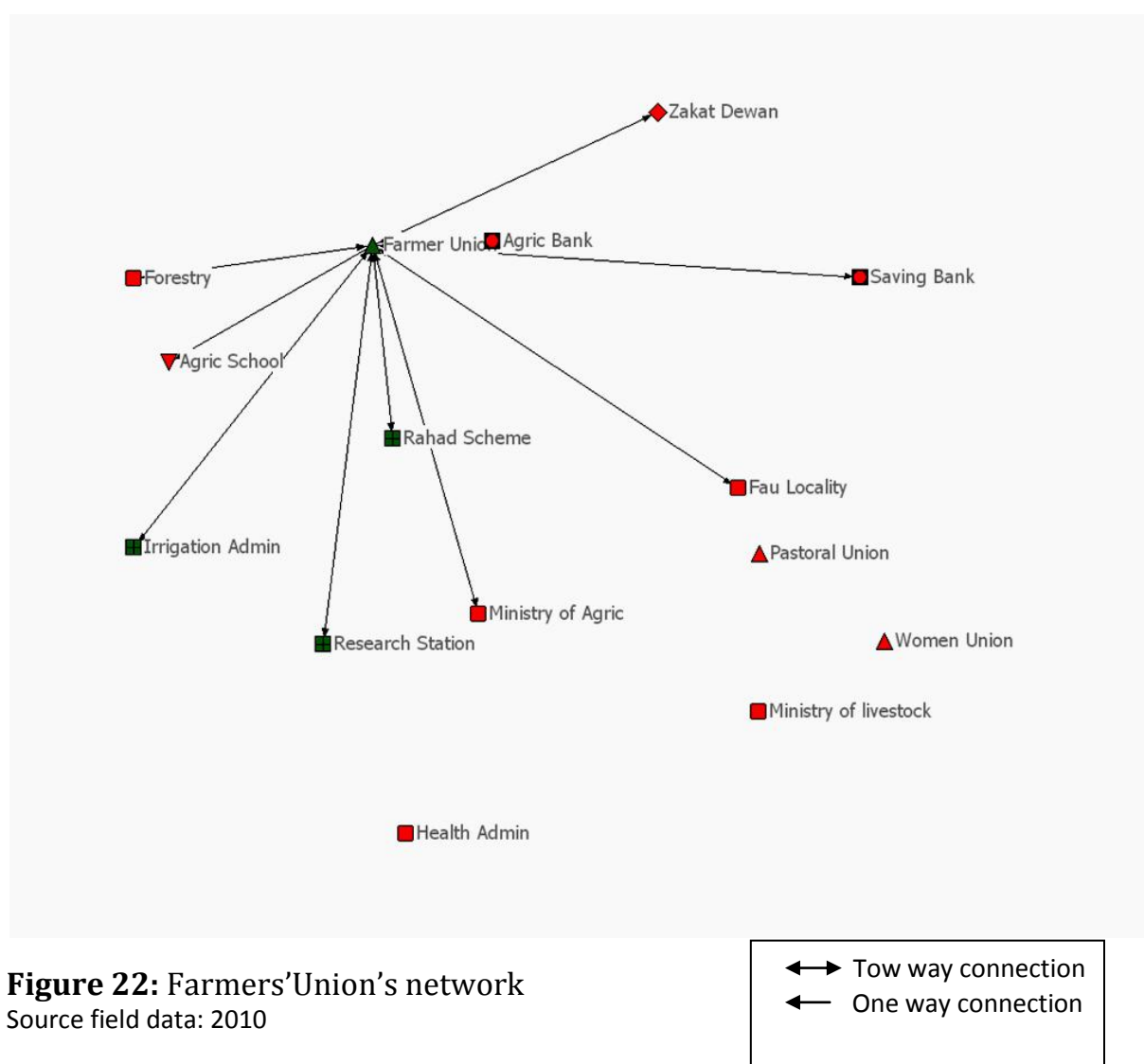
Figure 22: Farmers'Union's network
Source field data: 2010

Tow way connection
One way connection

Farmers' Union symboled as green up triangle mainly communicate with Rahad scheme administration and Sudanese Agrciulture Bank

Pastoral Union's network

The Pastoral Union contacts the El Fau locality executive office and credit institutions in order to monitor access to pasture and reduce tax on herds imposed by localities, (see figure 23 Pastoral union network). Pastoral Union contacts the credit institutions (i.e.the Agricultural Bank) to plan micro-projects for livestock owners. The Pastoral Union has contacts with Ministry of Livestock to gain personal advice on animal health issues. Pastoral Union actor is politically alient with the ruling party such a position created a political relation with Women's Union actor but not official one.
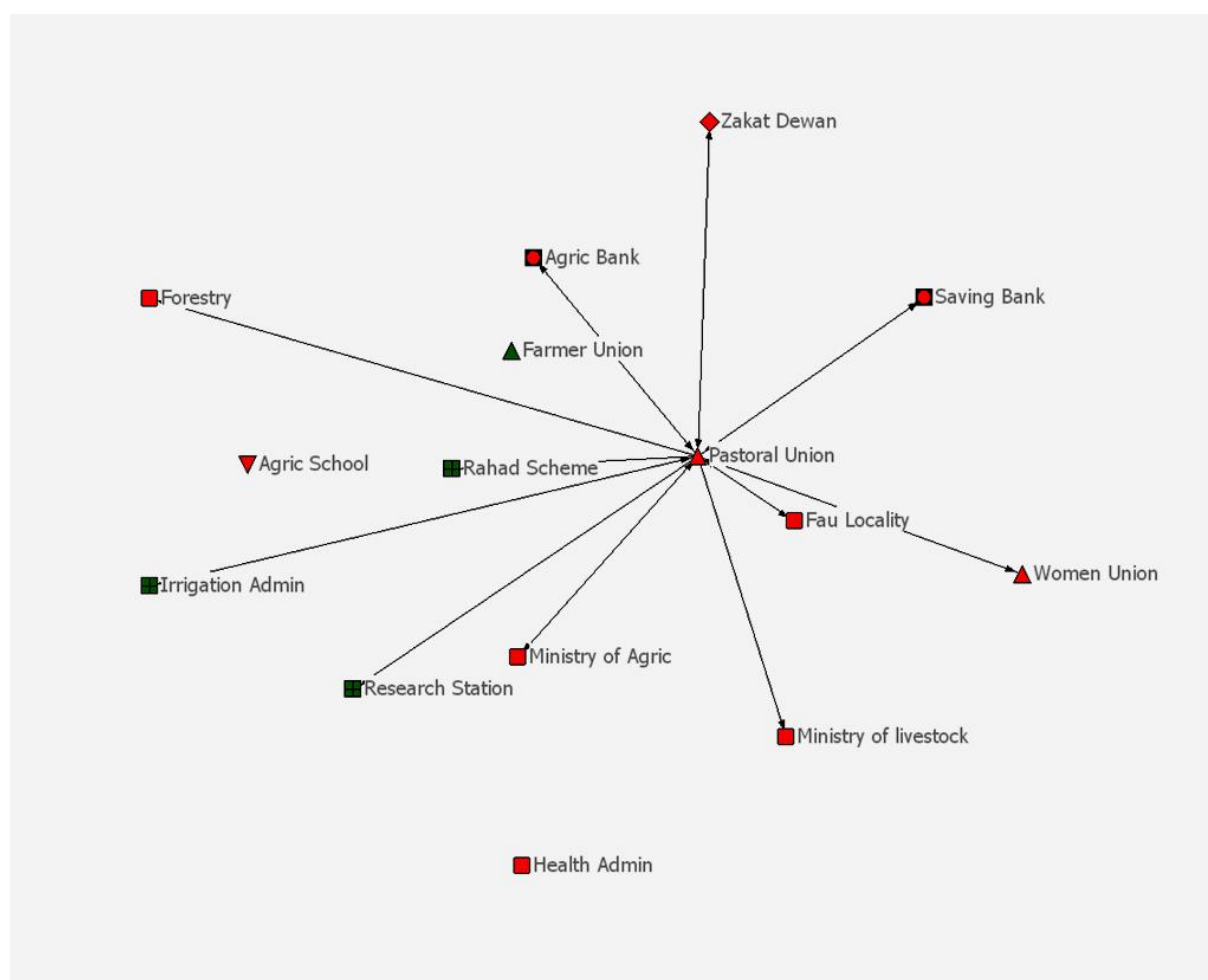
Figure 23: Pastoral Union's network
Source field data: 2010

Pastoral Union symboled as red up triangle has a network of contacts with El Fau locality Excutive office, Ministry of Livestock, and Finance institutions

Sudanese Agricultural Bank's network

Sudanese Agricultural Bank is the credit institution that facilitates credits of farming for both farmers within the irrigated schemes and farmers on rain fed areas, (figure 24 represents the Bank's network). For farmers within Rahad scheme the contacts go through Rahad scheme administration and Farmers' Union. For farmers within rain fed areas the process would involve Ministry of agriculture and Union of rain fed farmers. The Sudanese Agricultural Bank and Saving and Social Developement Bank communicate with each other to seek advices on credit management and other banking issues. As the figure shows the bank has a wide web of communication within the network.
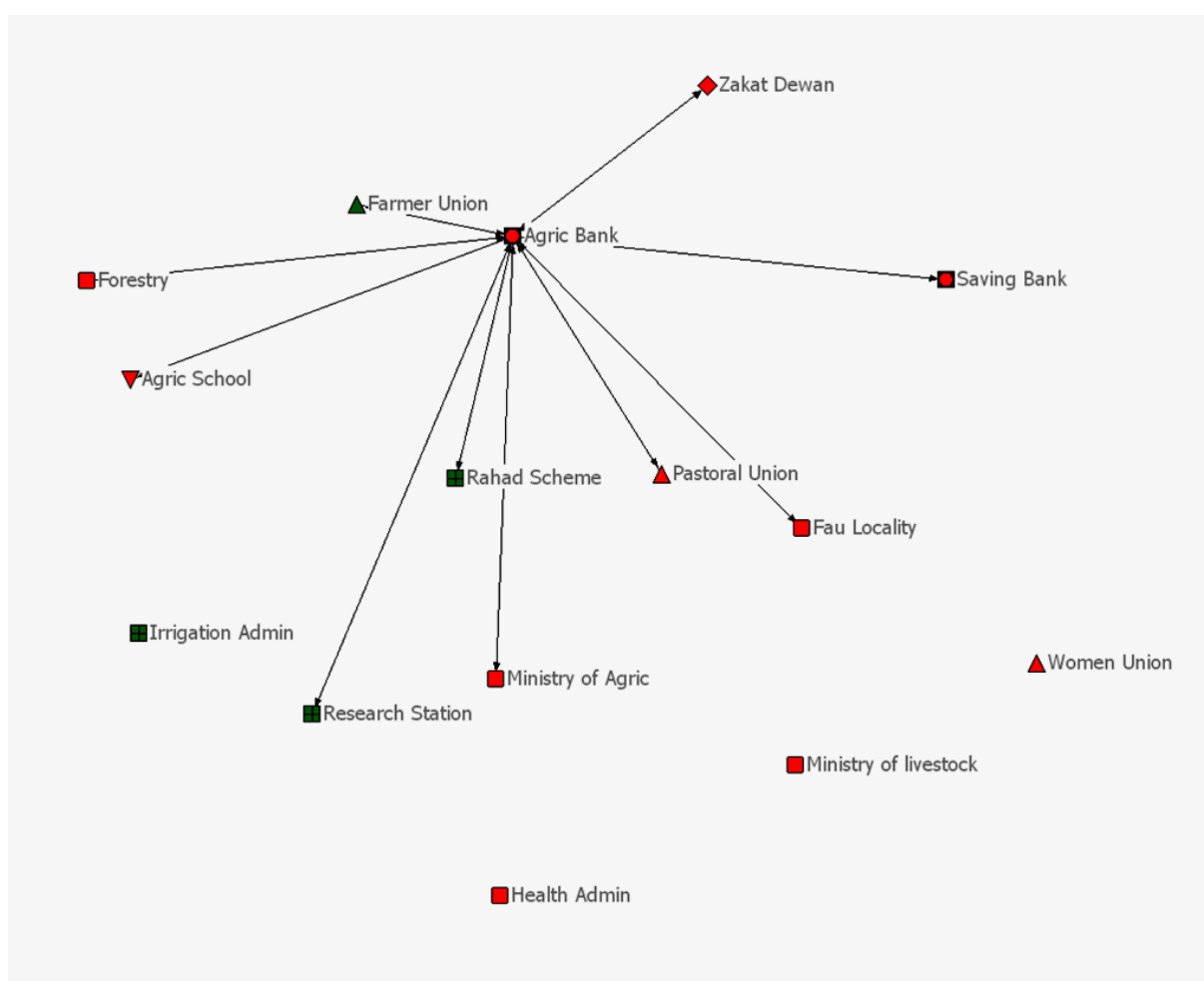
Figure 24: Agricultural Bank's network
Source field data: 2010

Tow way connection
One way connection

Sudanese Agircultural Bank symboled as circle in box communicates with Rahad scheme administration, Ministry of Agrciulture and Farmers organizations to facilitate finance of production inputs.

Saving and Social Development Bank's Network

The Savings and Social Development Bank is a private credit institution that contacts the Women's Union and the Pastoral Union in order to organize the disbursement of micro-projects for women's associations and livestock owners (figure 25 domenstrate the bank's networks). The Saving and social development bank is isolating itself from most government institutions within Rahad scheme such as Irrigation Administration, Rahad research station and Irrigation Administration.
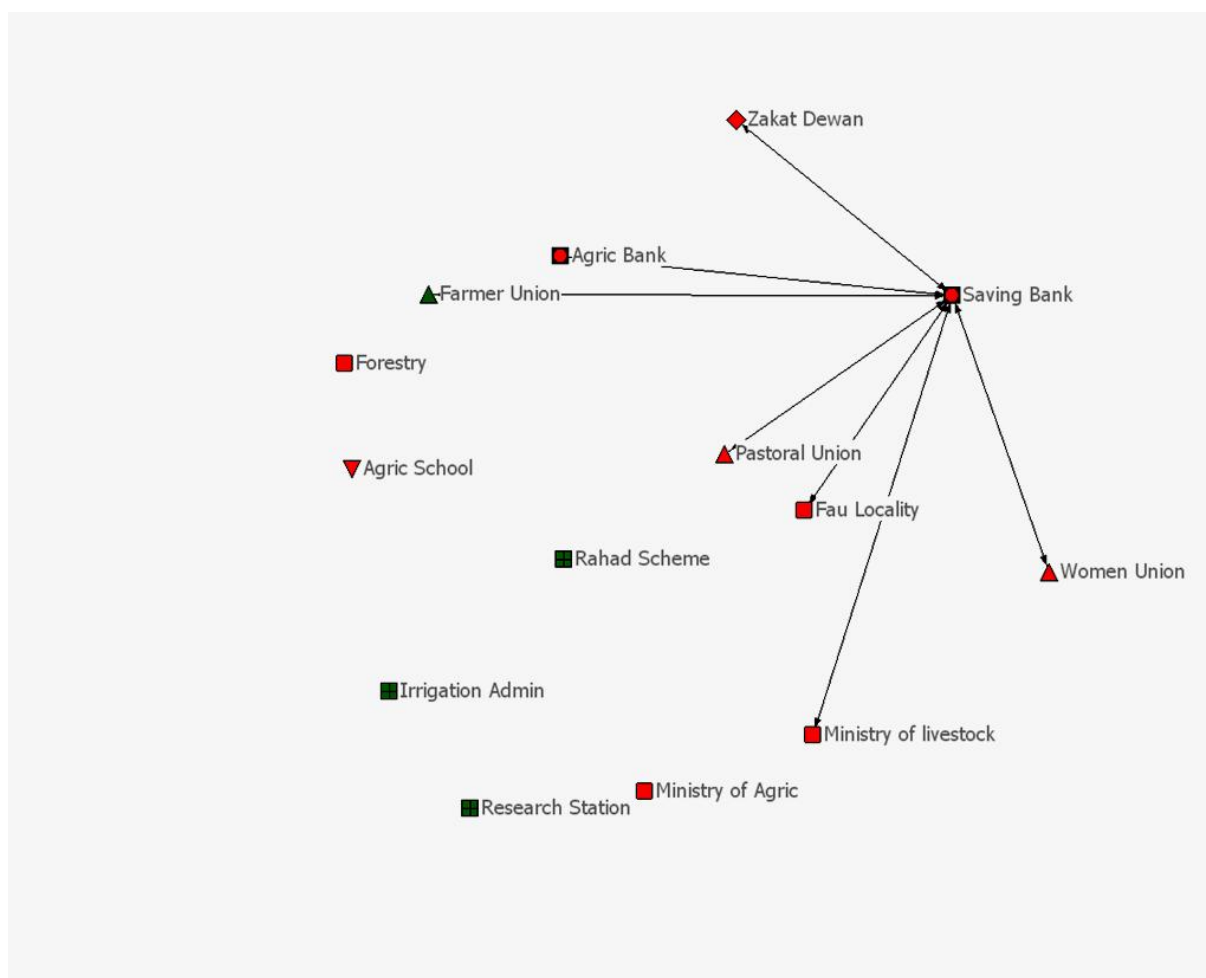
Figure 25: Saving and Social Development Bank's network
Source field data: 2010

↔ Tow way connection
← One way connection

Saving and Social development Bank symboled as circle in box contacts mainly Women's Union and Pastoral Union to facilitate finance of micro projects run by the bank at El Fau locality

National Forest Corporation's network

The National Forest Corporation is a governemental institute that communicates with the the El Fau locality executive office through Ministry of Agriculture in order to implement forest management and conservation programs within the El Fau locality,(see figure26 to note the corporation's network).The corporation communicates with Rahad scheme administration to coordinate logging of forests planted by the scheme. The National Forest Corporation admitted difficulties to involve women on plantation projects in the area due to cultural and traditional believes.Therefore, no connection exisits between Women's Union and the corporation.
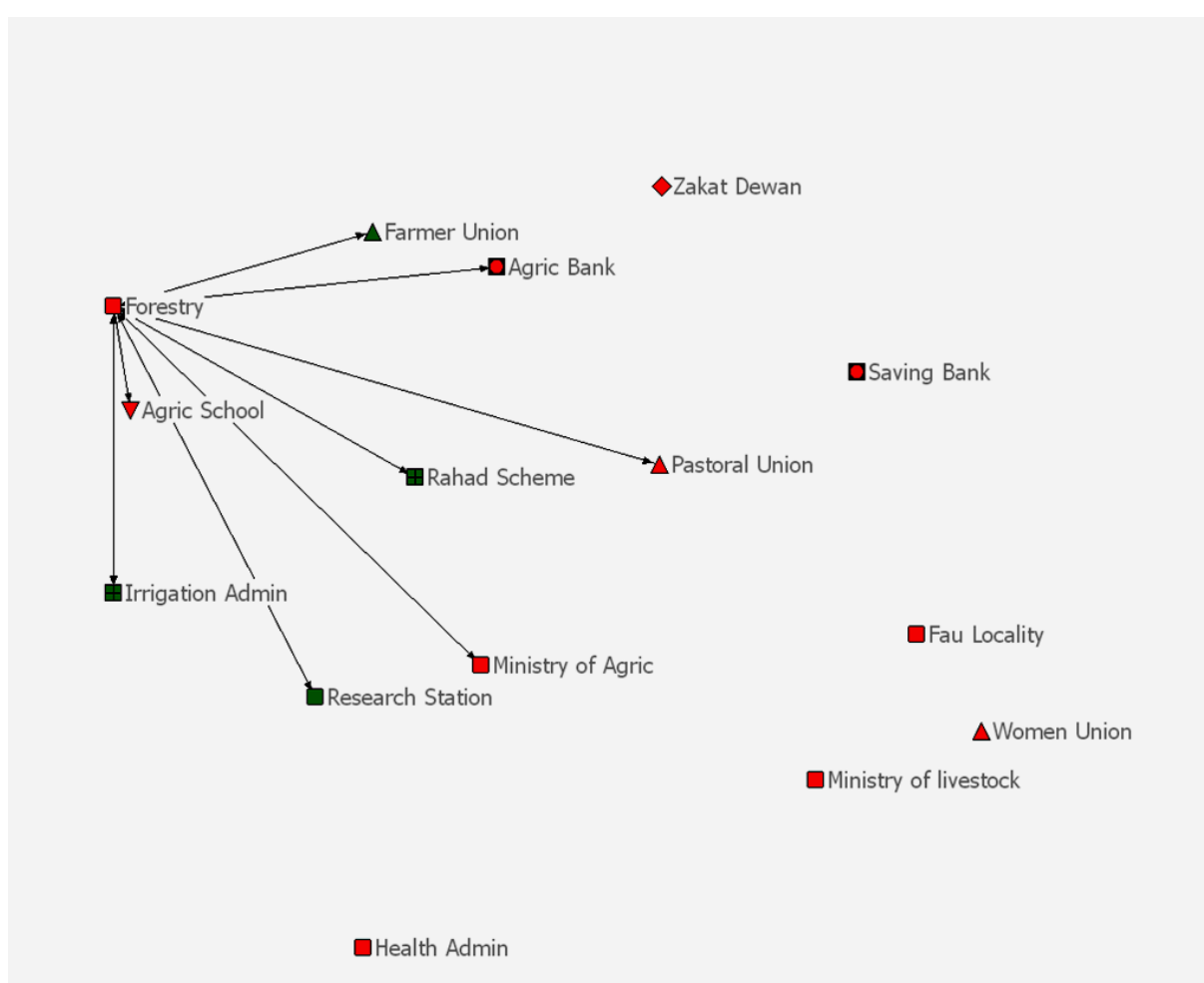
Figure 26: National Forest Corporation's network

Source field data: 2010

| ←→ Tow way connection |
| ← One way connection |

National Forest Corporation symboled as red rounded box communicates with Ministry of Agriculture to impelement forest management programs.

Zakat Dewan'network

Zakat Dewan (Islamic institution) in two directions of communication delivers donations to students and needy families by contacting the El Fau Agricultural School (figure 27 demonstrate Zakat dewan network). The Dewan also disucsses with representatives of Farmers' Union and Pastoral Union the food security projects managed by Zakat Dewan. However, the dewan does not coordinate with government actors who involved on farming and livestock in the area in processing of food security projects (Ministry of Agriculture, Ministry of Livestock). Women's Union contacts Zakat Dewan to enhance or improve involvement of women on projects run by the Zakat Dewan.
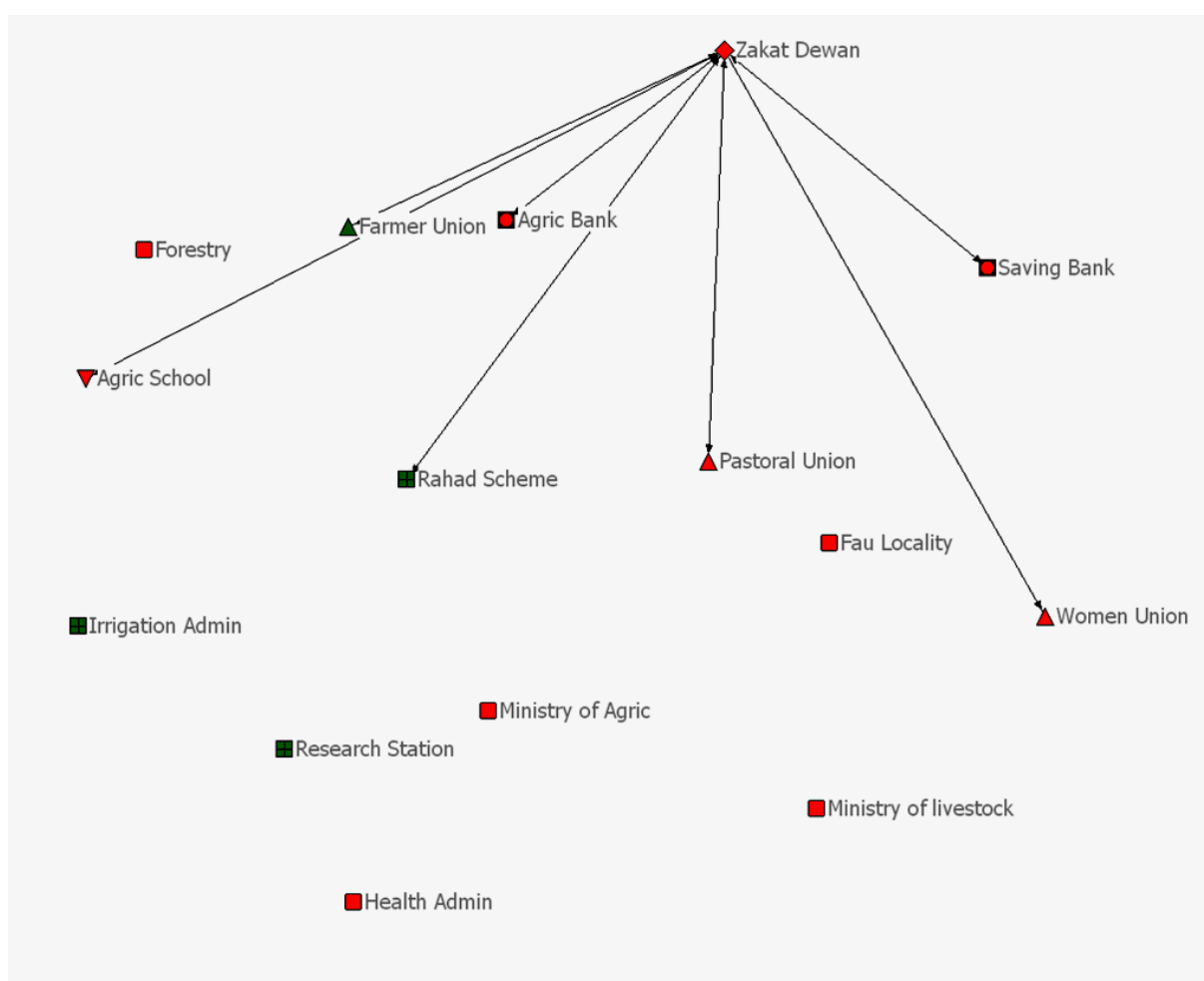
Figure 27: Zakat Dewan's network
Source field data: 2010

Zakat Dewan symboled as red diamond contacts Pastoral Union, Farmers' Union and Agricultural School to deliver donations to local people

El Fau Agricultural School'network

El Fau Agricultural School is a peripheral actor within Rahad Scheme levels, (figure 28 explains the school's network). Its main regular contacts are with Zakat Dewan for seeking donations for needy students and with Education Administration within El Fau locality to coordinate academic work of the school. Health Administration and National National Forest Corporation admitted contacts with the school only for short time. The corporation supported the school with seedlings, and Health Administration conducted one training for students on environmental health (insects spraying)
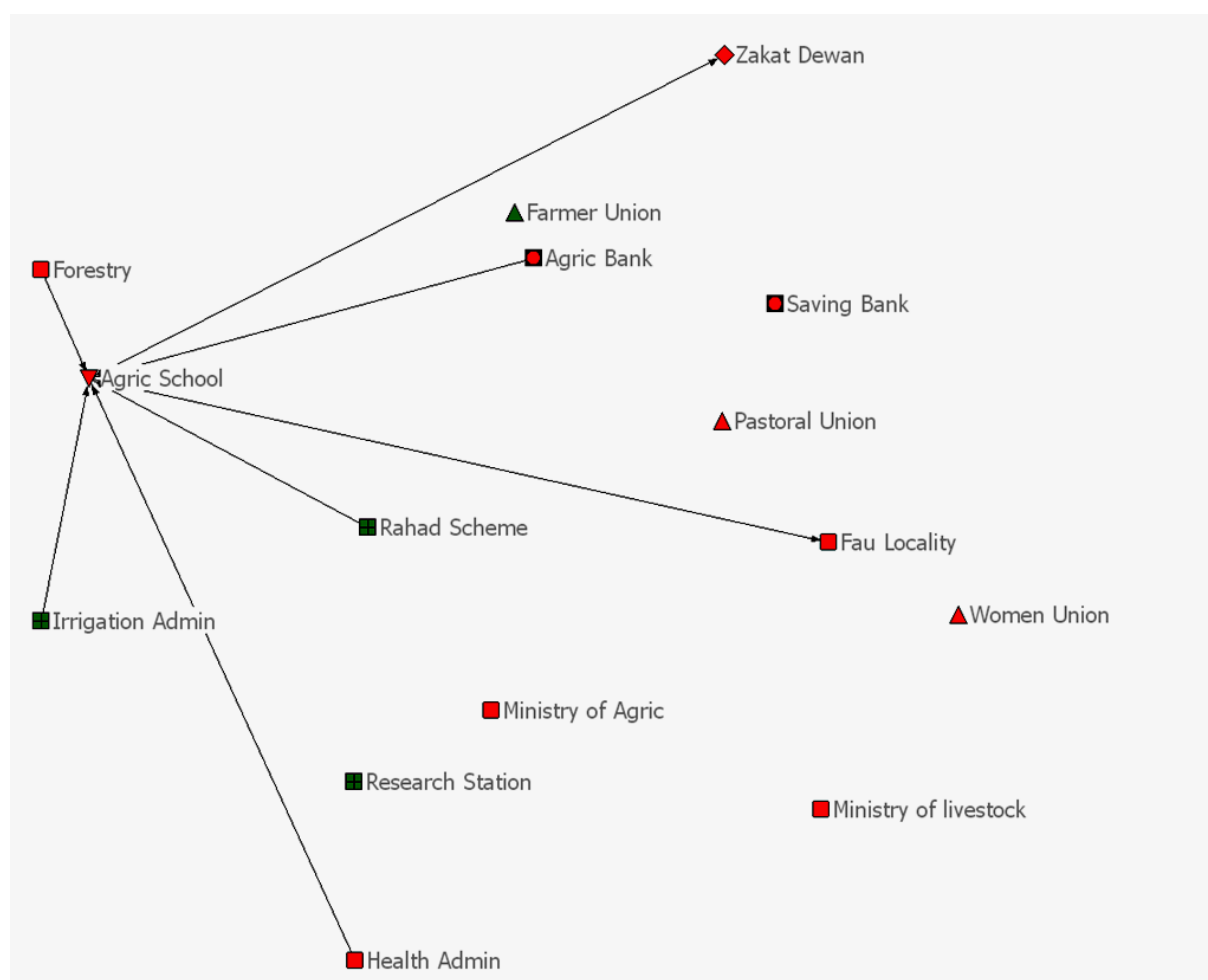
Figure 28: Agricultural School's network
Source field data: 2010

Elf au Agrciulture School symboled as red down triangle contacts with El Fau locality office and Zakat Dewan

Health Administration's network

Health Administration mainly contacts El Fau locality and Ministry of Livestockin implementing its public health activities, (see figure 29 to note the administration's network). The Health Administration does not coordinate or communicate with Pastoral Union and Farmers'Union within Rahad scheme. Although the Health Administration has a clear vision of who to contact to run a proper work but the administration isolates itself from most actors at level of the Rahad scheme
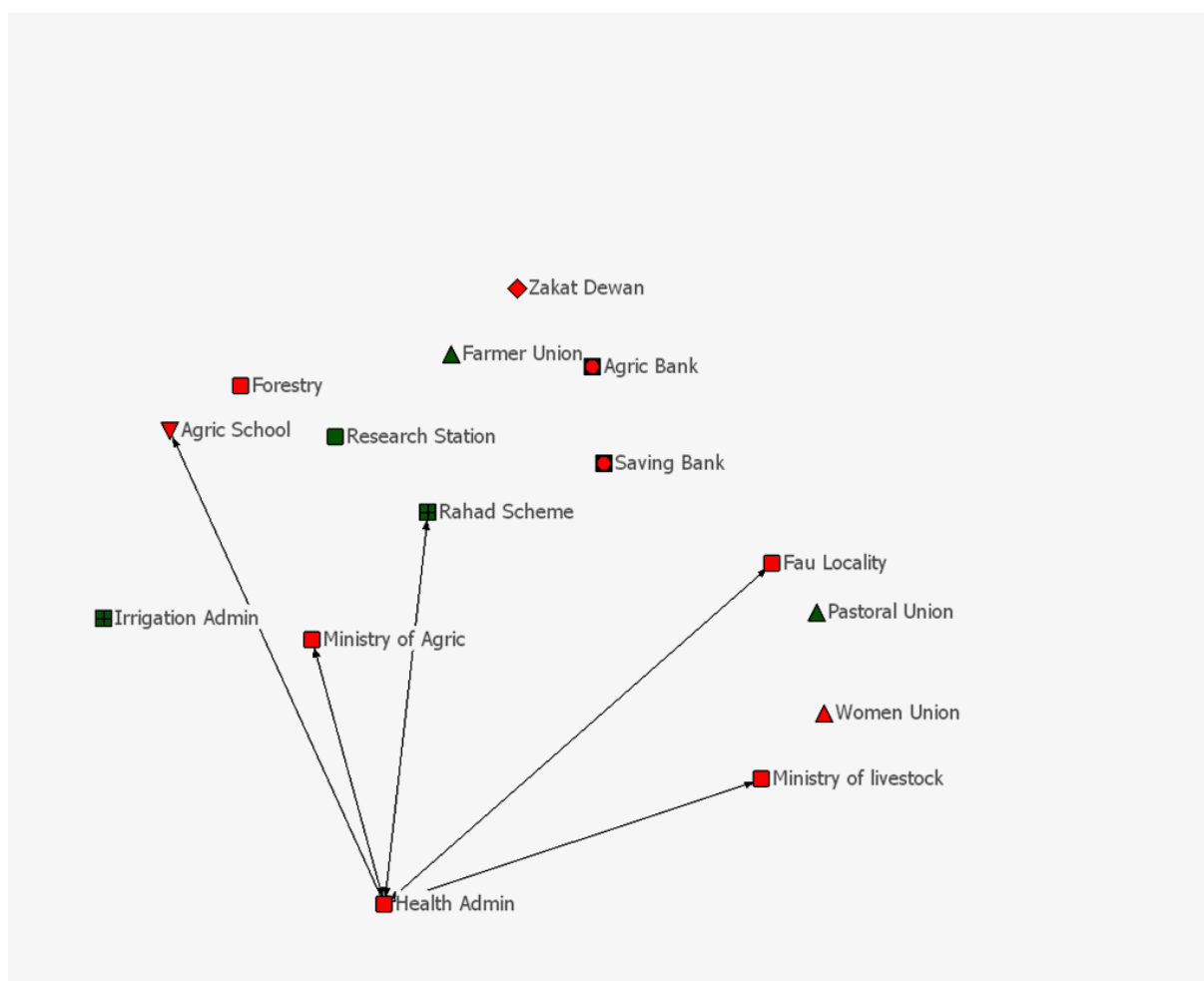
Figure 29: Health Administration's network
Source field data: 2010

Health Administration symboled as red rounded square communicates with El Fau Localiy excutive office and Ministry of livestock

Women's Union's network

Women's Union is mainly communicating with Saving and Social Development Bank to organize micro finance projects for women in El Fau locality, (see figure 30 to note Women's Union' network). Women's Union monthly reports performance and finance needs to El Fau locality Executive office. The few communications which the union enjoys led to a peripheral position for the union within Rahad scheme
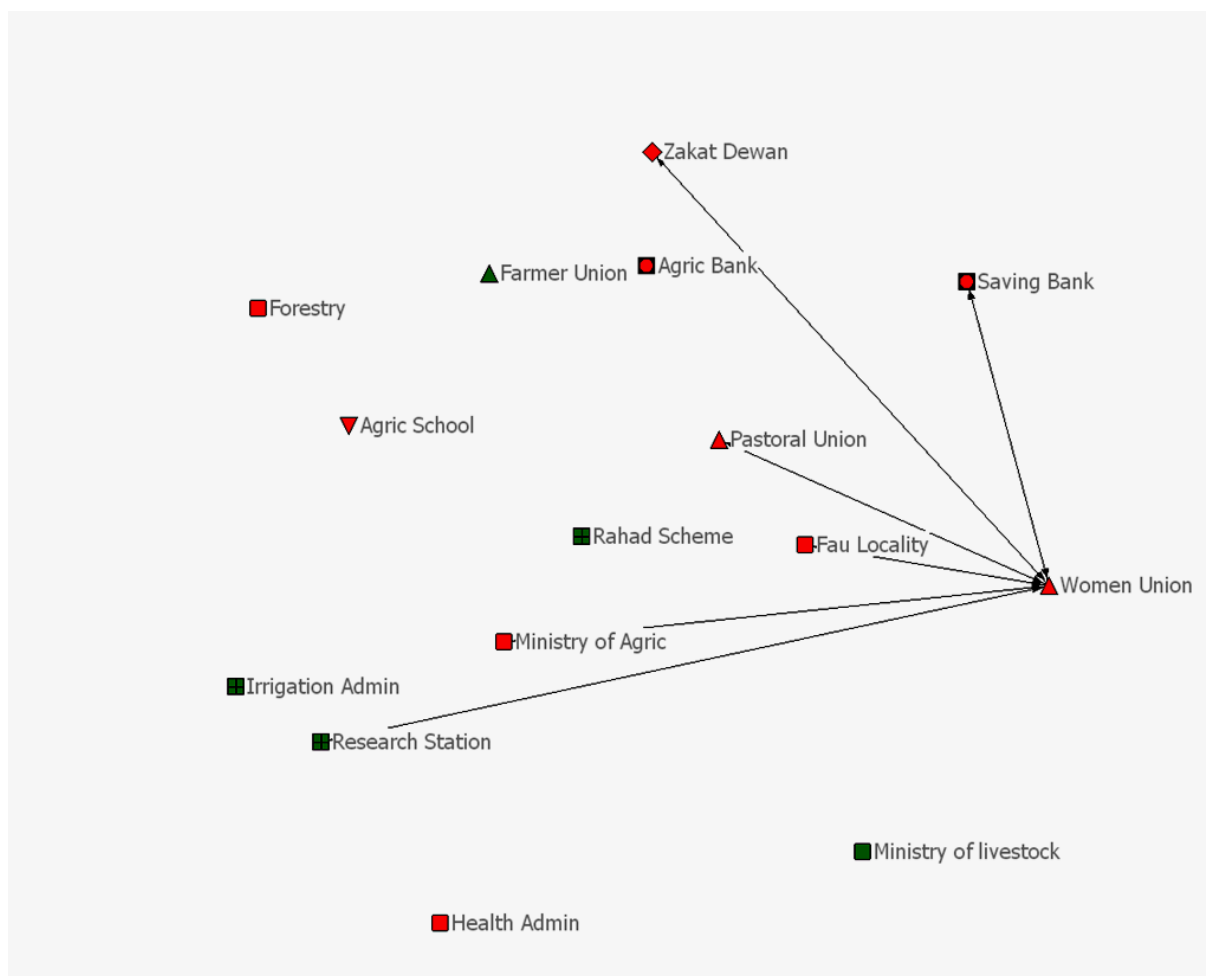
Figure 30: Women's Union's network
Source field data: 2010

⟷	Tow way connection
←	One way connection

Women's Union symboled as red up triangle communicates with Saving and Social Developement Bank and El Fau Locality Excutive office

El Fau Locality's network

El Fau locality excutive office communicates with Ministry of Agriculture, Ministry of Livestock and Health Administration to get feedback on monthly performace and financial needs for the three actors, (figure 31 demonstrates Elfau locality excutive office network). It communicates with Pastoral Union in rain fed area to solve problems of animal introducing between farmers and livestock keepers. The office coordinates with Rahad scheme administration on emergiencies such as floods or pests invation. If the leader of Farmers' Union in Rahad scheme is politically involved within the locality, then contacts between El Fau locality executive office and Farmers' Union takes place to handle political issues or concern. Zakat Dewan is related to another section within El Fau locality (it has direct contact with the mayor but does not communicate with the excutive office)

Figure 31: El Fau locality office's network
Source field data: 2010

↔ Tow way connection
← One way connection
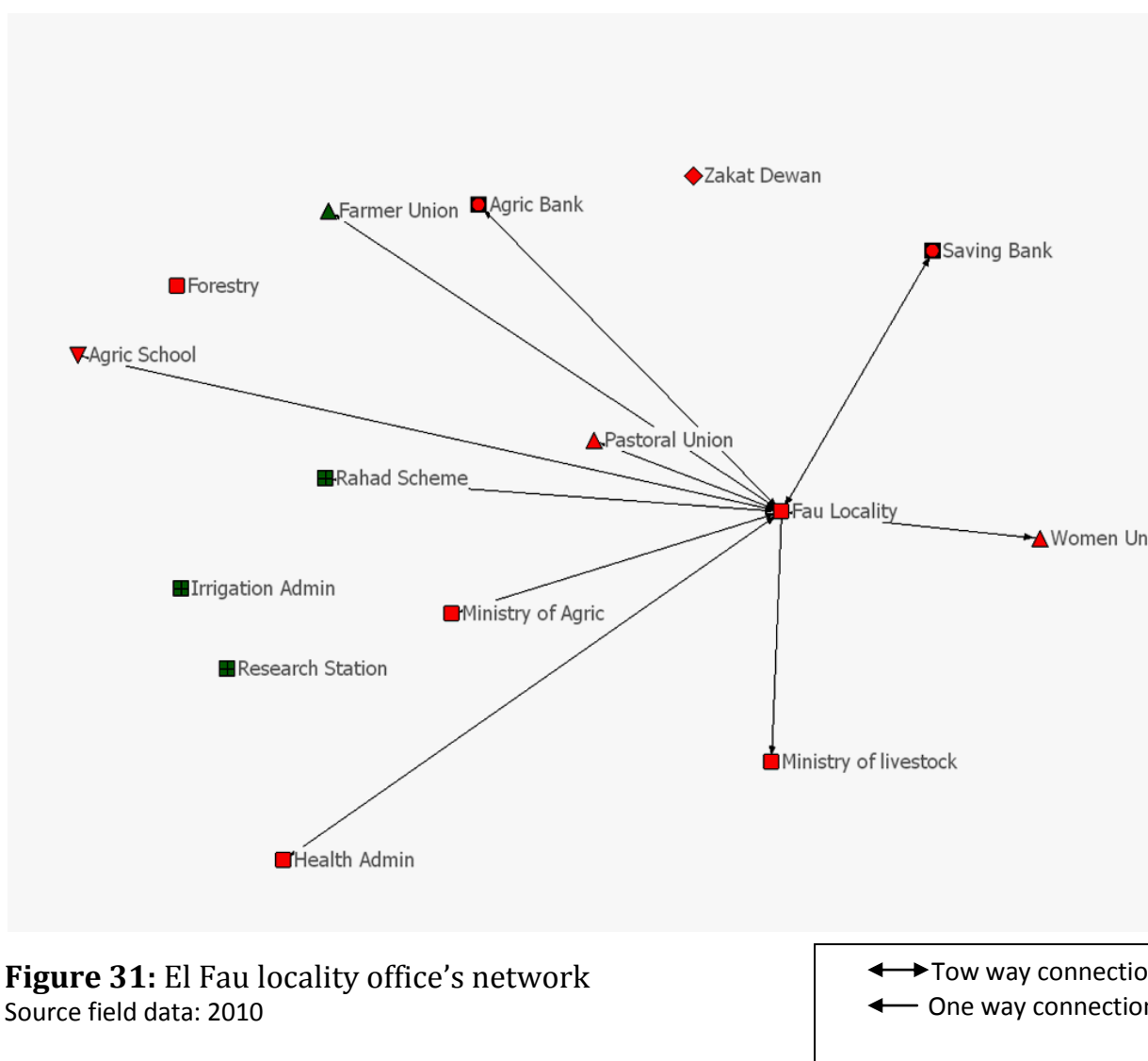
El Fau locality Executive office symboled as red rounded square contacts Ministries of Agricluture and Animal Wealth, Women's Union and Pastoral Union

5.4 Summary of connections at level of Rahad scheme

The researcher considers the network at the Rahad scheme level to be a transaction network where actors exchange information on farming, credits, and training services (BORGATTI 2009; CONWAY and STEWARD 1998) (see figure32 to note network of relations at level of Rahad scheme). Two-headed arrows mean both actors initiate contact with each other, and one-headed arrows mean only one actor initiates contact to another. Contacts in the network at the Rahad scheme level can be explained as follows, "The Rahad scheme administration is the technical body managing farming operations in the scheme area. There are two ways contacts between the scheme administration and the Agricultural Bank, which is the credit institution within the scheme that facilitates funding input costs of farming" The Rahad Farmers' Union represents farmers' contacts both with the scheme administration and the Agricultural Bank in order to facilitate technical supervision and access to credits for the farmers The Rahad research station represents the source of agricultural research outputs for the Rahad scheme administration; both actors communicate with each other.. In the same pattern, the Irrigation Administration and the Rahad scheme administration communicate in order to facilitate irrigation water requirements for farming .The Ministry of Agriculture, which is the technical supervisor for rain-fed farming (outside the scheme area), contacts the El Fau locality executive office and the Agricultural Bank in order to facilitate input funding and other administrative issues concerning rain-fed farming in the El Fau locality. The Ministry of Livestockand the Health Administration both contact the El Fau locality executive office in order to work on monitoring and supervising public health and livestock health within the locality .Zakat Dewan (Islamic institution) in two directions of communication delivers donations to students and needy families by contacting the El Fau Agricultural School and the Women's Union. The Pastoral Union contacts the Ministry of Livestock, El Fau locality executive office, and credit institutions (i.e. the Agricultural Bank) in order to monitor livestock health, access to pasture, tax reductions, and to plan micro-projects for livestock owners. The Savings and Social Development Bank is a private credit institution that contacts the Women's Union and the Pastoral Union in order to organize the disbursement of micro-projects for women's associations and livestock owners. The National Forest Corporation is a governmental institute that communicates with the youth and public committees through the El Fau locality executive office in order to implement forest management and conservation programs within the El Fau locality.
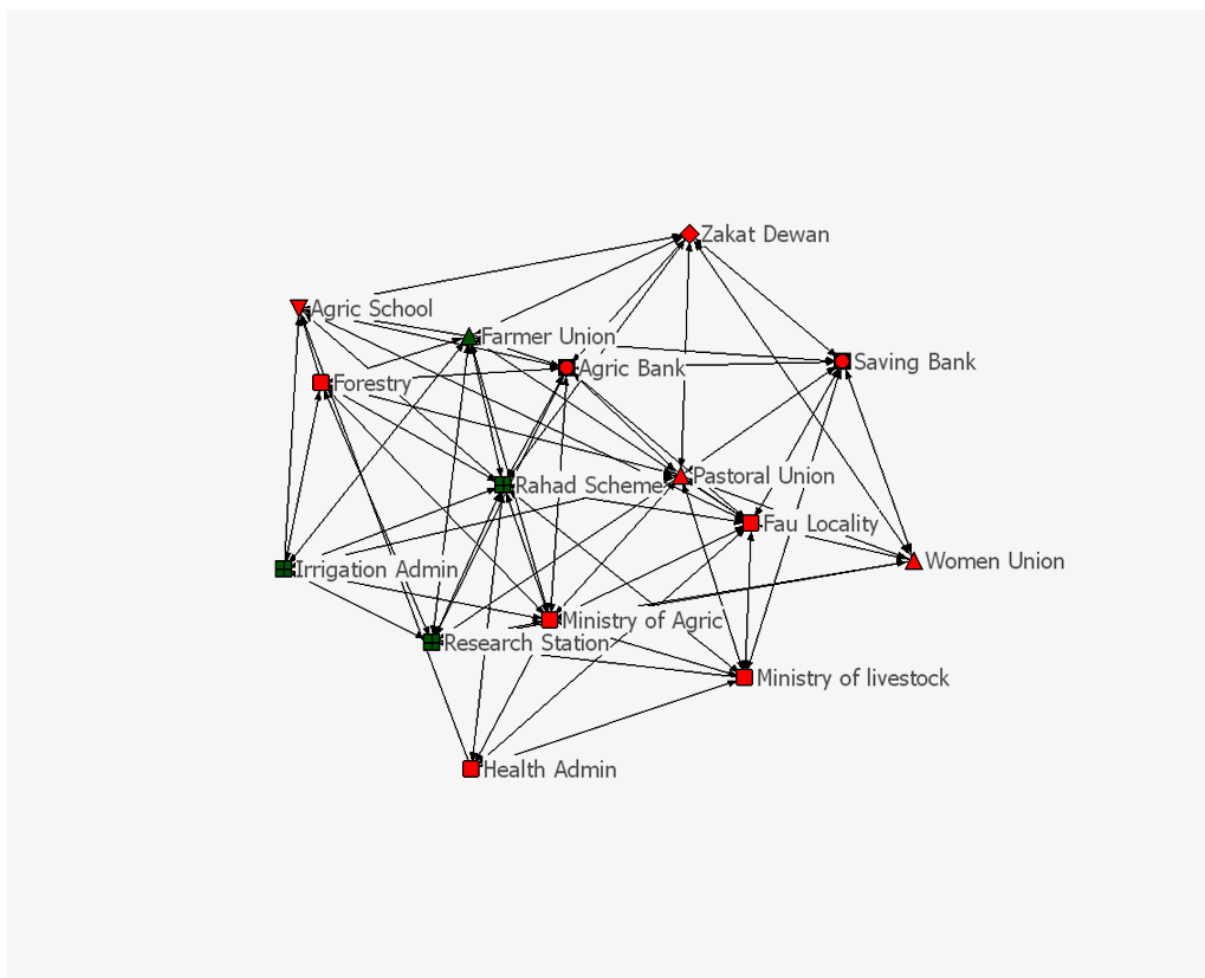
Figure 32: Connections of actors at the Rahad scheme level

Source: field data 2010

←→ Tow way connection
← One way connection

There is a core of actors in figure32; the Rahad scheme administration, Ministry of Agriculture, Pastoral Union, Farmers' Union, and Agricultural Bank are the main actors that circulate communication on irrigated farming, rain-fed farming, and credits for farming inputs.

6 The Rahad scheme network

Diffusion research employing a network perspective (LIU et al. 2005) stems from viewing the structure of the relations among members of the social system as a factor that shapes or constrains the spread of new ideas and practices in the social systems (BURT 1987) cited by (LIU et al. 2005).Therefore in this chapter the researcher is questioning the communication pattern of the actors at level of Rahad scheme (VALENTE 1995). Every actor at the Rahad scheme level was asked to mention who of the 15 actors he/she talked to, how often this talk took place and what the content of that discussion or talk was. Measurements of social network analysis were applied to the data collected. Geodesic distances, centrality, and density of network at the Rahad scheme level were calculated. Maxcoda for analyzing texts was also used to analyze information on actors' contents of discussion, meaning looking for who is communicating with whom. In this chapter also connections at different levels within Rahad scheme area are discusses; connections between actors at level of villages and connections between villages' actors and actors at administrative level of Rahad scheme.

6.1 General description of the network at the Rahad scheme level

To analyze this part the researcher depended on the theory of social network analysis and used UCINET 6.0 software (BORGATTI et al.1999).

To decide how actors are connected an adjacency matrix was developed. An adjacency matrix is a matrix in which a given cell X (i,j) contains a value of 1 if nodes i and j are connected, and 0 if nodes are not connected (BORGATTIi and FREEMAN 2002). The same data is presented in a directed graph (BORGATTI and FREEMAN 2002).

The graph is a set of nodes (representing our actors) with ties that link the nodes in the graph. The links are represented with arrows (BORGATTIet al. 1999).

One-headed arrows mean the relationship is directed from one node to another or in one direction, two-headed arrows mean the relation is directed in two directions, no arrows mean no connections between the two actors exist. Our graph represents directed relationships among the nodes (actors).

The information in the graph can also be presented in an adjacency matrix in which a given cell X(i,j) contains a value of 1 if i and j are connected and a value of 0 if they are not connected (BORGATTIet al. 1999) see(appendix page 304).

In discussing the network diagram, we are concentrating on showing actors who are connected with bidirectional relationships.

6.1.1 Geodesic distances in Rahad's network

In the Rahad network we find an average distance between actors of 1.400, so we can describe the network as moderately connected. It also follows that our network has a good cohesiveness or compactness of 0.800 (the range is 0-1); the larger the value of compactness the higher the value of cohesiveness in the network. The number of links between two actors or within the network of Rahad is either one or two links. The more frequent number of links between actors in the network is 1 (126.000) and the less frequent is 2 (84.000) (see appendix page 305). This indicates that only one link between two actors is the more dominant in the network. However, logically the more links that are connecting two actors, the more connectedness in the network. Accordingly we can describe the network as moderately connected, where actors are reachable by each other. In such a network information is likely to reach everyone.

6.1.2 Density and centrality of network at the Rahad scheme level

In our network we found the density to be 0.5981 (see table5). Therefore, the number of isolated actors "that have a smaller proportion of ties with the rest of the actors" in the Rahad network is similarly equal to actors that have a larger proportion of ties with each other. Accordingly, we can describe our network as moderately dense.

In the Rahad network, the Rahad scheme, Pastoral Union, Ministry of Agriculture, and El Fau locality have the highest closeness (reach other actors most quickly); followed by the Farmers' Union and Agricultural Bank; while the Women's Union, Health Administration, and Agricultural School are peripheral actors in the network.

In the network at the level of the Rahad scheme, researchers considered the density of all the connections within the network as one of the measurements of the Rahad network structure. In diffusion research, network density is associated with faster diffusion; higher network density indicates that there is a lot of communication among individuals within the network (VALENTE 1995). In line with this fact, RAINI et al. (2005) found that the flow of information within the Tomato IPM (Integrated Pest Management) network in Kenya was low due to it being a less densely knit network. However, the sparsely knit network of the Tomato IPM indicated connections through weak ties to other sources of information outside the network (GRANOVETTER 1973). A study by SPIELMAN et al. (2010) measuring how Ethiopian small holders innovate how they make use of new knowledge and technology in their livelihood decisions found that innovators have more ties to a large number of actors

than non-innovators. That makes the innovator network larger but less dense than that of non-innovators.

Density among actors in the Rahad network was found to be 0.5646, meaning that connections among actors seeking information on farming, credits, and livestock are moderate connections and not tightly knit. A densely knit network shows the cohesiveness of the community, but the flow of information can become fragmented and captured within the borders of communication (GRANOVETTER 1973). On the other hand, networks with less density indicate access to different sources of information through actors connected to outside sources of information (GRANOVETTER 1973; RAINI et al. 2005). Therefore the moderate density in the Rahad scheme formal network illustrates the prominence of actors connected to outside sources. Findings of density in the Rahad network lead to discussions on the centrality of actors in the formal Rahad network. Centrality is the degree to which links between the networks are centralized within a group of individuals (VALENTE 1995). A centralized network contains a few members who are the locus of the contacts (VALENTE 1995).

Individuals with high centrality closeness reach other individuals in the network more quickly or with fewer steps, and they can rapidly and influentially spread information concerning innovations to many others (VALENTE 1995).

In contrast to other literature, SPIELMAN et al. (2010) found that public sector actors were central to the network and had high centrality in the studied regions of Ethiopia. However, those government actors were unlikely to adequately meet their goal of commercializing small holder productions. There were other non-governmental organizations that had far-reaching ties that were most likely to bring new information and opportunities to innovate (GRANOVETTER 1973). Moreover, RAINI et al. (2005), studying the information flow among tomato stakeholders, found similar results that the Ministry of Agriculture, non-governmental organizations, and small-scale farmers in the studied region were the central actors in the IPM network but did not maintain frequent contact with each other. Thus information flow in IPM practices was not consistent. In the RAAKS research conducted, the *Rahad scheme administration, Ministry of Agriculture*, and *El Fau locality executive office* were the closest to be reached by other actors in the network (considering values of out-farness in table 4). Therefore information on farming within the locality where the scheme is situated is mainly sourced from the Rahad scheme administration for information on irrigated farming and from the *Ministry of Agriculture* for rain-fed information. The *El Fau locality executive office* represents the government authority in the scheme area, so administrative issues of farming such as tax collection or disputes between farmers are maintained by the

locality officers. The *Pastoral Union* and *Farmers' Union* are the secondary central actors in the network. The *Farmers' Union* describes itself as a partner in management of the Rahad scheme. The presence of the *Pastoral Union* as a central actor in the network is due to the actor's ability to reach other actors within the scheme (the representative of the *Pastoral Union* in the scheme area is a famous farmer with a considerable amount of livestock in the area, so he also has personal motives to research information on farming, livestock keeping, and credits). In spite of the mentioned realities, issues regarding training of pastorals are not considered between the Pastoral Union and the Rahad scheme (interview 12, paragraph 27; interview 5, paragraphs 12, 18).

The Pastoral Union is involved with the Ministry of Agriculture in solving problems of animals intruding on farms within the rain-fed sector whose involvement takes place at the time of the problems or during call situations (interview 2, paragraph 58), but there are no regular contacts between the two. The *Agricultural Bank* is central in the network, since it represents the main credit institution for input costs for farmers within the Rahad agricultural scheme or within the rain-fed sector in the El Fau locality. This would explain the peripheral role for the *Savings and Social Development Bank*, which is a private credit institution running micro-finance projects for animal owners and women groups within the El Fau locality (RAINI et al. 2005; SPIELMAN et al. 2010).

Closeness	Centrality	Measures		
	1	2	3	4
	In.Farness	Out.Farness	In.Closeness	Out.Closeness
	------------	------------	------------	------------
Rahad scheme	17	16	82.353	87.500
Ministry of Agric.	17	18	82.353	77.778
El Fau Locality	18	18	77.778	77.778
Pastoral Union	18	17	77.778	82.353
Agric. Bank	19	19	73.684	73.684
Farmer Union	19	18	73.684	77.778
Agric. School	2 0	29	7 0	48.276
Research Station	21	21	66.667	66.667
Zakat Dewan	21	21	66.667	66.667
Saving and Social Development Bank	21	21	66.667	66.667
Ministry of Livestock	22	21	63.636	66.667
Women's Union	22	22	63.636	63.636
Irrigation Admin.	23	21	60.870	66.667
Forestry	23	2 0	60.870	7 0
Health Admin.	24	23	58.333	60.870

Network	In.Centralization	28.23%
Network	Out.Centralization	38.50%

Table 4: Centrality of actors at the Rahad scheme level
Source: field data 2010

Input dataset	Newdata (Z: ucinet/newdata)
Output dataset:	Newdata-densityZ:/ ucinet/newdata-density
Density	0.5981
No. of Ties	125.0000
Avg Degree	8.333

Table 5: Density of actors at the Rahad scheme level
Source: field data 2010

6.2 Actor's strength of relationships at scheme level

To value the links between the actors in the Rahad scheme network, the researcher developed a valued graph on which relationships between actors were scored as a strong relationship, somewhat strong relationship, weak relationship, and no relationship. Respectively 3, 2, 1, and 0 were the numbers that corresponded to each relationship. The researcher chose to represent the strength of the ties with line thickness. In the graph there are three degrees of thickness, the thickest black lines represent the strong connections among actors, the somewhat thick blue lines represent the somewhat strongly connected actors, the thinner red lines connect weakly connected actors, and finally no lines occur where there are no connections between actors. We will now discuss content relationship strength actor by actor.

6.2.1 Description of connections

Fifteen actors were asked to describe their behavioral connections with each other (WASSERMANN and FAUST 1994). The extent that actors meet each other to discuss working issues was valued as strongly connected, somewhat strongly connected, weakly connected, and not connected (see figure 48 to note summary of connections at scheme level). Black lines indicate that actors would meet within a one month to discuss work, meaning actors are strongly connected. Blue lines mean somewhat strongly connected actors who meet once or twice a year. Red lines indicate weakly related actors who meet irregularly or without a schedule to discuss work. Finally, no lines means there are no connections between actors, or actors do not work together. The Rahad scheme administration is the actor that is most strongly connected in the network, meaning that the Rahad administration contacts the Agricultural Bank, Farmers' Union, Irrigation Administration and research station on a monthly basis. The El Fau locality is also strongly connected to the Ministry of Agriculture, Ministry of Livestock, and Health Administration. The Irrigation Administration is the actor who is next most strongly connected in the network; it contacts the Ministry of Agriculture, Farmers' Union, Pastoral Union, National Forest Corporation, and research station twice a year. Zakat Dewan is similar to the Irrigation Administration in its connection to the Farmers' Union, Agricultural Bank, Saving and Social Development Bank and the Rahad scheme administration. The Agricultural School is an actor that is less officially connected to the network followed by the Women's Union. In following section the researcher is explaining strength and weakness of relations for every actor separately.

6.2.2 The Rahad scheme administration

According to the data on the valued graph, we find that the Rahad scheme administration has strong connections with the Rahad research station, Irrigation Administration, and Agricultural Bank (see figure 33 to note the scheme's connections). The Rahad scheme administration and research station are strongly connected because the station is the technical advisor to the scheme when it comes to crop management as they discuss the details of applying certain technical packages such as the proper land preparation, proper seed rates, and economic viability of planted crops. The Rahad research station is also a source of knowledge for the scheme in solving field problems such as those related to pest infestations, pathogens, and deteriorating seed productivity (interview 81, paragraph 7-8). We learned that this connection was organized through the work of a technical committee composed of researchers and some staff in the scheme and is responsible for visiting farms in the scheme, taking notes on field observations, and then developing a report on field problems (interview 5, paragraph 8) (EL HASSAN 2004). Regularity and efficiency of work of the technical committee recently deteriorated due to the overall backward performance of the Rahad scheme (interview 3, paragraph 8).

The Rahad scheme administration is strongly connected with the Irrigation Administration because the administration is the responsible actor for providing and monitoring water requirements from the sources of the Blue Nile and Rahad scheme all the way to the farms in the scheme, it is also responsible for following canal maintenance (interview 81, paragraphs 35-37). Information on crop watering and requirements for canal maintenance are discussed in regular seminars with the scheme farm managers and scheme extensionists (interview 12, paragraph 18).

The Agricultural Bank has been the source of financing for farming inputs for farmers in the Rahad scheme since the time when the government stopped financing farmers (in beginning of the 1990s) (interview 4, paragraphs 2, 3) (EL AMIN and EL MAK 1997). The Agricultural Bank and the Rahad scheme administration discuss decisions on farming operations for every crop from land preparation until harvest in order to provide a total amount of financial aid needed from the bank in proper time. They also discuss and decide the time for paying back production costs so as to provide money for farming operations in the recommended time (interview 81, paragraphs 62-63).

Follow-up of financing is monitored by the Farmers' Union through financing farmers groups (interview 4, paragraph 2). We also know that financing reports are exchanged daily with the

head of the investment section in the Agricultural Bank and the farm manager in the Rahad scheme (interview 73, paragraph 7).

The Rahad scheme administration is strongly connected with the Farmers' Union see figure 33; both actors meet weekly to discuss farming operations for planted crops and update farmers' records. They also discuss related problems facing farmers (such as financing issues) (interview 81, paragraphs 43-44). The Rahad scheme administration is somewhat strongly connected with the Ministry of Agriculture; the Rahad scheme administration and the Ministry of Agriculture in the El Fau locality exchanged staff with each other. Mainly the Rahad scheme administration hired agricultural staff to train them in the scheme (interview 2, paragraph 6). There used to be regular meetings during the farming season of around six times every three months to discuss irrigation of fodder and horticulture farms (farms outside the scheme) (interview 81, paragraphs 14-15). According to the Ministry of Agriculture actor, *"We talk about extension such as the type of extension services that should be given to farmers, exchange experiences, produces an extensional bulletin with the agricultural research center,* (interview 80, paragraph7).

The Rahad scheme administration had contact with the El Fau locality twice a year. Contents of this contact were reports on spaces planted by the scheme and crops planted. They also exchange letters on training of agricultural staff in the Rahad scheme (interview 75, paragraph 7). The Rahad scheme administration and the National Forest Corporation meet once a season (twice a year) to discuss plantation in villages and horticultural fields within the scheme (interview 81, paragraph 95). The National Forest Corporation technically supervises logging of forests planted by the scheme, so whenever the scheme plans to log trees, the Forest Corporation is consulted (interview 66, paragraph 6). This corporation continued even after the KIAS Company. *"In April KIAS wanted to sell some forests; I was in the technical committee, and accordingly the forest was sold and we took 5% of it"* (interview 66, paragraph 13).

The Rahad scheme administration and Zakat Dewan meet twice a year. The Zakat Dewan representative personally will contact the manager of the scheme to know how much productivity is in the scheme, and then he will contact managers of the sections to coordinate collections of *zakat* from farmers (interview 62, paragraph 7). The Zakat Dewan representative thinks the scheme provides almost 50% of *zakat* in the El Fau locality (interview 62, paragraph 3).

Extensional programs of animal production are applied by the ministry along with ones applied by the scheme of the same nature (AI and nutrition). The difference is that the scheme

is limited by the number of farms irrigated by the scheme, but the ministry is limited by the borders of the locality or the owners of animals who fall within El Fau. The Rahad scheme administration actor confessed to a sort of cooperation in implementing awareness programs in AI and vaccination of cattle with the ministry, but the Ministry of Livestockdenies the connection with the scheme (interview 81, paragraphs 22-23; interview 70, paragraph 3). Therefore it can be assumed that the relationship between the two actors is weak since there is no regular contact or meeting between the scheme and the ministry.

The Pastoral Union representative negotiates issues of grazing inside the scheme with the scheme managers, but there is no regular base for meeting to discuss these issues (interview 59, paragraphs 5, 7). The representative of the Pastoral Union in the El Fau locality is generally a well-known farmer in the area who has farms within the scheme and outside the scheme, and he is the owner of 15,000 head of cattle. Therefore, he can reach many actors within the scheme, and his personal interests can very much mask the conversation he has with the scheme as well as other actors. We cannot be sure whether issues of animal grazing for all farmers are regularly discussed with the scheme administrators. Also from discussions with other farmers, we understood members of the Pastoral Union are not officially involved in issues of animals intruding on Rahad scheme farms (interview 44, paragraphs 17, 18).

The Rahad scheme administration actor (formal farm manager of the scheme) admitted that no official meeting or coordination was taking place between the Health Administration and the Rahad scheme administration (interview 81, paragraph 73).

The Rahad scheme administration actor and the Agricultural School have both admitted knowing each other, but no regular meetings took place between the two (interview 68, paragraph 3). Ideas on the kind of assistance that the scheme can provide to the school have been discussed between the two actors (interview 68, paragraph 5; interview 81, paragraphs 87, 88). Additionally, the scheme administration has no connection or relationship with the Women's Union and Savings and Saving and Social Development Bank (interview 81, paragraph 52; interview 77, paragraph 3). The Women's Union was not involved in any official meeting with the scheme actor (interview 81, paragraph 54). The actor of the Savings and Saving and Social Development Bank deals with farmers directly without involvement from the scheme (interview 77, paragraph 3).
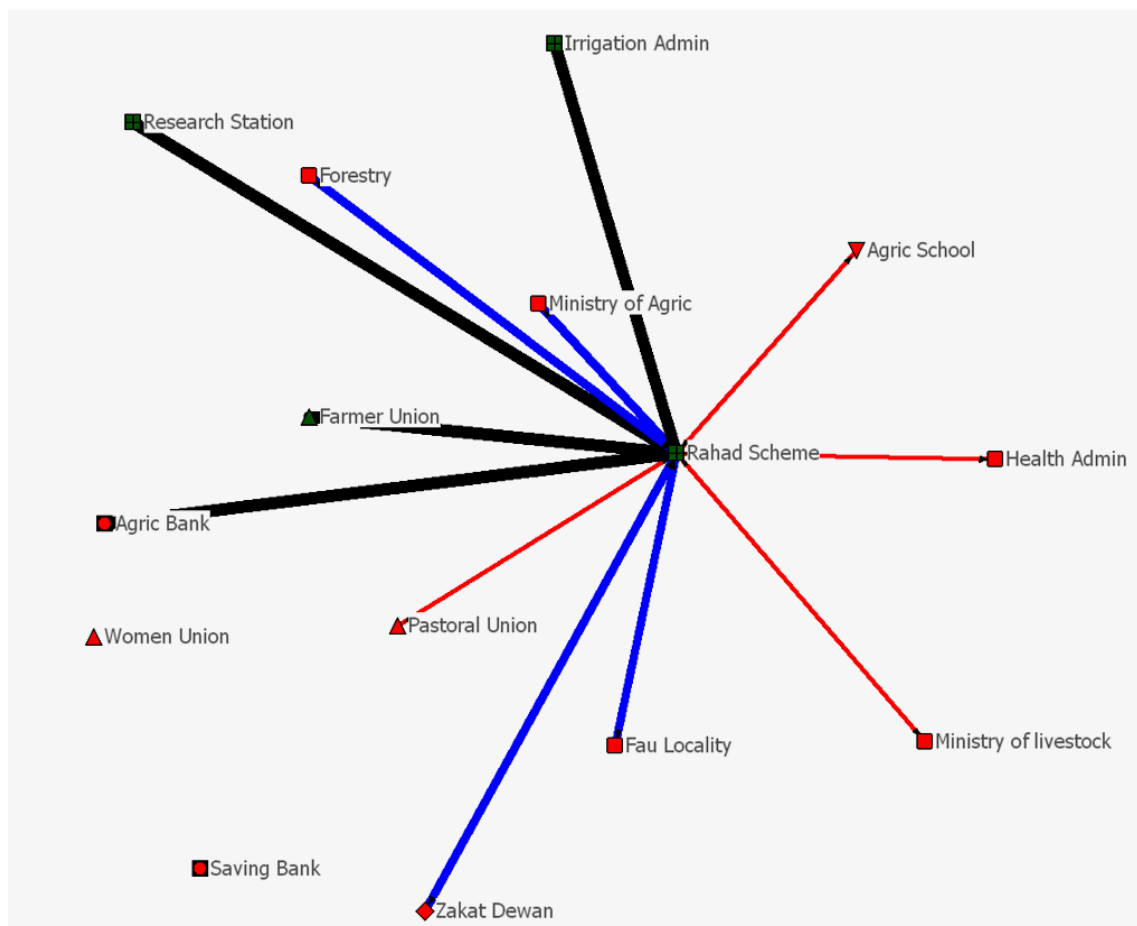
Figure 33: Rahad scheme valued connections
Source field data: 2010

Legend:
- **Strong connection** (black)
- **Somewhat strong connection** (blue)
- **Weak connection** (red)
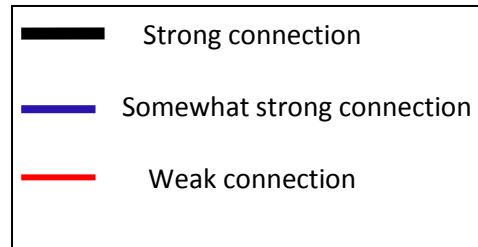
Rahad scheme administration symboled as red box has strong communications with Farmers' Union, Rahad research station, and Irrigation Administration

6.2.3 Rahad research station

The Rahad research station has a strong connection with the Rahad scheme administration, explained through the work of the technical committee, but generally the actor believed that contact with the company that is supposed to manage the scheme is becoming less frequent, including contacts for facilitating the work of the technical committee(see figure 34 to note the station's connections) . The Rahad research station has somewhat strong relationship with the Irrigation Administration see figure 34; they contact each other twice a year during preparation of the farming season to provide water irrigation and clean the canals for the

station's experimental farms. The Rahad research station would also contact the Irrigation Administration whenever it needed, for example, assistance maintaining broken canals (interview 71, paragraphs 15-17).

The Rahad research station describes their relationship with the Farmers' Union as strong because they used to meet twice a month during meetings of the technical committee with the Rahad Agricultural Corporation (previous administration of the Rahad scheme) (interview 71, paragraph 22). The actor used to buy fertilizer from the head of Farmers' Union (interview 71, paragraph 25). The actor mentioned that together with the Farmers' Union they used to discuss problems of farming such as low productivity and crop diseases. The actor added that whenever there was a problem on farms, the head of the Farmers' Union would come and discuss it with them (interview 71, paragraph 24).

The Rahad research station is somewhat strongly connected with the Sudanese Agricultural Bank see figure 34; the actor explained that the Agricultural Bank used to attend technical committee meetings. The Bank usually is the buyer of seed crops planted in the scheme, and the Rahad research station tests the seeds. Therefore, the Agricultural Bank has to be involved in technical work regarding seeds and crop management (interview 71, paragraphs 33, 35). The Rahad research station and the Agricultural Bank stopped meeting after the work of the technical committee stopped (interview 71, paragraph 35). The Rahad research station's bank account is in the Agricultural Bank, so official letters regarding fund handling are usually exchanged between the two actors (interview 71, paragraphs 31, 36).

The Rahad research station is somewhat strongly connected with the National Forest Corporation see figure 34, since the later technically supervises forest planting within the Rahad research station's farming area. They contact each other once a year when it comes to logging the forest (interview 71, paragraph 42).

The Rahad research station considers their relationship with the Ministry of Agriculture to be weak because there is no official meeting between the two actors (interview 71, paragraph 6), but there are irregular meetings or contacts between staff members in the Rahad research station and the Ministry of Agriculture to discuss controlling crop pests such as the white fly (interview 80, paragraph 13).

In spite of recognizing each other, the Rahad research station admitted no relationship with the Ministry of Livestock , El Fau locality, Pastoral Union, Saving and Social Development Bank, Women's Union, Health Administration, Agricultural School , and Zakat Dewan see figure 34. The situation is like this because no contacts on official work have taken place between the mentioned actors and the Rahad research station (interview 71, paragraphs 11,

13, 27, 38, 29; interview 61, paragraph 6). We knew that the Rahad research station actor had personally supported some activities for the Women's Union (it was money donated for charity work in support of war refugees in the Blue Nile region in 2011 (interview 71, paragraph 29). The actor of the Rahad research station admitted that she had connections with the mayor and executive manager of the locality (who is her husband) during visits from ministers or politicians (interview 71, paragraph 13). The Rahad research station actor is also personally connected with the Pastoral Union and once consulted the actor for soil surveys (interview 71, paragraph 27).

According to the results above, we conclude that although formal actors in the area recognize the role of the Rahad research station in the area, the Ministry of Agriculture and Ministry of Livestock do not coordinate with the Rahad research station
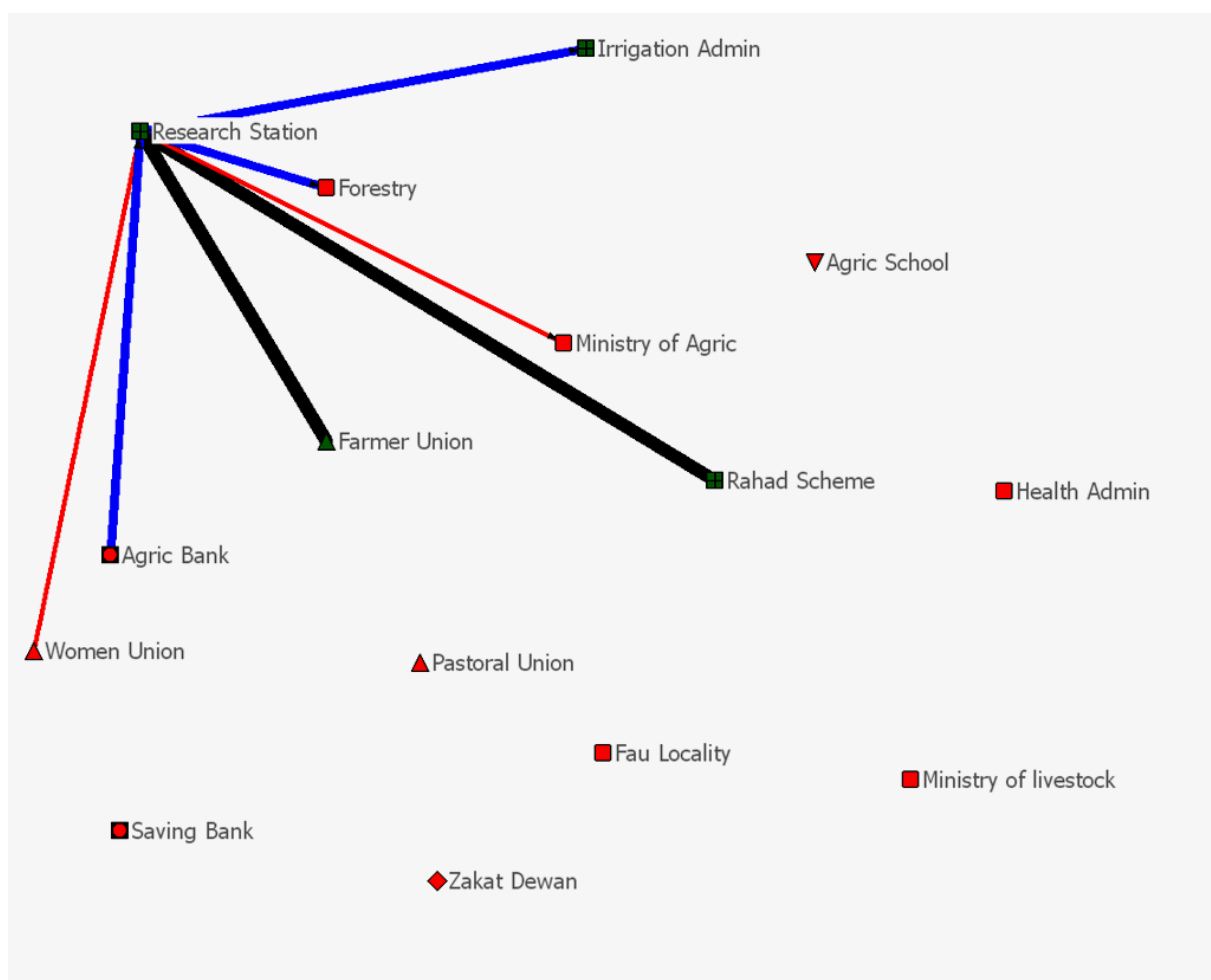
Figure 34: Research station valued connections
Source field data: 2010
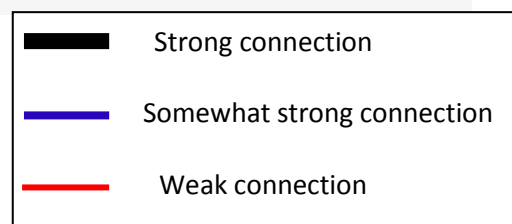
Rahad research station symboled as green box has strong connections with Rahad scheme, and Farmers' Union, the station is peripheral to the rest of actors at level of Rahad scheme

6.2.4 El Fau locality

The El Fau locality has a strong relationship with the Ministry of Livestock, the Ministry of Agriculture, the Health Administration, and the Women's Union. The four actors meet monthly with the locality executive manager to report their activities (interview 75, paragraphs 13, 19, 50, 37) (see figure 35 to note Locality's connections). The locality has a somewhat strong relationship with the Rahad scheme administration because they meet twice a year to report spaces and crops planted (interview 75, paragraph 7). The locality is somewhat strongly connected with the Saving and Social Development Bank see figure 35; every year the locality writes to the actor to pay taxes. The Saving and Social Development Bank is also connected with social welfare (an administration within the locality) to coordinate lawns for social projects supervised by the office (interview 77, paragraph 15).

El Fau has a somewhat strong relationship with the Pastoral Union; the actor of the Pastoral Union regularly meets the executive of the locality. They discuss issues of farmers in rain-fed farming or reducing taxation on animals moving from or entering the locality. The Pastoral Union representative was a member of the legislative council for the locality, so he is also known as a political figure within the locality (interview 75, paragraph 31). The locality is weakly connected to the Agricultural Bank because they only write to the bank once a year to pay taxes (interview 75, paragraphs 41, 44).

Although the locality (executive office) has no discussion with the Farmers' Union, from last year we understood that the Farmers' Union in the area politically supports the locality. The Farmers' Union may get involved in supporting political decisions taken by the locality (interview 7, paragraph 26). However, the locality is connected to the rain-fed Farmers' Union; they meet to discuss access to pathways at the locality level (interview 75, paragraph 29). The executive office within the El Fau locality has no relationship with the Agricultural School (interview 75, paragraph 59), but the locality supervises the exam process (provides security and transportation during exams) (interview 63, paragraph 17). The El Fau locality has no connection and no discussion with the Rahad research station, Irrigation Administration, or Zakat Dewan (interview 75, paragraphs 23, 54, 56; interview 71, paragraph 13).
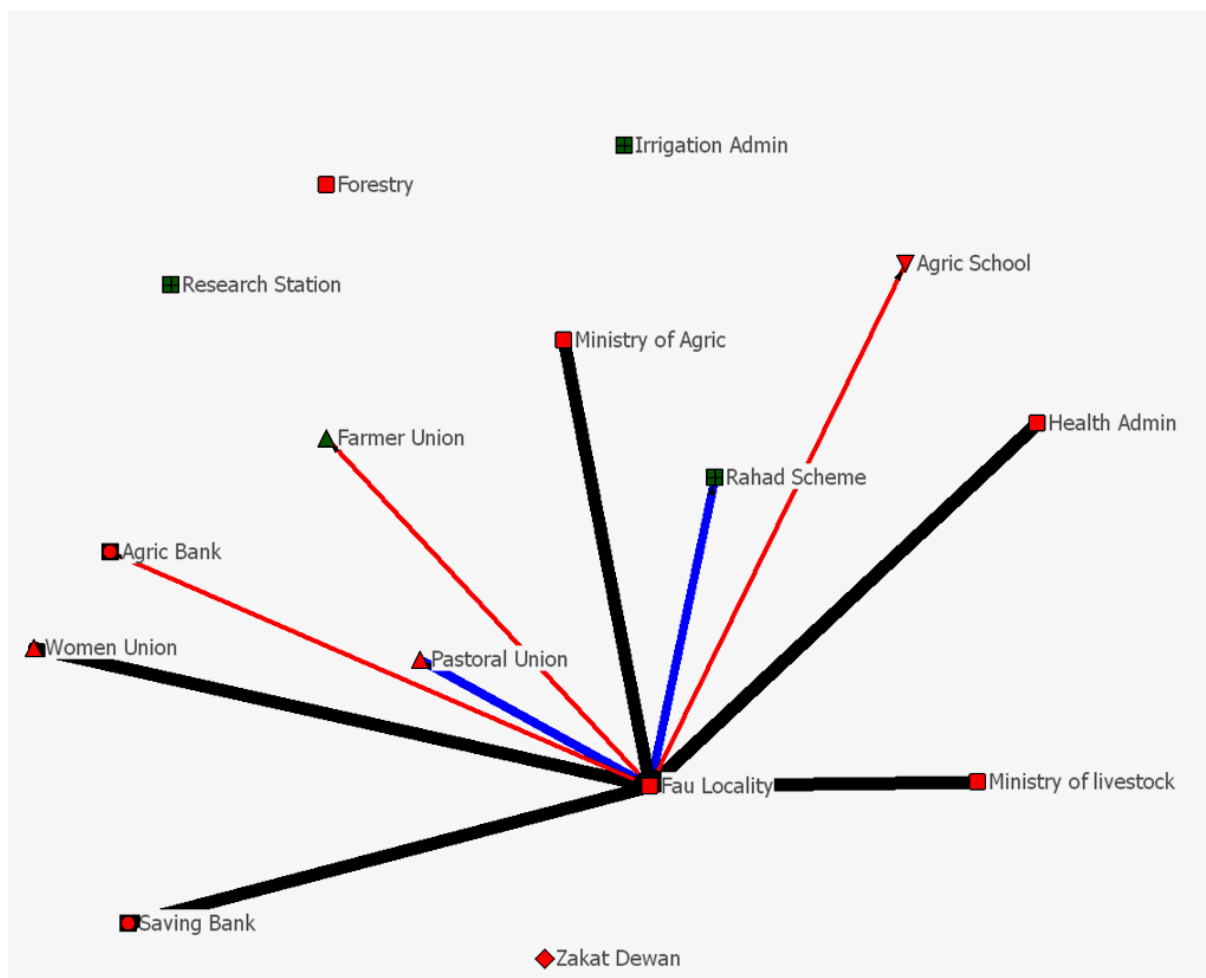
Figure 35: El Fau locality office valued connections
Source field data: 2010
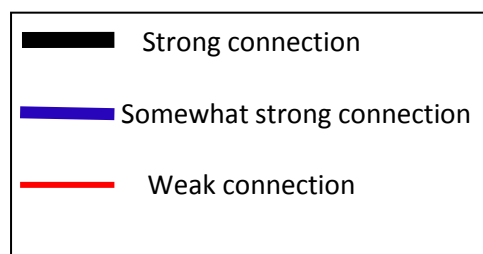
▬▬▬	Strong connection
▬▬▬	Somewhat strong connection
▬▬▬	Weak connection

El Fau locality executive office symboled as red rounded square is some what strongly related to Rahad scheme administration but has strong relations with ministries at level of El Fau locality

6.2.5 Ministry of Agriculture

The Ministry of Agriculture is strongly connected with the El Fau locality (executive office); both actors can see each other daily (interview 80, paragraph 23) (see figure 36 to note the Ministry's connections). The Ministry of Agriculture develops performance reports on office activities (supervising farming activities within rain-fed farms in the locality) three times per year and hands it to the executive manager (interview 75, paragraph 13).

During field work we noticed that even stationary supplies and computer usage of the Ministry of Agriculture is also facilitated by the locality.

The Ministry of Agriculture is strongly connected with the National Forest Corporation; both actors meet every month, sometimes daily, to coordinate trees planted in schools and other government buildings (interview 80, paragraphs 70, 73). The Ministry of Agriculture and the National Forest Corporation also coordinate together in evaluating rain-fed farms and Rahad river cliffs within the El Fau locality *(If a farm needs registration, the process starts from the Ministry of Agriculture, when trees within these farms need to be cut down, National Forest Corporationneeds to be consulted).* Both actor representatives are also personal friends who studied together.

The Ministry of Agriculture is somewhat strongly connected with the Rahad scheme administration as mentioned in the training of ministry staff within the Rahad scheme, and sometimes both actors discuss and exchange general information on crop management twice a year.

The ministry is somewhat strongly connected with the Agricultural Bank see figure 36; they meet seasonally to monthly to discuss releasing certificates of land ownership for farmers so as to be able to get loans. They also discuss evaluations of farmers when giving them the *loans (ownership certificates are certificates that prove that the farmer owns such land. The certificate is released, renewed, and authenticated by the Institute of Land in El Fau).* Both actor representatives are also personal friends who studied together (interview 66, paragraphs 20-21).

The Ministry of Agriculture communicates with the Irrigation Administration twice a year or sometimes according to the need to discuss irrigation of farms outside the rotation (it is a list of farms that fall outside the Rahad scheme, and farmers need a license for its irrigation) (interview 80, paragraph 27).

The ministry has a weak relationship with the research station, as there are irregular communications between the two. The ministry admits that it has never contacted the head of the station, but sometimes they communicate with other technical staff for information on pest control. The ministry has weak connections with the Ministry of Livestock because there is no discussion of work taking place between them, even though they meet every month at the locality office to report on their activities (interview 70, paragraph 9). However, the actor admitted that discussions on animal production activities were initiated between him and an officer of animal production (interview 80, paragraph 19). The ministry is weakly connected with the Farmers' Union because there are no regular meetings taking place between the two

actors, and if they meet, they would discuss general problems in the scheme (e.g. certificate of ownership of farmland) (interview 80, paragraph 37).

The Ministry of Agriculture admitted that their relationship with the head of the Farmers' Union was better when he was responsible for the union of fruits and vegetables in rain-fed sectors (interview 80, paragraph 35). The ministry is weakly connected with the Pastoral Union because they do not discuss Pastoral Union problems, although they meet regularly to discuss problems of irrigation in rain-fed areas and distribution of seeds to farmers (interview 80, paragraphs 40, 42). The Ministry of Agriculture is weakly connected with the Health Administration because no interaction between both actors takes place, although the Ministry of Agriculture meets representative of the Health Administration every month to report activities to the locality *(The meeting is concerned with handling reports and receiving directions from the head of the locality)* (interview 61, paragraph 15). However, both actors might sometimes meet and discuss common issues of farming and health such as the necessity for farm spraying (interview 80, paragraph 63) The ministry is weakly connected with the Women's Union; there is no official work with them, but they meet probably once in a month at the locality (interview 80, paragraph 47). There they might discuss how the Women's Union can help develop women in the El Fau area. They might also met and not discuss these issues (interview 80, paragraph 49). There is neither official work nor discussion between the Ministry of Agriculture and Zakat Dewan, the Agricultural School , or the Savings and Saving and Social Development Bank (interview 80, paragraph 68, 77, 59).
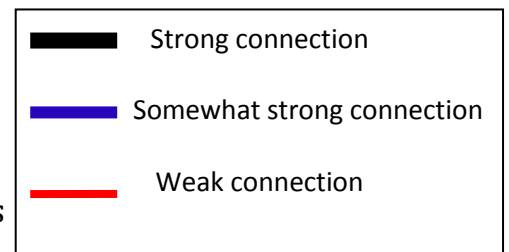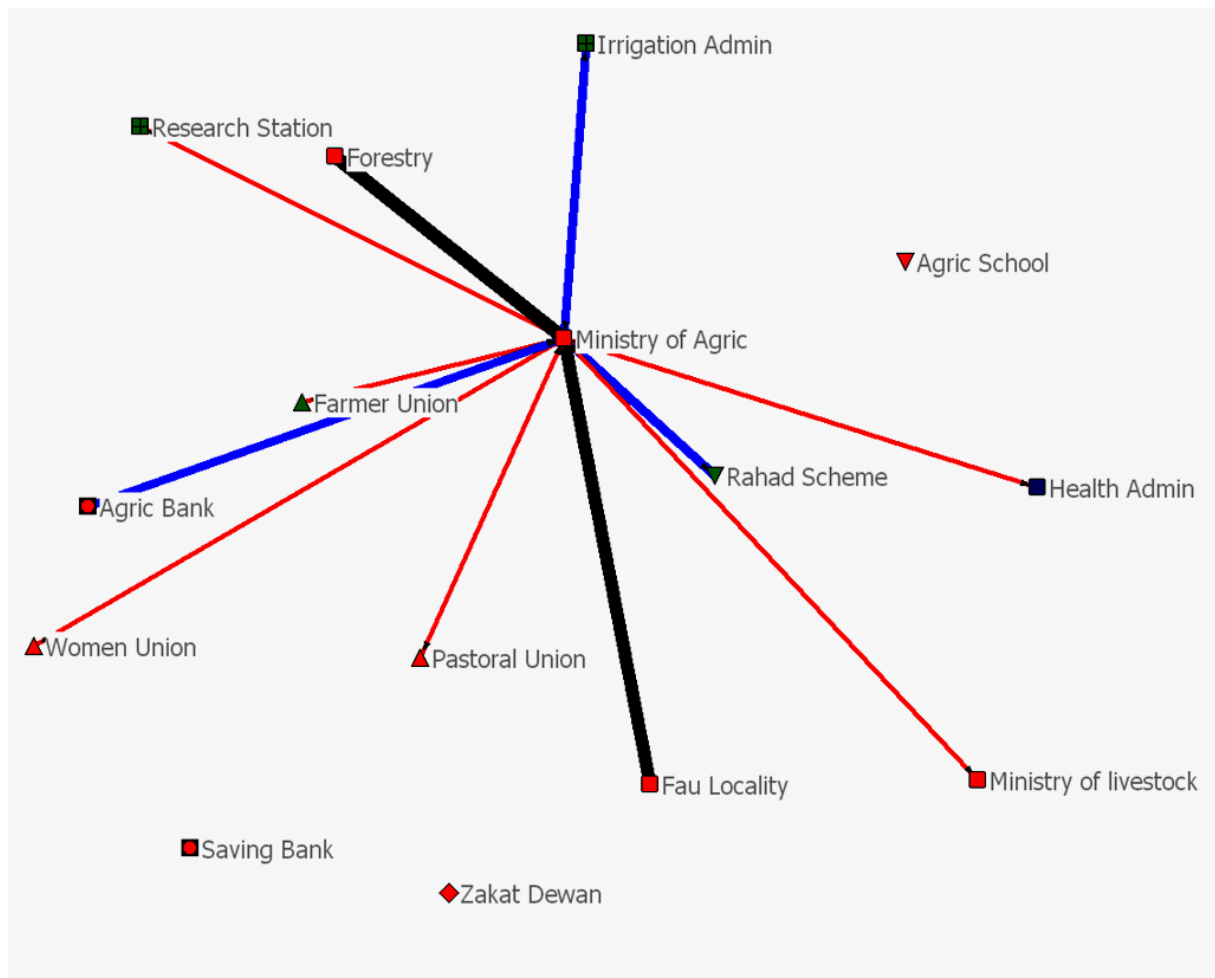
Figure 36: Ministry of agriculture valued connections
Source field data: 2010

Ministry of Agriculture symbol as red rounded square is somewhat strongly related to Rahad scheme administration but strongly connected with National Forest Corporation

6.2.6 Ministry of Livestock

This ministry is strongly connected with the El Fau locality, (see figure 37 to note the ministry's connections); both El Fau locality and Livestock Ministry meet every three months to report on their performance (reporting the number of slaughters and number of cattle in the locality). Additionally, the administrational work of the ministry is done through the locality (interview 70, paragraphs 13, 15). The ministry is strongly connected with the Pastoral Union. They meet once every month and discuss animal diseases, report on diseases, and ask how to

treat them. The actor thinks the representative of the Pastoral Union in the area follows good methods for treating animals, and they trust him, but the Ministry of Livestockdoes not interfere with issues of the Pastoral Union or give it any help. The ministry thinks the Pastoral Union is a political body. The representative of the Ministry of Livestock mentioned that the *"Pastoral Union does not mention their issues or problems with us*, *when they come to get vaccinations from the office and do not find it, they report us to the responsible people"* (interview 70, paragraphs 27, 29, 30). The ministry is somewhat strongly connected with the Health Administration see figure 37; they meet every month to coordinate the management of animal carcasses and report on the hygiene of slaughters. *"Last year when we collected data, we knew that work was not going smoothly. The health officer reported that the killing of animals was taking place without informing her"* (interview 70, paragraphs 44-46).

In spite of regular meetings every month, there is no interaction in applying activities between the Ministry of Livestock and the Ministry of Agriculture. Therefire, both actors are weakly connected (interview 70, pargraphs 7, 9). Officially there is no connection or discussion between the ministry and the Saving and Social Development Bank, but a representative of the Ministry of Livestockhas a private project funded by the bank (interview 70, paragraph 40). The Ministry of Livestock at the time of data collection admitted that there is no discussion in the work between the Rahad scheme administration and the Ministry of Livestock.

There is neither discussion nor official work going on between the Ministry of Livestock and the Irrigation Administration, Farmers' Union, Zakat Dewan, Women's Union, Agricultural Bank, National Forest Corporation, and the Agricultural School (interview 70, paragraphs 17, 21, 34, 36, 50, 52, 54).
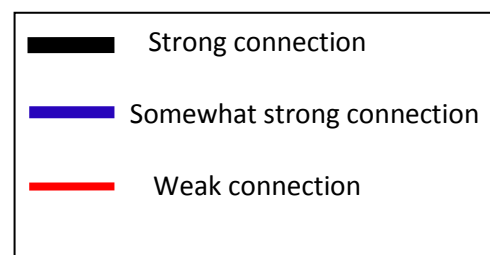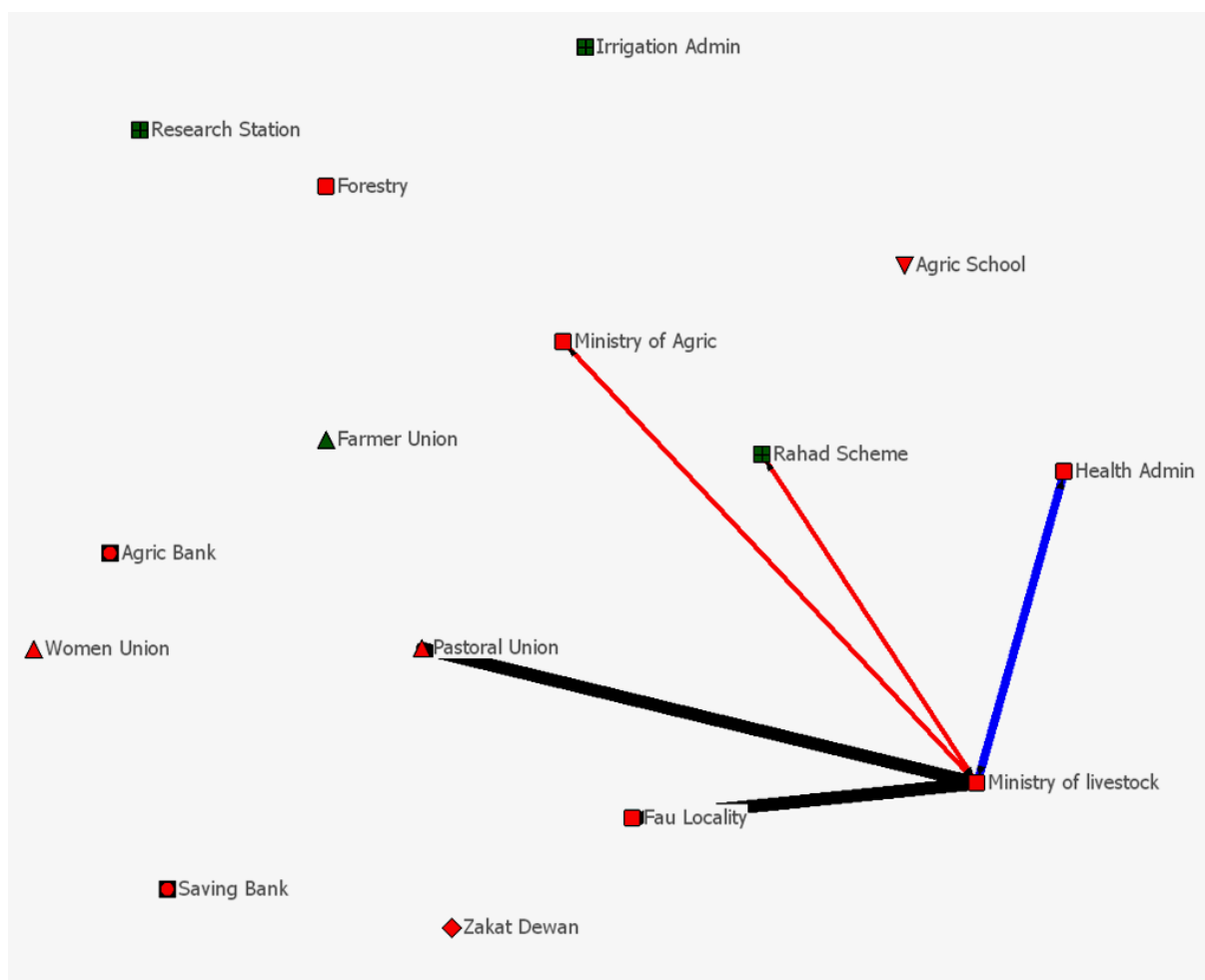
Figure 37: Ministry of Livestockvalued connections
Source field data: 2010

Ministry of Livestock has strong connections to Pastoral Union but weakly connected to Rahad scheme administration

6.2.7 Irrigation Administration

The Irrigation Administration is strongly connected with the Rahad scheme administration; the strength of connection has been explained above, and it has been concluded that provision of irrigation water and maintenance work for canals is monthly shared and discussed with the Rahad scheme administration (interview 81, paragraph 34; interview 12, paragraph 32) see figure 38 to note Irrigation Administration's connections. The Irrigation Administration has a

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somewhat strong relationship with the Rahad research station, as it is explained that they contact each other twice a year or whenever needed for irrigation of Rahad research station's experimental farm (interview 71, paragraph 17). The Irrigation Administration is somewhat strongly connected with the Ministry of Agriculture; both actors contact each other yearly when it comes to irrigation of horticultural farms (interview 74, paragraph 27) see also figure 38. The Irrigation Administration is strongly connected with the Farmers' Union because both actors meet daily to discuss problems of watering farms (interview 72, paragraph 17).

The administration is somewhat strongly connected with the National Forest Corporation. Both actors coordinate cleaning the canals three times per year, and that takes place as the National Forest Corporation is consulted for cutting down plants growing on the canals. Both are also somewhat strongly connected because there are irrigated forests planted by the Rahad Agricultural Corporation, so it is irrigated by facilitation from the Irrigation Administration and the National Forest Corporation (interview 66, paragraph 31). The Irrigation Administration has a weak relationship with the Pastoral Union because no regular meetings or discussions on work (e.g. animal issues) were mentioned between the two actors, but watering animals especially in the summer was made possible by the Irrigation Administration, *"allowing animals to be freely watered from canals and adjusting parts of canals within the scheme to be suitable for animals watering"* (interview 59, paragraph 27; interview 12, paragraph 5).

Irrigation had weak connections with the Agricultural School; only one contact between the two actors took place. The Irrigation Administration constructed a water pump for the school, and a study was prepared by the administration for constructing a canal to irrigate the school's experimental fields. Unfortunately, that canal was never constructed because the Agricultural School failed to get funding (interview 68, paragraph 23). The Irrigation Administration has no discussion, no official work with the Ministry of Livestock , El Fau locality, Women's Union, Agricultural Bank, Saving and Social Development Bank, or Zakat Dewan (interview 70, paragraph 18; interview 75, paragraph 23; interview 60, paragraph 25; interview 73, paragraph 19; interview 77, pargraph 17; interview 62, paragraph 17).
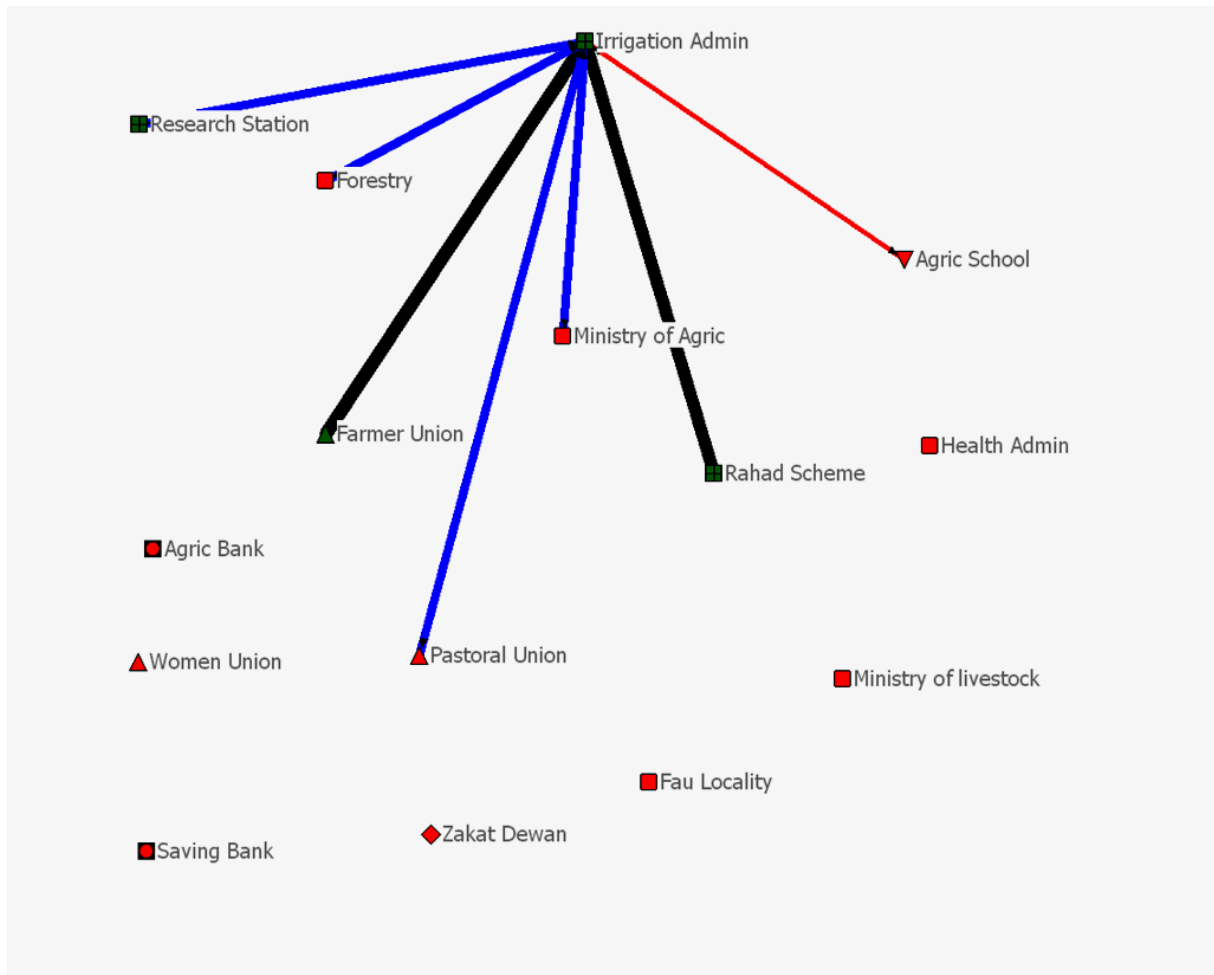
Figure 38: Irrigation admnistation valued connections
Source field data: 2010

▬▬▬	Strong connection
▬▬▬	Somewhat strong connection
▬▬▬	Weak connection
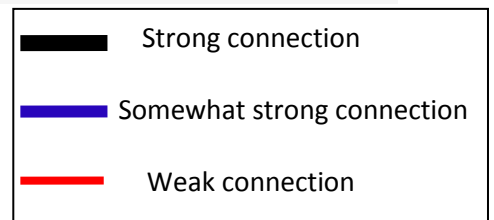
Irrigation Administration symboled as green box keeps strong level of connections with Rahad scheme admnistration and farmers' organizations but had irregular contact with El Fau Agricultural School

6.2.8 Health Administration

The Health Administration is strongly connected with the El Fau locality; the actors meet monthly to discuss performance reports. The Health Administration also submits annual planning to the executive officer of the locality each year (interview 61, paragraph 27;

interview 75, pargraph 50) (see figure 39 to note the administration's connections). The Health Administration has no official relationship or technical connection with the Rahad scheme administration (interview 61, paragraph 7; interview 81, paragraphs 73, 75). The Health Administration and Ministry of Livestockare somewhat strongly connected, as both actors meet twice a month and sometimes weekly to discuss shared activities between the two actors; we know the Health Administration supervises hygiene conditions for slaughtering animals and handling killed animals. During the interviews we noticed that sometimes clashes or contradicting views exist between the two actors in implementing these shared responsibilities. These clashes reflect a negative relationship or contact between the two actors. *"The actor from the Ministry of Livestock thinks that the Health Administration interferes by knowing the number of slaughters done by the ministry and reporting them to the locality; on the other hand we learned that thee Ministry of Livestock may condemn animals without informing the health actor"* (interview 61, paragraph 21; interview 70, paragraphs 45, 48).

The Health Administration is weakly related to the Ministry of Agriculture; both actors meet regularly every month to report on their activities, but no discussion takes place between them to interact in their work. It is also possible that staff of both administrations can encounter each other and discuss health problems in the locality and possible ways to solve them, but no concrete official coordination exists between them (interview 61, paragraph 15). However, the Ministry of Agriculture reports discussion and contacts on work with the Health Administration, especially spraying insects on farms (interview 80, paragraph 63). The Health Administration is weakly connected with the Agricultural School because there is official contact between both actors to involve students of the school in implementing environmental health hygiene, but no data was given to us saying that this contact regularly takes place. It would depend on logistics and time available for both actors (interview 61, paragraph 43; interview 63, paragraph 53).

The Health Administration has neither connections nor official work with the Rahad research station, Irrigation Administration, Farmers' Union, Pastoral Union, Women's Union, Agricultural Bank, Saving and Social Development Bank, Zakat Dewan, or National Forest Corporation (interview 61, paragraphs 9, 29, 31, 33, 35, 37, 39, 41; interview 60, paragraph 42). Knowing this, the representative of the Health Administration has suggested ideas of future connections and coordination between the administration and actors who are not presently communicating with the Health Administration.
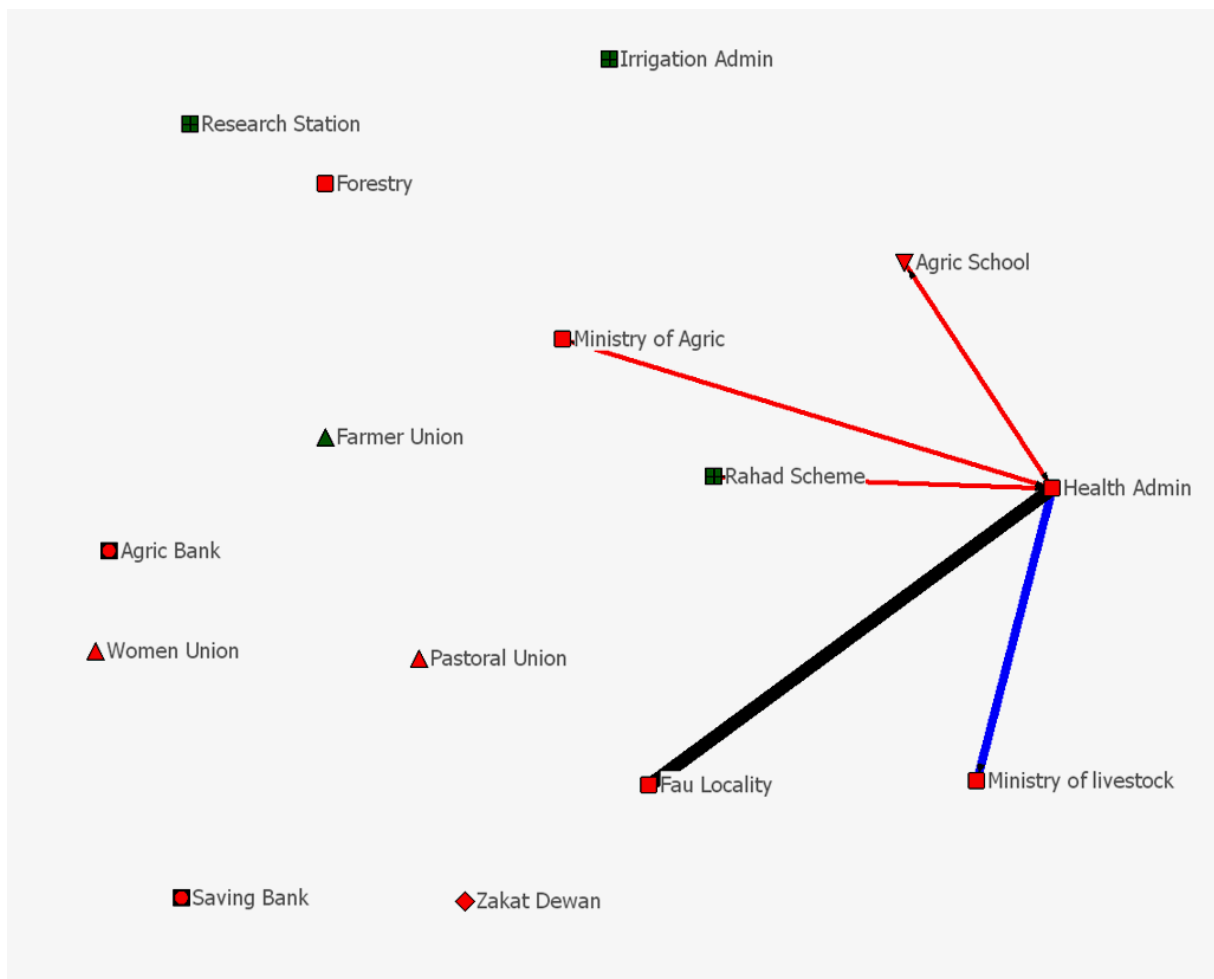
Figure 39: Health Administration valued connections

Source field data: 2010

███████	Strong connection
███████	Somewhat strong connection
───────	Weak connection
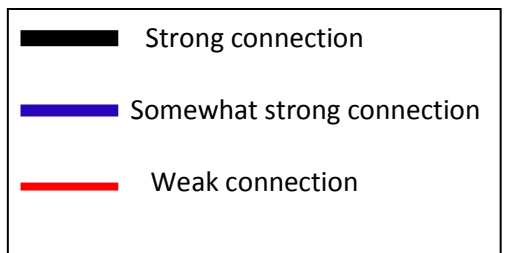
Health Administration symboled as red rounded square has irregular connections with Rahad scheme administration in issues of public health

6.2.9 Zakat Dewan
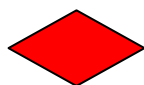
Zakat Dewan is strongly connected with the Pastoral Union; its representative regularly consults the Pastoral Union representative on which places animals for *zakat* collection can be

found and collected from pastorals. (Usually *zakat* is collected from payers and distributed to needy people twice a year). Both actors are also closely related because the Pastoral Union representative is a member in the Zakat Dewan council at the El Fau locality (interview 62, paragraph 29; interview 59, paragraph 63) (see figure 40 to note Dewan's connections). Zakat Dewan is somewhat strongly connected with the Women's Union because the union representative meets the Zakat Dewan representative twice a year to get financial support for poor families. The Zakat Dewan representative also reported that discussion about suitable income generation projects for women in the area is mentioned during meetings between both actors (interview 62, paragraphs 33, 35; interview 60, paragraph 49). Zakat Dewan is somewhat strongly connected with the Agricultural School because Zakat Dewan helps some students at school pay the student and examination fees. Dewan also yearly supports school accommodations during Ramadan (month of fasting). We learned that Zakat Dewan helps school students in the El Fau locality, generally including students of the Agricultural School (interview 62, paragraph 49; interview 14, paragraph 7). Zakat Dewan is somewhat strongly connected with the Agricultural Bank. Both contact each other yearly in order to realize licenses for crop transportation.

It was previously explained that farmers pay *zakat* to Dewan from their crops and pay the bank's cost in kind. Zakat Dewan releases a certificate for the Agricultural Bank that *zakat* from crops has been paid if that condition is fulfilled. The bank would be able to get a license from Zakat Dewan that the Agricultural Bank can transport crops outside the locality (interview 62, paragraph 41). Zakat Dewan is somewhat strongly connected with the Savings and Saving and Social Development Bank. The actors regularly contact each other, since Zakat Dewan's account is found in the Saving and Social Development Bank. Moreover, if farmers (agents with the Saving and Social Development Bank) are in debt, Zakat Dewan will be asked by the bank to pay for them (interview62, paragraph 43; interview 77, paragraph 45). Zakat Dewan is somewhat strongly connected with the Rahad scheme administration, as in every season of *zakat* collection, Zakat Dewan contacts the Rahad scheme manager to get information on the productivity of crops in the Rahad scheme, and accordingly, *zakat* will be collected from farmers in different sections of the Rahad scheme (interview 62, paragraph 7). Zakat Dewan is somewhat strongly connected with the Farmers' Union, which is explained because both actors mainly meet each other on political or religious occasions in the locality. The Farmers' Union is also a member of the Zakat Dewan council at the locality level where Zakat projects are decided (interview 62, paragraph 23; interview 72, paragraph 54). Zakat Dewan has neither a connection nor official work with the Rahad research station, Ministry of

Agriculture, or Ministry of Livestock. We understood that once the Ministry of Livestock technically supervised a charity project for poultry in some villages, but that cooperation did not continue and the project failed. According to the El Fau locality executive office, *"The Zakat manager does not report to the locality about activities of Dewan, but Dewan is officially connected with Zakat Dewan at Gedarif state."* Zakat Dewan also has no connection to the Irrigation Administration, Health Administration, or National Forest Corporation (interview 62, paragraphs 9, 15, 17, 45, 47; interview 71, paragraph 40).

Figure 40: Zakat Dewan valued connections
Source field data: 2010

▬▬▬	Strong connection
▬▬▬	Somewhat strong connection
▬▬▬	Weak connection
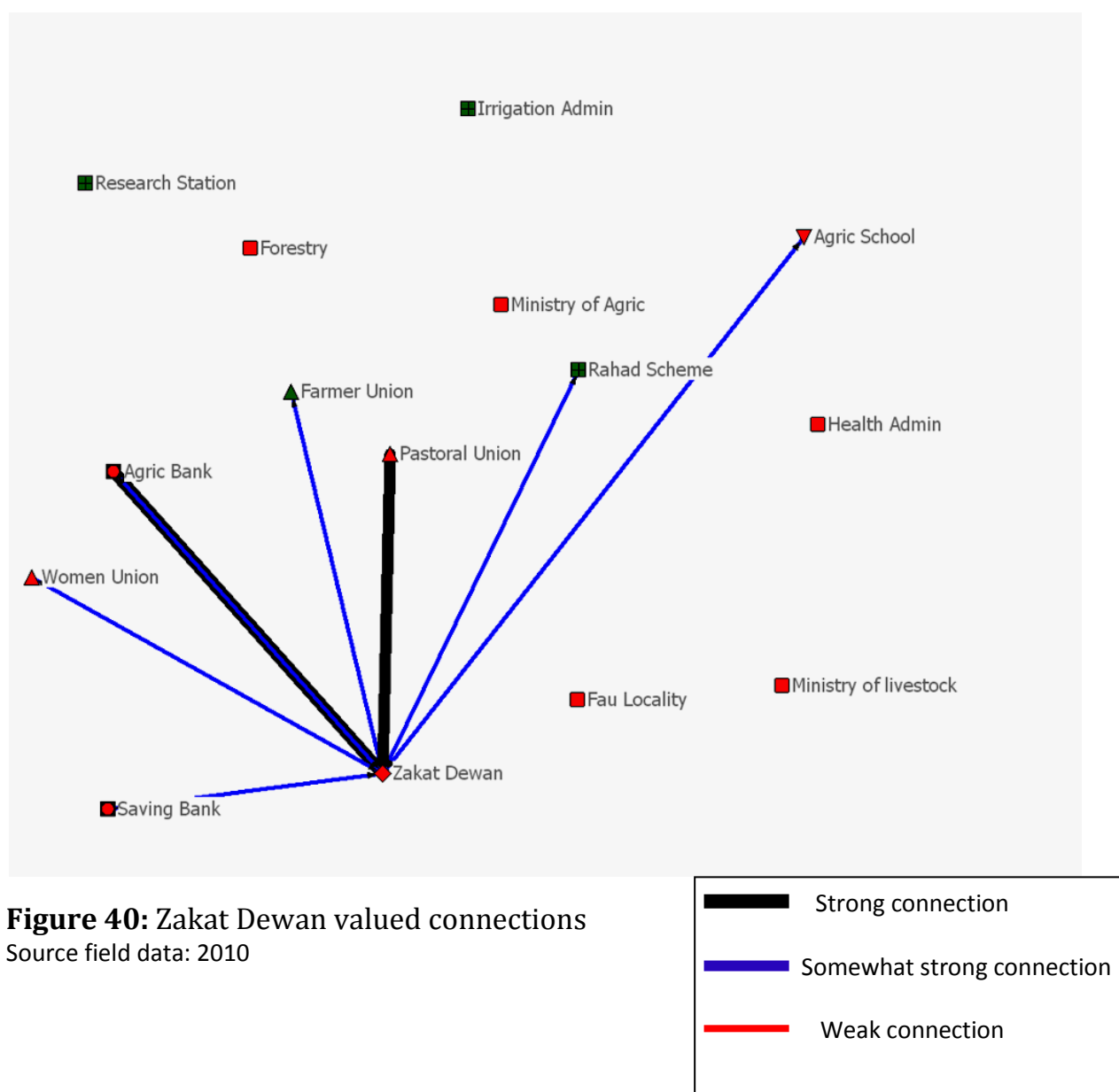
Zakat Dewan symboled as red diamond keeps somewhat strong connections with Rahad scheme administration, farmers' organization and finance institutions

6.2.10 National Forest Corporation

The National Forest Corporation is strongly connected with the Ministry of Agriculture; they meet frequently every month because both actors are members of a committee that evaluates farms outside the scheme and vegetable farms closer to the Rahad River. The National Forest Corporation in this committee is entitled to release licenses whenever trees on those farms need to be cut down. Moreover, the Ministry of Agriculture is consulted and informed by National Forest Corporationduring tree planting in schools and other public places within the locality (interview 66, paragraph 21; interview 80, paragraph 70)(see figure 41 to note the Corporation's connections). The National Forest Corporation is somewhat strongly connected with the Rahad scheme administration. Both actors meet seasonally or whenever needed to coordinate logging of forests planted by the Rahad scheme (interview 66, paragraph 13). The National Forest Corporation is somewhat strongly connected with the Rahad research station. Both actors regularly coordinate logging of forests planted on the research station's farm. The National Forest Corporation also considers the representative of the Rahad research station to be a good researcher within the area whom they contact when needed (interview 66, paragraph 13). The National Forest Corporation is somewhat strongly connected with the Irrigation Administration. Both actors seasonally coordinate cleaning of canals when there are trees growing in them. The Irrigation Administration needs the technical expertise of the National Forest Corporation. Irrigated forests planted by National Forest Corporationare irrigated through Irrigation Administration monitoring (interview 66, paragraph 31). The National Forest Corporation is weakly connected with the Pastoral Union, although the actor of the Pastoral Union is a personal friend of the representative of the National Forest Corporation whom we interviewed. However, official cooperation on dealing with issues of the Pastoral Union is not found (interview 66, paragraph 43), even though both actors realize how important it is to cooperate and know what issues need to be discussed between them. The Pastoral Union representative explained that animals sometimes should not be allowed to browse near some trees, especially small ones. He also mentioned cases where animals could be dangerous for forests; pastorals should be educated about that. On the other hand, the National Forest Corporation actor mentioned that the officials in the corporation do understand there are certain pathways for animals to pass through the forest, so they allow pastorals to use them and do not object to pastorals moving on these pathways (interview 66, paragraph 43; interview 59, pargraph 71). Therefore, we conclude that issues of grazing animals in forests are mentioned spontaneously but not formally.

The National Forest Corporation is somewhat strongly connected with the Agricultural Bank because actors communicate only on money transactions regarding the bank account of Forestry, and there is no involvement in the technical work of the National Forest Corporation. Both actors are friends and neighbors in town (interview 66, paragraphs 48, 50; interview 73, paragraph 47).

The National Forest Corporation is weakly connected with the Farmers' Union; we understood that there is no regular contact regarding official work between the two actors. However, the National Forest Corporation can approach the Farmers' Union for logistics assistance (e.g. using the Farmers' Union's meeting hall for training and such) (interview 66, paragraphs 35, 36). The National Forest Corporation is weakly related to the Agricultural School, as the National Forest Corporation had one visit from students to the Forestry's Nursery. Moreover, the National Forest Corporation has freely distributed seedlings to the Agricultural School some years ago. Moreover, the National Forest Corporation actor explained that in the future the corporation can accept visits from the Agricultural School 's students or other universities' students (interview 66, paragraph 59; interview 68, paragraph 61, 64).

The National Forest Corporation mentioned that no present coordination exists between them and the Ministry of Livestock(National Forest Corporationpreviously planted trees on the ministry's property), Zakat Dewan (National Forest Corporationpreviously planted trees on Zakat's property), Women's Union, Saving and Social Development Bank, El Fau locality (if any contact were needed with the locality, it would be through the Ministry of Agriculture, education administration), and Health Administration (National Forest Corporationplants trees in their new building. The National Forest Corporationactor added that they have a friendship with the Health Administration staff) (interview 64, paragraph 52; interview 66, paragraphs 56, 46, 52, 27, 45)
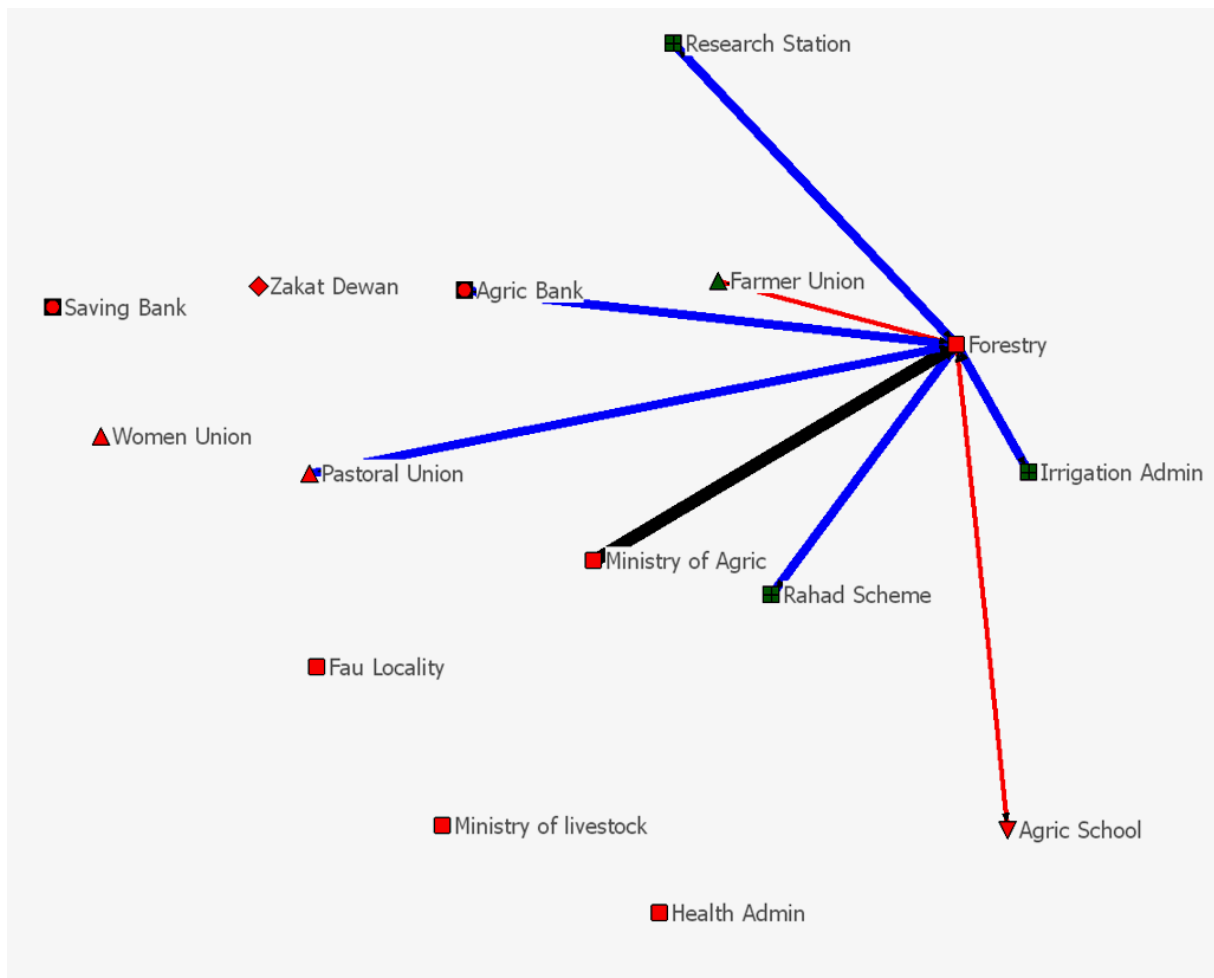
Figure 41: Forest Corporation valued connections
Source field data: 2010

■■■■	Strong connection
■■■■	Somewhat strong connection
■■■■	Weak connection
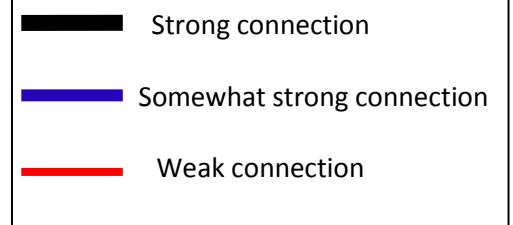
National Forest Corporation symboled as rounded square has irregular connections to El Fau agricultural school, and Farmers' Union

6.2.11 Agricultural School
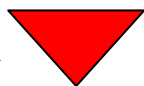
The Agricultural School has somewhat strong connection with Zakat Dewan, and that is due to the fact that the school receives yearly financial aid for students in hostels, and also Zakat Dewan pays school fees for some students (interview 63, paragraph 59)(see figure 42 to note the school's connections). The school has no connections with the executive office in the El Fau locality, but the school receives assistance from the education administration in the locality during exams (transportation of exam papers, security during the exams process). Therefore, the relationship between the Agricultural School and El Fau locality was regarded

by researchers as weak (interview 63, paragraph 71; interview 75, paragraph 59). The school is weakly connected with the Farmers' Union because the union representative admits that there has been no contact between the Agricultural School and the Farmer' Union regarding any kind of assistance or consultation. Moreover, the actor of the Farmer's Union thinks that individuals who represent the school administrations do not inform the union of the activities or programs organized by the school (interview 72, paragraph 63; interview 11, paragraph 26). Accordingly, to the actor of the Agricultural School, the only connection that exists between the two actors now is the recent council of technical learning that was formed by the education administration. The Farmers' Union and the headmaster of the Agricultural School are members in this council. This council is new (October 2010) and supposed to provide material assistance for technical education in the area including agricultural education (interview 63, paragraph 29). The Agricultural School is weakly connected with the Health Administration; we know that every year the administration of the school contacts the Health Administration to spray insects on the land surrounding the school. However, only in 2011 were students of the school involved in training to teach students how to spray insects, but this involvement is not regularly organized by the Health Administration (interview 63, paragraph 53). The school has weak connections with the Rahad scheme administration because the two actors had only met two or three times since the establishment of the school in 1994. Discussion between the Agricultural School and the Rahad scheme administration would contain possibilities of logistic aid and capacity building for students studying in the school, but no previous training or significant assistance was offered by the scheme administration (interview 63, paragraph 5). The Agricultural School has a weak connection with the Irrigation Administration because the school only once contacted them to construct a canal for irrigating demonstrational fields of the school (interview 63, paragraph 23; interview 10, paragraph 12).

Presently there is no relationship between the Agricultural School and the Agricultural Bank. Knowing this, the Agricultural School initiated contacts with the Agricultural Bank to finance the construction of an animal production unit in the school, but the bank gave no response. The school needs to be registered as a cooperative association in order to get the financing. The school also applied at the Agricultural Bank to get the school a tractor so students can get well-trained (interview 63, paragraphs 44, 45). The Agricultural School has weak connections with the National National Forest CorporationCorporation. Once coordination took place between the two actors, which was the distribution of 1,500 seedlings to the Agricultural School. Also students of the school were taken once to visit the Forestry's nursery (interview

63, paragraphs 64-66). The Agricultural School has neither a connection nor official work with the research station, Ministry of Agriculture, Ministry of Livestock , Pastoral Union, Saving and Social Development Bank, or Women's Union (interview 63, paragraphs 7, 9, 11, 33, 47, 37). A personal relationship exists between the Agricultural School and the Women's Union, as both actors live in the same village and issues of women's development in the area are mentioned between them.
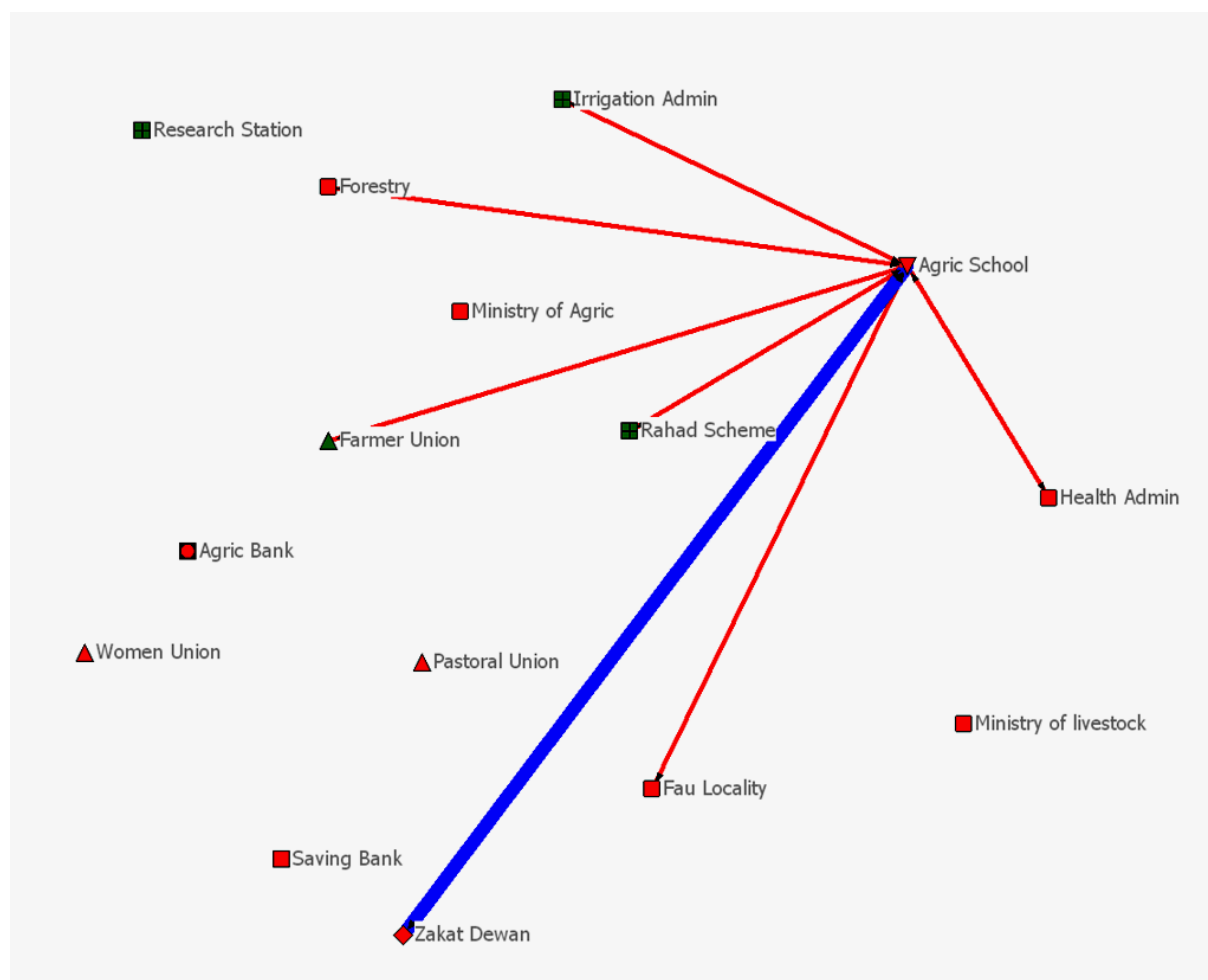
Figure 42: Agricultural School valued connections
Source field data: 2010
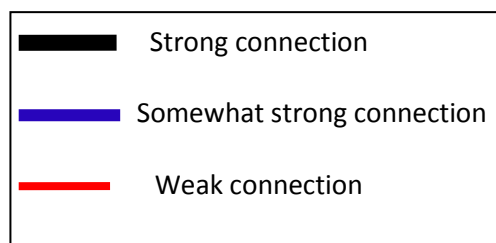
El Fau Agricultural School symboled as red down triangle has irregular communication with most of government instituions within Rahad scheme

6.2.12 Savings and Saving and Social Development Bank

The Savings and Saving and Social Development Bank is strongly connected with the Pastoral Union; this is because both actors meet to coordinate micro-finance projects for pastoral associations. The Pastoral Union representative mediated contact and coordinated financial transactions between the associations and the bank (interview 77, paragraph 25) (see figure 43 to note the bank's connections). The Savings and Saving and Social Development Bank has a strong relationship with the Agricultural Bank; of course both actors are considered the main financing agencies in the area of the scheme. The difference is that the Savings and Saving and Social Development Bank is mainly considered for families in the area with micro-finance projects (including financing animals' revolving fund projects, small trading, or businesses). The Agricultural Bank finances farmers with farming inputs, but they are also involved in micro-projects for families within the scheme area. Therefore, in addition to a competitive relationship that connects both banks, they daily contact each other for information and to enquire about agents. The Savings and Saving and Social Development Bank criticizes individually financing farmers, which is among the financial methods adopted by the Agricultural Bank (interview 77, paragraph 37; interview 4, paragraphs 3, 6; interview 4, paragraph 22). The Savings and Saving and Social Development Bank is a strongly connected with the El Fau locality; both actors meet once a month to discuss finance projects for working staff (we understood these projects are coordinated by the office of social affairs in El Fau. Moreover, there are yearly taxes paid by the bank to the locality, which makes the bank connection to the locality more legitimate (interview 77, paragraph 15; interview 75, pargraph 45). The Savings and Saving and Social Development Bank is strongly connected with Zakat Dewan, as the bank writes monthly to Zakat Dewan to pay for agents who failed to pay back their loans from the bank (mainly paying the micro-finance projects, and that is according to conditions of *zakat* distribution). The bank account of Zakat Dewan is found in the Savings and Saving and Social Development Bank, and this fact makes communication between the two actors more frequent (interview 77, paragraph 45). The Savings and Social Development Bank and the Women's Union are strongly connected with each other; they meet almost every day to discuss financing the recent 10 women's associations (interview 77, paragraphs 29, 31). The Savings and Saving and Social Development Bank and the Ministry of Livestockare only connected at a personal level, since the representative of the Ministry of Livestockis running a micro-finance project with the bank (interview 77, paragraph 9; interview 70, paragraph 38). The Savings and Saving and Social Development Bank has

neither connections nor official work with the Rahad scheme administration, Rahad research station, Health Administration, Irrigation Administration, National Forest Corporation, or the Agricultural School (interview 77, paragraphs 3, 5, 39, 17, 47, 49).
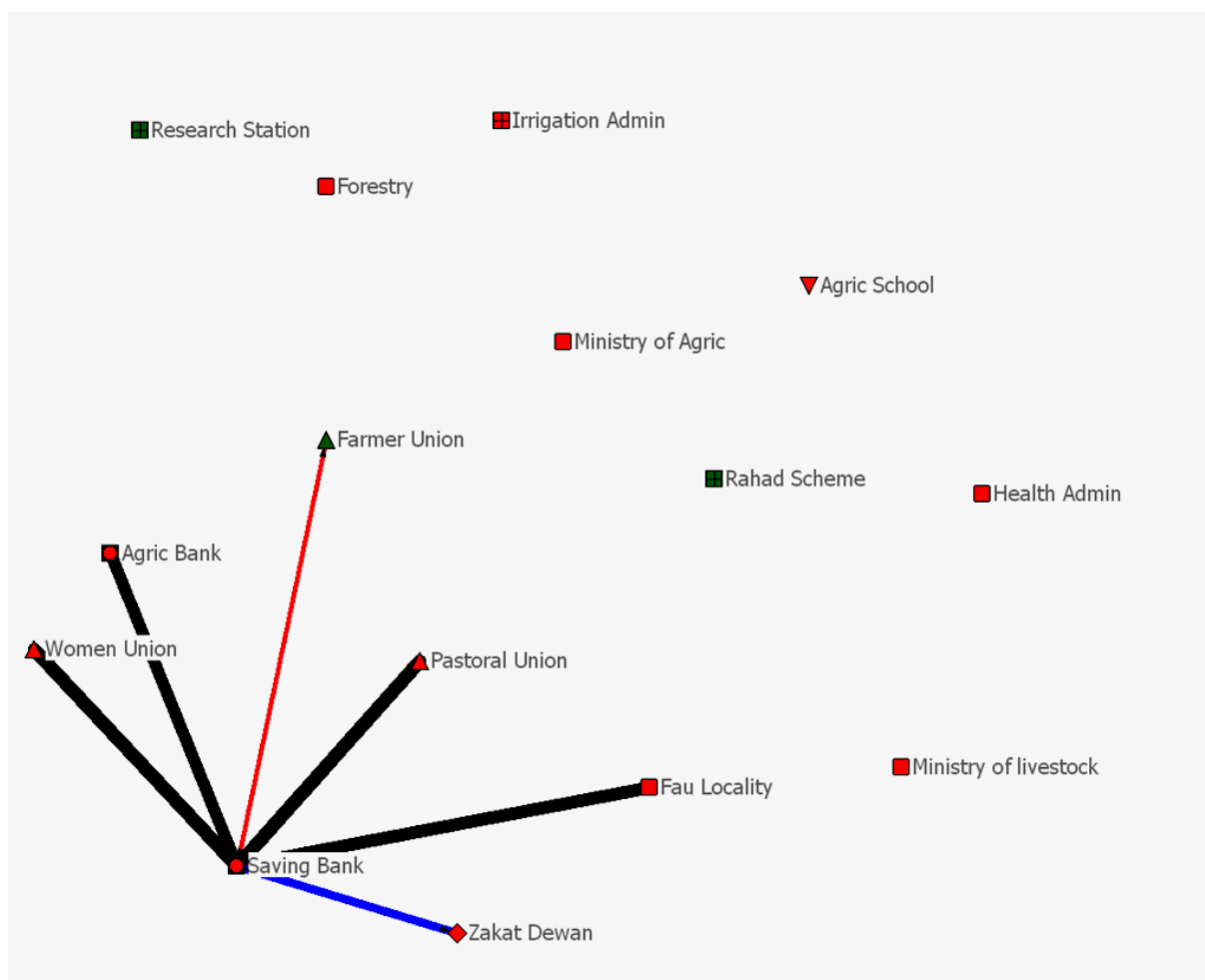
Figure 43: Saving and Social Development Bank valued connections
Source field data: 2010

▬▬▬	Strong connection
▬▬▬	Somewhat strong connection
▬▬▬	Weak connection
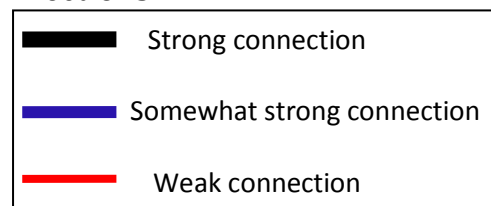
Saving and Social Development Bank symboled as circle in box has strong connections with limited numbers of actors mainly Women's Union, Pastoral Union and Sudanese Agricultural Bank

6.2.13 Sudanese Agricultural Bank

The Agricultural Bank is strongly connected with the Rahad scheme administration because the farm manager in the Rahad scheme and the head of finance section in the bank meet regularly to discuss finance requirements (the bank is financing inputs productions to farmers) (interview 73, paragraph 7; interview 81, paragraph 62) (see figure 44 to note the bank's connections). The Agricultural Bank is also strongly connected with the Farmers' Union. In the process of financing, the Farmers' Union is included because farmers are financed with the supervision of the union (members of the Farmers' Union are the ones who mediate contacts with farmers' groups and the Agricultural Bank. Also the finance section within the bank discusses with the Farmers' Union farmers' payment and whether financing is available to them or not (interview 73, paragraph 25; interview 23, paragraph 9). The Agricultural Bank and the Savings and Saving and Social Development Bank are strongly connected because both actors regularly discuss agents: who repays and who does not (interview 73, paragraph 35). The Agricultural Bank is strongly connected with Zakat Dewan; both actors regularly meet because the Agricultural Bank needs to get a license from Zakat Dewan to transport crops that are paid to the Agricultural Bank by farmers. *"Farmers pay their input costs in kinds of crops; these crops need proof from Zakat Dewan that their* zakat *is paid, and then the bank needs a license from Zakat Dewan to transport the crops for sale, this process applies also to farmers within rain-fed farms"* (interiview 73, paragraph 43). The Agricultural Bank has a somewhat strong relationship with the Rahad research station. Both actors meet once a year to discuss tests of which seeds are to be grown by farmers in the scheme. The Agricultural Bank finances the seeds and the station tests their germination or validity, so the actors share the information in this process. The Agricultural Bank is also involved in meetings of the technical committee, which is composed of researchers from the Rahad research station and staff from the Rahad scheme (interview 73, paragraph 13; interview 71, paragraphs 33, 35, 36). The Agricultural Bank is strongly related to the Pastoral Union. Both actors meet regularly, as the representative of the Pastoral Union has his personal account in the Agricultural Bank and admitted that he discusses with the bank the need to invest in animal wealth. However, the Agricultural Bank did not go for this suggestion, and apparently no official work has been launched between the bank and the union. We graded the contact between the Agricultural Bank and Pastoral Union as strong (interview 73, paragraph 27; interview 59, paragraph 47). Researchers considered the Agricultural Bank to be somewhat strongly related to the Ministry of Agriculture; both representatives have a good personal relationship with each other, and there are regular contacts between the two actors regarding

official work connecting them (i.e. issues of financing farmers in rain-fed areas) (interview 80, paragraph 55). However, the interviewed actor from the Agricultural Bank did not mention this cooperation during interviews (interview 73, paragraph 15). The Agricultural Bank and Agricultural School are related to each other, as the Agricultural School applied to the Agricultural Bank to finance an animal production unit and a tractor. Unfortunately, the Agricultural Bank responded negatively to these applications. Although official contact between the two actors has taken place, and the head master of the Agricultural School has his own account with the bank, the relationship between the two actors does not exist (interview 68, paragraphs 44, 45; interview 73, paragraph 47).

The Agricultural Bank and the National Forest Corporation are somewhat strongly. The bank account of the National Forest Corporation is in the Agricultural Bank, so both actors contact each other for money transactions, but there is no interference in the technical work of either actor (interview 73, paragraph 46; interview 66, paragraph 50).

The Agricultural Bank has neither contact nor official work with the Ministry of Livestock , Irrigation Administration, Women's Union, or Health Administration (interview 64, paragraph 36; interview 73, paragraphs 19, 29, 37).
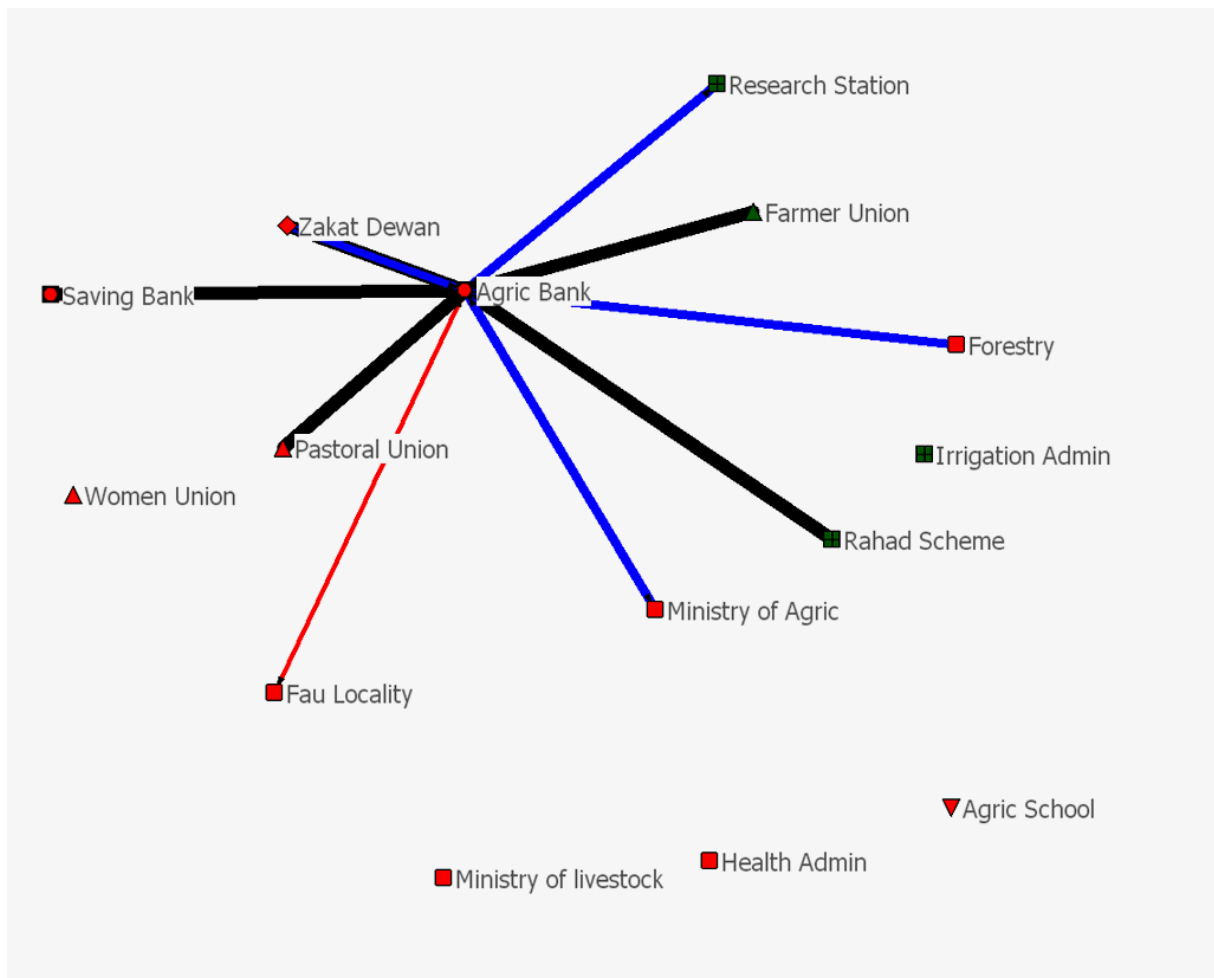
Figure 44: Sudanese Agricultural Bank valued connections

Source field data: 2010

▬▬▬	Strong connection
▬▬▬	Somewhat strong connection
▬▬▬	Weak connection
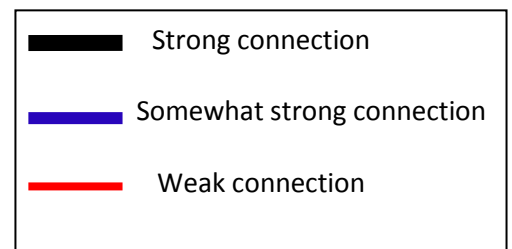
Sudanese Agricultural Bank symboled as circle in box has strong level of communication with actors on its network

6.2.14 Farmers' Union

The Farmers' Union has a strong relationship with the Rahad scheme administration. We explained that the union frequently communicates with the scheme administration to discuss managerial issues related to farmers. Three members of the Farmers' Union executive office also used to be board members with the scheme administration and attend meetings with the scheme administrators. According to this position, the executive of the union participates in

decision making with the scheme administrators, and sometimes reviews and accounts for financial plans prepared by the scheme administrators (interview 11, paragraph 4) (see figure 45 to notice the union's connections). Therefore, the Farmers' Union represented by its executive continues its strong connections with the scheme administration.

The Farmers' Union is strongly connected with the Sudanese Agricultural Bank, as the bank is the main financial resource for farmers with production inputs: seeds, fuel, fertilizers. The actors meet daily to discuss financing of farmers, as the Farmers' Union is entitled to some duties with farmers' groups when it comes to paying input costs (interview 72, paragraphs 35, 37; interview 73, paragraph 25). Those duties include the Farmers' Union delivering reports on which farmers pay the cost of inputs and collecting the cost of inputs from farmers who pay (interview 23, paragraph 9).

The Farmers' Union has a strong relationship with the Rahad research station; we explained that connection, as both actors used to meet monthly with the technical committee in farms of the scheme. The Farmers' Union also insists on the importance of the Rahad research station within the scheme area (interview 71, paragraphs 22, 24).

The Farmers' Union also has a strong relationship with the Irrigation Administration; the actors meet daily to discuss irrigating farms and problems with water pumps. We know that after KIAS management, the union contacted other engineers within KIAS, but the same connections remain (interview 72, paragraph 17). The union has a weak relationship with the Ministry of Agriculture. The representative of the Farmers' Union stated that he does not meet representatives of the Ministry of Agriculture that much because he has no services to provide for irrigated farms in the scheme. The Ministry of Agriculture is more connected with rain-fed areas. The Farmers' Union also thinks the Ministry of Agriculture is more interested in taking care of tax collection from farmers than providing services (interview 72, paragraph 11). Despite this, the Ministry of Agriculture admits knowing the representative of the Farmers' Union when he used to be a representative of the Fruits and Vegetables Union. The Ministry of Agriculture sometimes communicates with the Farmers' Union representative and discusses general problems in the scheme (interview 80, paragraph 35). The Farmers' Union is weakly connected with the Saving and Social Development Bank; the Farmers' Union representative would sometimes meet the manager of the Saving and Social Development Bank to discuss supporting revolving fund projects for farmers or convincing the bank to open accounts for some farmers. We can say that this actor is using his social situation as a head of the Farmers' Union to communicate with the bank on those issues, but he is not officially entitled to go for these discussions (interview 72, paragraph 43). The representative of the

Farmers' Union admitted that he has no connections with the Agricultural School (interview 72, paragraph 62). We interviewed an actor of the Agricultural School, since we knew that one executive member in the Farmers' Union is a member of a newly initiated council for technical learning. The mission of the council is to help technical schools including the Agricultural School do its role better (providing financial support and linking schools with relevant agencies) (interview 68, paragraph 29). Accordingly, we assumed that presently the Agricultural School is weakly connected with the Farmers' Union.

The union is somewhat strongly connected with Zakat Dewan because no regular official meetings connect the two actors in work but only according to their needs. The Farmers' Union representative would call the Zakat Dewan representative to discuss collecting *zakat* from farmers (interview 72, paragraph 54). On the other hand, Zakat Dewan mentioned that it meets with the Farmers' Union on political, religious, and social occasions (interview 62, paragraph 23). The Farmers' Union is also weakly connected with the National National Forest CorporationCorporation. The National Forest Corporationactor mentioned that no regular work meetings take place between the two; however, logistical assistance may be asked by National Forest Corporation from the Farmers' Union (interview 66, paragraph 36). For example, a meeting hall to conduct a workshop can be freely provided by the Farmers' Union to the National Forest Corporation. However, the representative of the Farmers' Union admitted connections with National Forest Corporation for discussing forests and horticultural issues (interview 72, paragraph 60).

The Farmers' Union has no connection with the Ministry of Livestock, but it is connected with the investment section in the Rahad scheme (interview 72, paragraph 13). It has no connection in technical work with the locality of El Fau (interview 72, paragraph 15). However, as discussed the Farmers' Union supports political events initiated by the locality (interview 7, paragraph 26). The Farmers' Union has neither a connection nor discussion with the Health Administration or Women's Union (interview 72, paragraph 29, 47). The Farmer's Union has no connection but also a negative relationship with the Pastoral Union. We scored their relationship as negative, because the *"Pastoral Union does not talk to us unless there is a problem with animals intruding on fields. The union is bad for us; they have a wrong understanding for opening pathways and solving problems, they have no organized institution, and they are not effective"* (interview 72, paragraph 25).
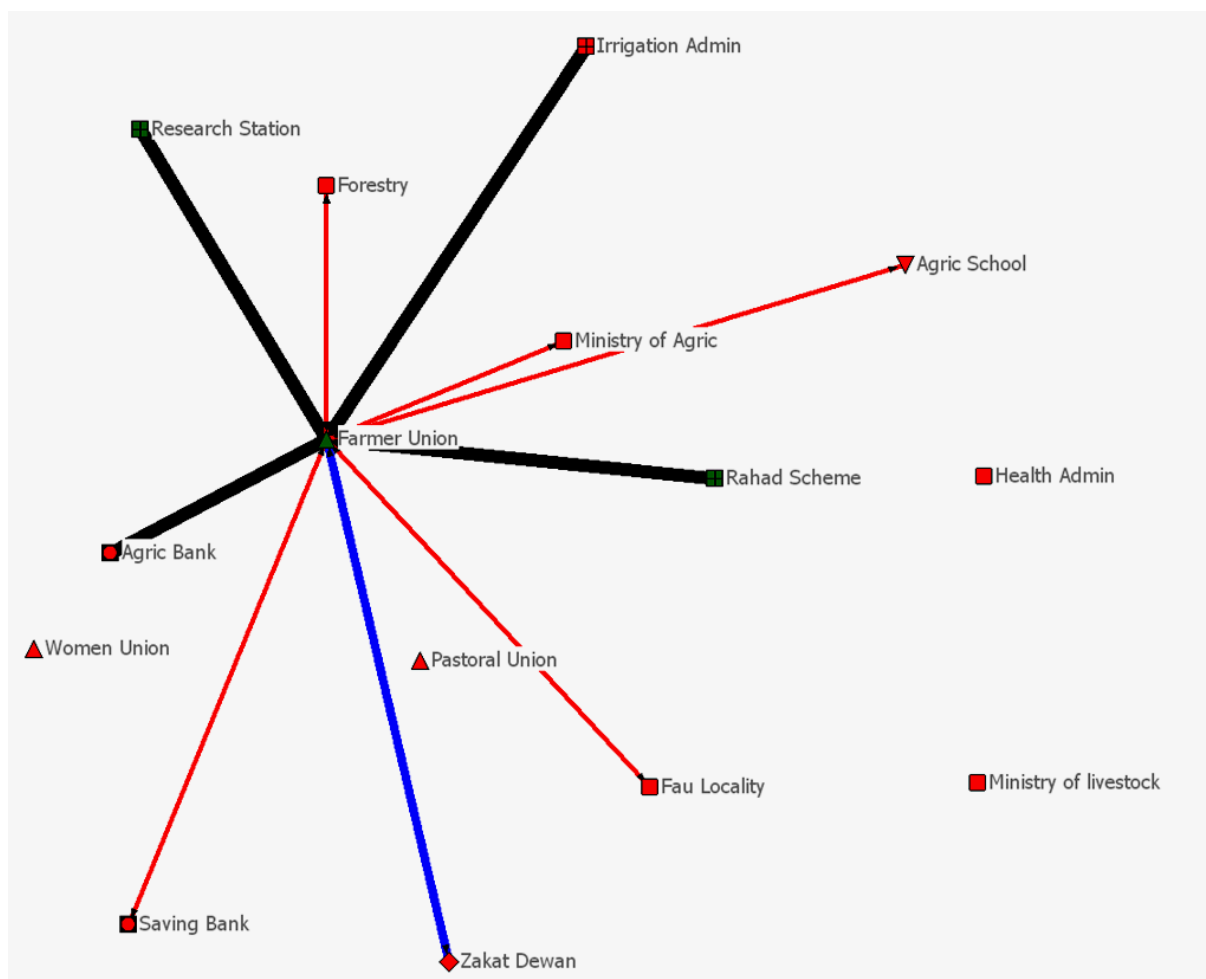
Figure 45: Farmers' Union valued connections
Source field data: 2010

▬▬▬	Strong connection
▬▬▬	Somewhat strong connection
▬▬▬	Weak connection
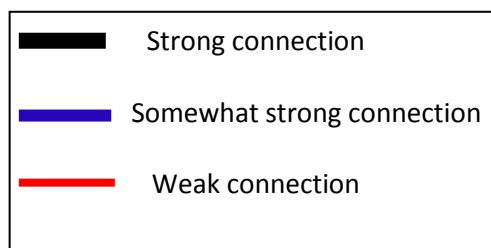
Farmers' Union symboled as green up triangle, keeps a balanced level of weak connections and strong connections at level of Rahad scheme. Women's Union, Pastoral Union, and Ministry of Livestock are peripheral on the Farmers' Union network

6.2.15 Pastoral Union

The representative of the Pastoral Union is a well-known farmer in the area who has plenty of farming space and almost 15,000 cattle. Therefore, the representative is recognized by almost every actor we interviewed. The Pastoral Union has a strong relationship with the Agricultural

Bank; the Pastoral Union representative is a regular agent in the bank. He meets officials there quite frequently (once or twice every month), mostly to discuss his money transactions, but the actor also mentioned that he discusses with the Agricultural Bank about initiating investment projects in cattle (interview 59, paragraph 47). The Sudanese Agricultural Bank can finance pastorals with animals so they can propagate, and pastorals can pay the cost of financing. However, the Agricultural Bank did not go for such a project; the representative thinks the reasons for that is the perception of administrators that are found there. They think such projects would not succeed with the limited skills of pastorals in dealing with bank regulations (interview 59, paragraphs 47, 49) (see figure 46 to note the union's connections).

The Pastoral Union representative is also strongly connected with the Savings and Saving and Social Development Bank, in the same way as the Agricultural Bank. He also has a bank account with them and discusses with bank administrators about financing micro-projects of animals for poor families. Actually the Savings and Saving and Social Development Bank once financed a project of 20-30 head of cattle for pastoral associations, and some farmers paid back. The Pastoral Union representative in this project was involved in communication between the bank and owners, or he facilitated communication during the project (interview 59, paragraphs 55, 57). The Pastoral Union has a strong relationship with the Ministry of Livestock; he contacts it more than twice monthly to discuss problems such as infections of animals or disease outbreaks. When it comes to issues related to the Pastoral Union, the actor only discusses the cost of vaccinations that should be paid by pastorals (interview 59, paragraphs 17, 19). We knew that the representative also had good personal relationships with officers in the Ministry of Livestock, and they trust him as a good animal keeper who follows medical methods in animal care (interview 70, paragraph 29).

 The Pastoral Union representative has a weak relationship with the National Forest Corporation. This connection is explained as the Pastoral Union admitted that it regularly meets actors of the National Forest Corporation, but issues of how animals should graze inside the forest are sometimes raised between them. It is known, for example, that the areas with small trees should not be grazed inside the forests, also in certain times animals are not allowed to graze in forests, so the Pastoral Union directs shepherds to avoid it (interview 59, paragraph 71). However, knowing this, the actor of the National Forest Corporation reported that the pastoral representative is a personal friend of staff in the forest corporation and has official connections that consider Pastoral Union issues seldom to take place between them (interview 66, paragraphs 38, 40).

The Pastoral Union and Zakat Dewan are strongly connected. First, the pastoral representative is a member of the Zakat Dewan council at the locality level. Second, both actors meet every month to discuss plans for distributing the *zakat*: who is the most in need and how to distribute the *zakat*. They discuss sources of *zakat* and what projects could be considered for bringing people of the area out of poverty (interview 59, paragraphs 63, 65).

The Pastoral Union is somewhat strongly connected with the El Fau locality. He meets executives in the locality monthly to discuss taxes on cattle moving within the locality, decisions about slaughtering animals, and documents proving ownership of cattle that should be shown by the pastorals (interview 59, paragraph 25). However, movements of pastorals on pathways within the El Fau locality are discussed with the head of the Rain-fed Farmers' Union, who is also member of Pastoral Union.

The Pastoral Union has weak connections with the Rahad scheme administration because there are irregular discussions between the Pastoral Union representative and the Rahad scheme administration on animals grazing inside the fields.

The Pastoral Union has a weak relationship with the Ministry of Agriculture because the two actors meet regularly every month, yet they discuss issues related to farming in rain-fed areas more than Pastoral Union issues. The Pastoral Union representative is also a member of the Rain-fed Farmers' Union in the area (interview 75, paragraph 25).

The Pastoral Union is weakly related to the Irrigation Administration, as no regular discussions on animals issues (e.g. watering animals) is mentioned, although initially watering animals was considered a main concern for the Irrigation Administration (interview 59, paragraphs 29, 31). It is also not known for us who among the Irrigation Administration contacts the Pastoral Union.

The Pastoral Union and Women's Union meet in political events within the El Fau locality, but no official work regarding women's needs or pastoral needs in specific is taking place between the two (interview 59, paragraph 41). Therefore, we considered the type of relationship between both as officially weak but political. The Pastoral Union representative recognizes the Farmers' Union in the area but thinks the Farmers' Union is a conspiracy with KIAS to establish unfair conditions for pastorals (interview 59, paragraph 37). Therefore, the actors meet and discuss with each other but they are negatively related. We scored their relationship as negative. The Pastoral Union has neither connections nor discussions with the Health Administration, Agricultural School, and Rahad research station (interview 59, paragraphs 73, 59; interview 71, paragraph 27).
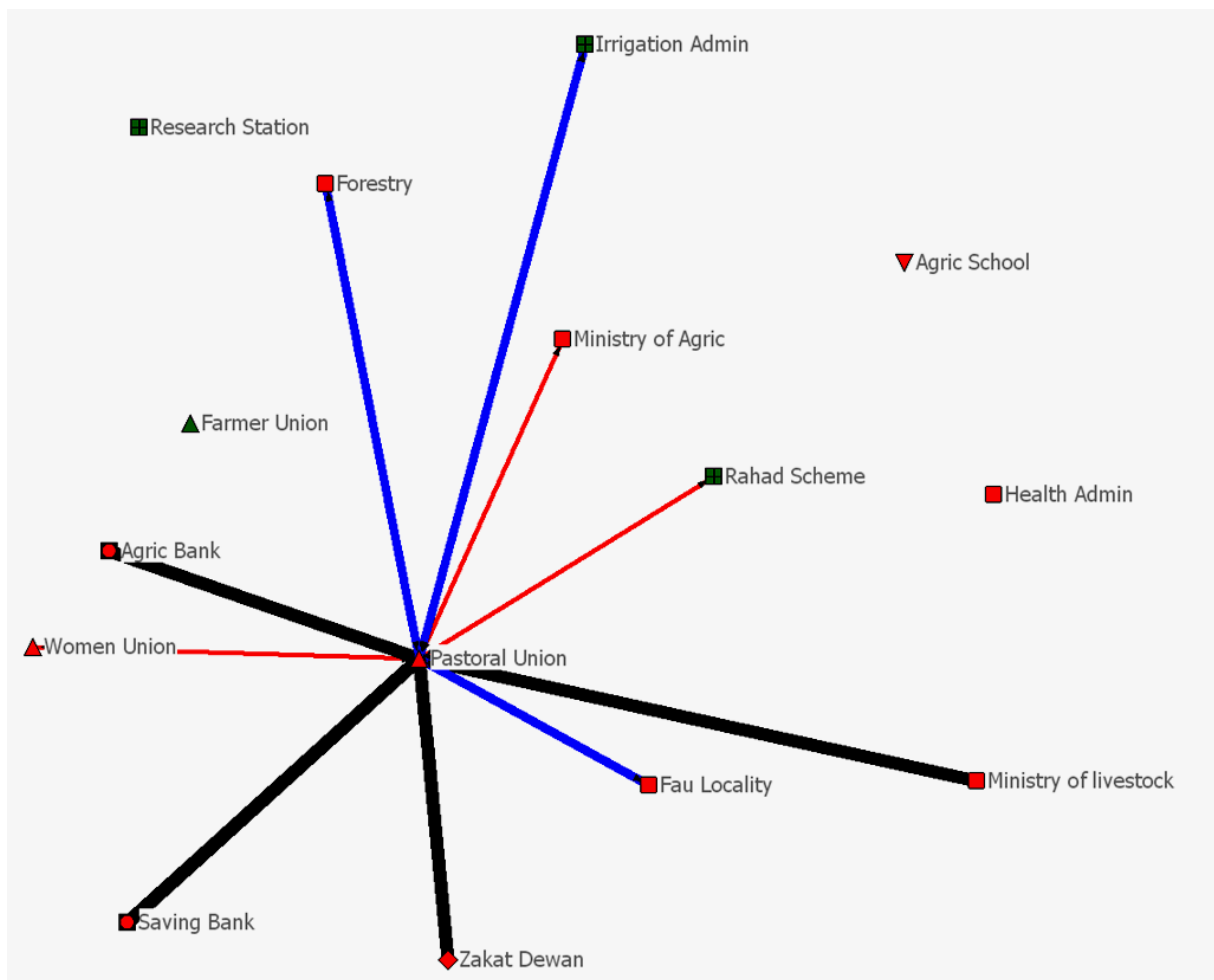
Figure 46: Pastoral Union valued connections
Source field data: 2010

■■■ (black)	Strong connection
■■■ (blue)	Somewhat strong connection
■■■ (red)	Weak connection
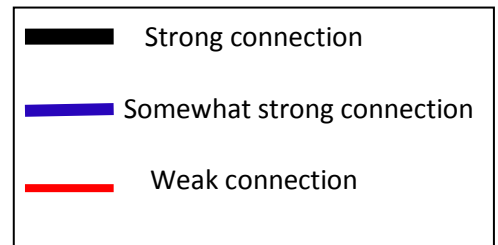
Pastoral Union symboled as red up triangle, keeps weak connections to Rahad scheme administration and no connections to Farmers' Union, however, the union has strong connections with finance institutions in the area

6.2.16 Women's Union
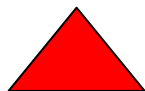
The Women's Union has a strong relationship with the El Fau locality; the Women's Union representative meets executives of the locality monthly to report activities of the union (see figure 47 to study Women's Union's connections). We know that the Women's Union can ask for financial support from the locality for implementing some activities. The locality also

links the Women's Union in the El Fau locality with the state union in Gedarif or in the center Khartoum, especially in informing of training and workshops events. The Women's Union coordinates micro-finance projects with Saving and Social Development Bank for women's associations within the scheme area including working staff women in the El Fau locality.

About 10 associations within the scheme were established in October 2010, 40 (memberships per association). The bank would finance construction materials for building houses, refrigerators, animals, and commodities. The value of the financing is 50,000 Sudanese pounds. The Women's Union is middle contact between women's associations and the bank."

The office of social welfare at the El Fau locality facilitates registration and administration of these associations with the Women's Union. Moreover, the Women's Union actor comments that executives in the El Fau locality encourage her work with women (interview 60, paragraphs 8, 7.21; interview 75, paragraphs 35, 37). The Women's Union is somewhat strongly connected with Zakat Dewan; the Women's Union representative meets with the manager of Zakat Dewan twice a year or according to their need in order to discuss with him ways of finding financial support for women.

Additionally, the Women's Union has a representative in Zakat Dewan committees in villages. According to the head of the Women's Union in El Fau, this membership is only valid in documents. Women are not practically participating (interview 60, paragraphs 48, 49; interview 8, paragraph 15). The Women's Union has a strong relationship with the Savings and Saving and Social Development Bank. She would meet staff of micro-finance projects in the bank almost weekly to discuss with them the running and financing of micro-projects. We understood that this sort of connection between the Women's Union and the Savings and Saving and Social Development Bank is new and has been lately initiated as a result of new women's associations; therefore, we decided to grade this connection as somewhat strong (interview 60, paragraph 38; interview 77, paragraph 31). The Women's Union has weak connections with the Ministry of Agriculture. The actor has no official work with the ministry, but the Women's Union representative often meets and discusses with staff of Ministry of Agriculture on issues related to women development in the area (e.g. encouraging the actor to establish women's associations). The researcher decided to score the Women's Union's relationship with the Ministry of Agriculture as weak (interview 60, paragraph 8). The Women's Union has only a political relationship with the Pastoral Union, as both actors meet during political meetings of the ruling party in the locality. Therefore, in our opinion both actors are weakly related (interview 60, paragraph 30). The Women's Union has no official connection with the Rahad scheme administration, Rahad research station (the head of

the research station had personally supported some Women's Union activities), Ministry of Livestock , Irrigation Administration, Agricultural Bank (Women's Union is considering going for financial support from the Agricultural Bank), National Forest Corporation, Agricultural School (there is only a personal relationship, as both actors live in the same village), Farmers' Union, and Health Administration (interview 60, paragraphs 4, 6, 15, 25, 28, 32, 42, 51, 54).
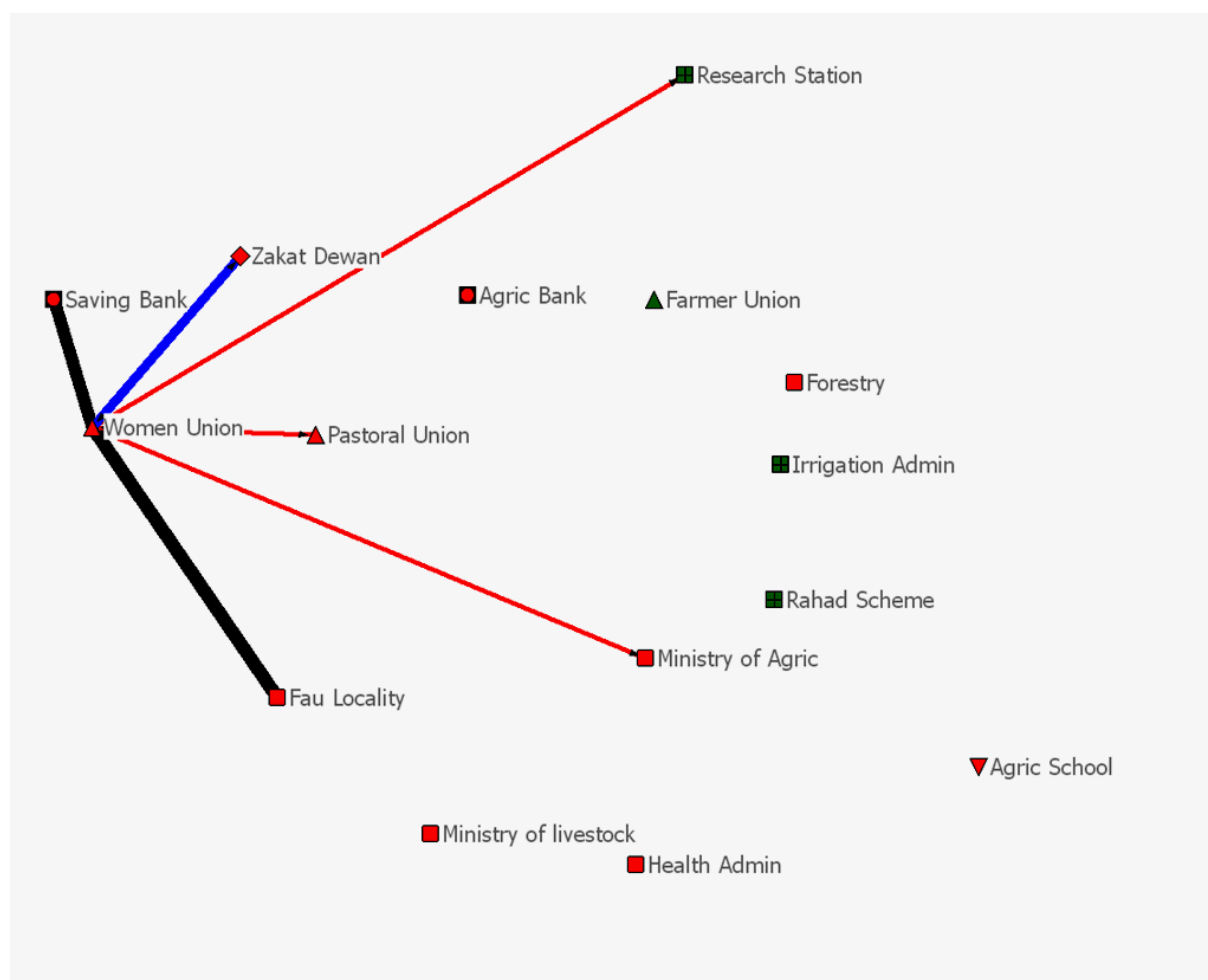
Figure 47: Women's Union valued connections
Source field data: 2010
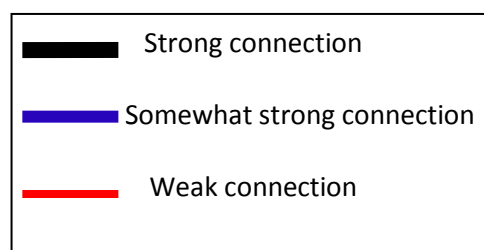
Women's Union symboled as red down triangle has strong connections to Saving and Social Development Bank and El Fau locality excutive office, However, the union is peripheral in the network of Rahad scheme administration and keeps irregular connections with few actors such as Ministry of Agriculture

6.2.17 Summary of Strong connections in the Rahad scheme

Strong connections in the Rahad scheme administration network can be noticed at three levels, the Rahad scheme administration level, El Fau locality level, and financial institutions level.

1- The Rahad scheme administration is strongly connected with the Rahad research station, Irrigation Administration, National Forest Corporation, and Farmers' Union.

2- El Fau locality is strongly connected with the Ministry of Livestock, Ministry of Agriculture, Health Administration, and Zakat Dewan.

3- The Sudanese Agricultural Bank is strongly connected with the Farmers' Union.

4- The Savings and Saving and Social Development Bank is strongly connected with the Women's Union and Pastoral Union.

5- The Farmers' Union and Pastoral Union are strongly connected but negatively related to each other.

6- The Health Administration and Ministry of Livestock also negatively related because they lack proper coordination with each other.
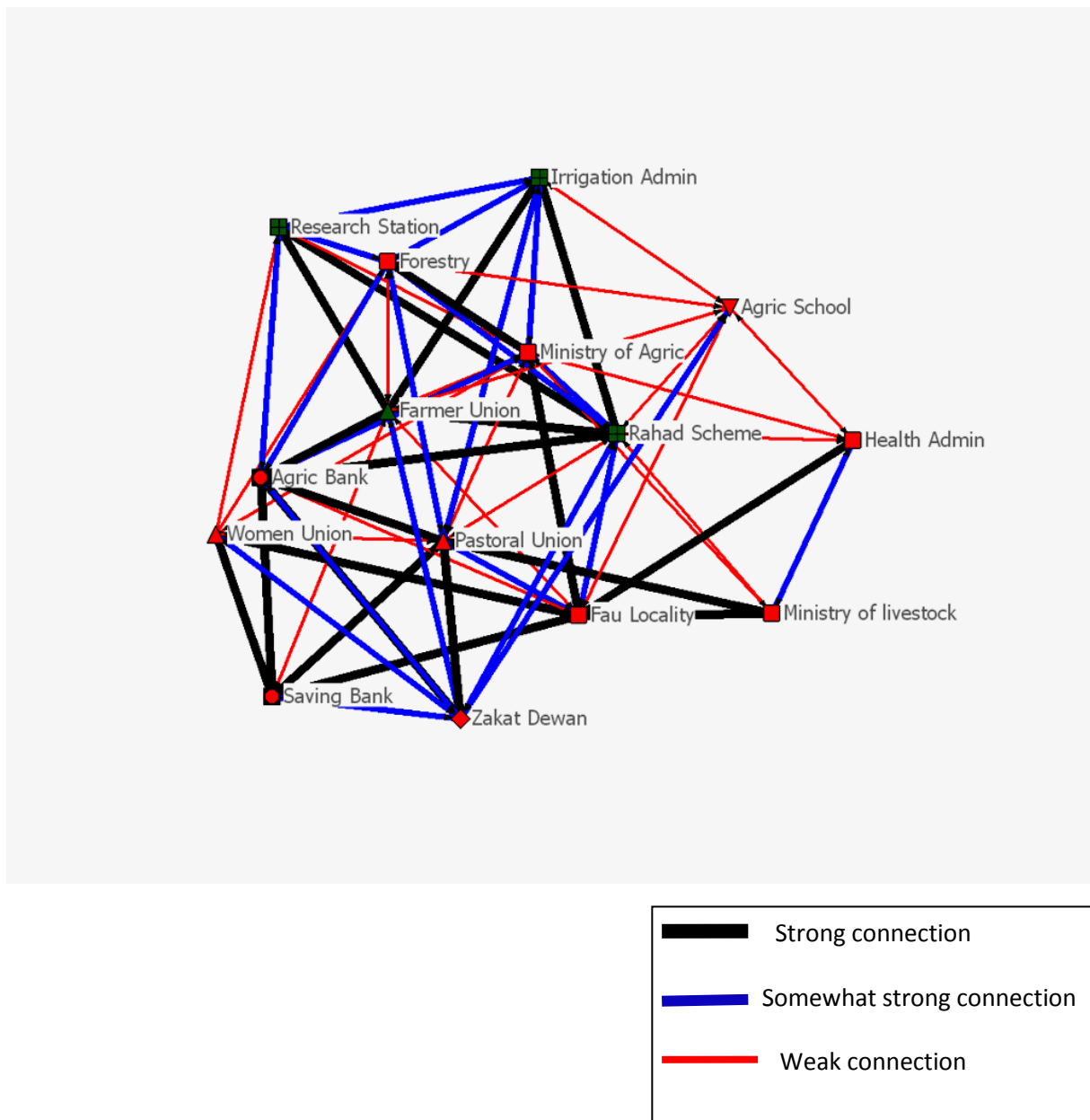
Figure 48: Valued connections between actors at the Rahad scheme level
Source: field data 2010

Black lines show strongly related actors; actors would meet monthly to discuss specific working issues. Blue lines indicate somewhat strongly related actors, which mean actors meet twice a year. Finally red lines indicate weakly related actors, where actors meet irregularly or without a schedule to discuss work.

6.3 Special connections in networks at the Rahad scheme level

Following the research concern of inquiring about the structure of relations among actors at the Rahad scheme level, weak ties in the network were identified (see figure 49). In this context every actor was asked to mention which of the 15 actors he/she talked to, how often

these talks took place, and what the content of those discussions or talks were. Weak ties in the network at the Rahad scheme level mean actors have no regular meetings to discuss work issues. Therefore, actors might contact each other once a year or every two years; sometimes actors would not remember when was the last time they met to discuss or do work together. The red lines in these connections such as the ones between the Agricultural School and the Rahad scheme administration, Irrigation Administration, Health Administration, National Forest Corporation, Farmers' Union, El Fau locality, and Agricultural Bank mean that there are irregular connections at work with the Agricultural School and the mentioned actors. In this context, the Women's Union is also the actor who has the fewest work connections with the rest of the actors. In addition to its weak connections to the Ministry of Agriculture, there is irregular contact between the Women's Union and the ministry in regards to discussions on development projects for women within the scheme area and the establishment of women's associations. Grey connections between the Ministry of Livestock and the Health Administration mean there is an irregularity of contacts in work besides negative views held by actors of each other's work. The same can be said about the Farmers' Union and Pastoral Union. Both actors negatively criticize each others' ideas and activities for farming and livestock keeping within the scheme. This type of connection is viewed as strong connection with negative viewing

Black lines in this network of weak connections mean both actors share the same political ideas and conduct political activities or meetings together but irregularly contact each other in regards to their official work on farming and livestock keeping. Examples of these connections are the ones found between Zakat Dewan and the Farmers' Union, and the Farmers' Union and the El Fau locality.

The El Fau Agricultural School, Health Administration, and Women's Union, are peripheral in the network at the Rahad scheme level; they have fewer connections within the network of the scheme but are connected with other circles outside the Rahad scheme network (RAINI et al. 2005; SPIELMAN et al. 2010).

The Women's Union, El Fau Agricultural School, and Health Administration are weakly connected with the rest of the actors in the Rahad scheme Consistent with literature findings, some of the mentioned actors have outside connections (GRANOVETTER 1973; RAINI et al. 2005; SPIELMAN et al. 2010). The Women's Union is a volunteer women's association working to improve the economic and social situation for women in the area. It is also connected with the Federal Women's Union in the capital. The Women's Union in the scheme area is connected to other women's groups (i.e. workers on farms, Quran learning groups);

however, no present extension programs are being directed at those groups by the Rahad scheme administration or Ministry of Agriculture in the area. The El Fau Agricultural School represents a formal education on farming in the area (chapter 5). Unfortunately there is no regular communication to coordinate with the Rahad scheme, Agricultural Bank, National National Forest CorporationCorporation, Irrigation Administration, or Farmers' Union.

The coordination was expressed by the school as training students, supporting demonstrational equipment, giving the school students a chance to train farmers (interview 10, paragraphs 6, 9). In reality, the El Fau Agricultural School is not getting any support to train students in agricultural practices, but students who study in the school are the sons of farmers in the area with well-organized and equipped training in farming. In the long run, students can add further farming knowledge of innovations in the Rahad scheme.

The Health Administration does not exchange information on issues regarding livestock keeping with either the Pastoral Union or Farmers' Union; however, the Health Administration is a source on environmental health in the area (connected to the state Ministry of Health in Gedarif through the El Fau locality). Building connections between the Ministry of Health and farmers' organizations in the Rahad scheme can improve chances for innovation performance in the scheme .The research station and Ministry of Livestockare also among the actors who are weakly connected to others. The connection between the research station and the Rahad scheme has existed since the establishment of the scheme. That connection materialized in the technical follow-up for farming by a technical committee formed from researchers of the reserch station and staff members from the scheme. According to the actor of the station, that connection deteriorated in parallel to the deterioration of the Rahad scheme (i.e. deterioration of productivity due to irregularity of maintenance operations and delays in input funding). However, the research station of Rahad is a source of agricultural information because it is connected to the National Research Station of Sudan (BEINTEMA et al. 1995; ARC 2007). Research stations are important stakeholders for developing policies and planning for agriculture in the whole country (ARC 2007). Moreover, during data collection we found that the Rahad research station itself had no component of sociological research within its section. Socioeconomic and extension research departments are only found at the headquarters in Medani (interview 3, paragraph 12) (ARC 2007). By creating such a department in the Rahad research station, it can bring new insights to the social sphere of communities benefiting from the scheme and therefore further integration of communities into agricultural innovations of the scheme The Ministry of Livestockalso has weak connections to the rest of the actors. Actually the Rahad scheme had a department of

investment in livestock with its own technical staff. The Ministry of Livestockis not contacted for information or consultation on livestock issues by the scheme (consultation on curing diseases or animal production activities) (interview 70, paragraph 3). However, the Ministry of Livestockis connected with the animal research center in Gedarif state (interview 15, paragraph 15). Building connections between the Ministry of Livestockand the animal production department in the Rahad scheme can merge and integrate activities on animal production practiced either by the scheme or the ministry

Figure 49: Special connections between actors at the Rahad scheme level
Source: field data 2010

The graph shows weak connections within actors in the formal Rahad scheme network. Red lines indicate the weak connections, blue lines weak but personal connections such as friendships, as in the case of actors of the National Forest Corporation and Pastoral Union. Grey lines mean strong connection with negative relationships such as between the Pastoral Union and Farmers' between Health Administration and Ministry of Livestock. Black lines mean political relationships with the existence of weak connections

6.4 Connection of actors at the village level in the Rahad scheme

Connections between actors at the village level could be connections or ties to pursue different social activities, funerals, wedding, illiteracy classes, religious classes, cleaning villages, sports, donation of finances for rehabilitation of schools, health centers, etc. Such connections in a network have been defined as social exchange networks (CONWAY and STEWARD 1998). Contacts between actors at the village level could be farming contacts such as farm work, sharing information on farming, training on farming, etc. This type of connection in a network has been defined as a discrete connection (BORGATTI 2009) the connections that matter in this research study are those between actors in farming activities or the discrete connections(see figure50 to note weak and strong connections in farmingand livestock keeping between actors at villages level). Hence if actors are connected by farming besides connections due to other social activities, they are considered strongly connected actors. If farming connections do not exist between actors, they are considered weakly connected. This way of identifying weakness and strength in connections could be unfamiliar in network analysis. However in reviewed literature, the identification of weak and strong ties was differently managed, and scholars used different measures to decide on the ties (GRANOVETTER 1983). For example, weak ties were decided upon based on frequency of contact between men and women searching for jobs by GRANOVETTER (1973). ERICKSON and YANCEY (1980) cited by (GANOVETTER 1983) studied respondents who had significant help from other persons in finding jobs. In this study, if the person was a relative or friend of the respondent, the tie was considered strong. If the person was an acquaintance, the tie was considered weak In FRIEDKIN (1980) cited by (GANOVETTER 1983), while studying spread of scientific ideas in seven science departments in an American University, two scientists were said to have weak ties if one reported having talked to the other about current work, but the other made no such report or did not do the same. (When both scientists talked to each other about current work, the tie was defined as strong, accordingly; connections in farming determine the weakness or strength of the ties between actors at the village level in this research. In this study, actors at the village level in the Rahad scheme are public committees, womens' associations, youth clubs, sheikhs or local leaders, farmers' committees, and individual farmers. The connections in farming and livestock keeping between these actors are discussed according to Granovetter's theory of strength of weak ties.

6.4.1 Public committees - connections

Public committees – youth clubs connection
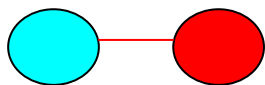
The interviewed public committee members think that youth clubs are the representatives of youth activities in villages, and the public committees organize the work or activities of youth in the clubs (interview 28, paragraph 12). Public committees inform the youth about activities that need to be done for the villages such as a cleaning campaign etc. (interview 38, paragraphs 12-14).

Youth club activities in villages are mainly forming football teams; sometimes they conduct campaigns to clean the villages, but they have no regular or specific activities on farming.

One interviewed youth club member was also a member of the public committee. He thinks the public committee represents the authority in the village, but according to him few youth in his village are really active and communicate with public committees. He expects youth to be more organized and request the public committee to give them what they need (interview 42, paragraph 19). According to information given, the connections between the public committees and youth clubs are mainly to organize youth social sports activities but not for farming.

Youth and public committees officially follow the El Fau locality; youth clubs consider public committees to be facilitators of youth clubs in the locality (interview 42, paragraphs 16-18). Youth club members admitted that youth activities such as football games are organized by the locality through public committees (interview 41, paragraph 10).

In spite of that, youth clubs do not get regular financial support from the locality, and some interviewed youth admitted that clubs have been built by youth from their own finances (interview 31, paragraph 18; interview 39, paragraph 12; interview 38, paragraph 62). Youth club members think the funds provided by farmers' committees or the locality to the villages are used to finance other services such as the health center and schools, and youth activities are not a priority (interview 42, paragraphs 11-12). Some interviewed youth club members expressed their desire to be members of village committees such as farmers' committees and public committees, meaning that youth are looking to build links with public committees and farmers' committees (WOOLCOCK and NARAYAN 2000) (interview 31, paragraph 52). Therefore, the connection of youth clubs to public committees in social issues exists, but there is a weak connection to farming

Public committees – sheikhs' connection
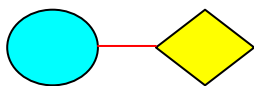
Sheikhs can become members of public committees and be assigned the duties in these committees (interview 7, paragraph 34).

One interviewed public committee member thinks the authority of local sheikhs was invented by the English in order to enhance tribes, because leadership was inherited within the tribe. However, public committees are elected and can represent everyone regardless of their tribes. Some sheikhs join public committees; their people will vote for them and can enter the public committee, so now they are more developed (interview 78, paragraphs 19-20). Other interviewed members of the public committee had the same opinion and added that duties of the public committee members and tribal leaders are generally the same, but duties carried out by the public committee itself had developed; they became control and services, and now they have planning responsibilities. Members of public committees are supposed to plan for schooling, water, and health services in villages. In his view, the village sheikh was responsible for bringing lawbreakers to court or judging, but now the duties of public committees are developed according to the needs of the people (interview 28, paragraph 6). Therefore, public committees are connected to local sheikhs in social issues.

By interviewing some tribal leaders (sheikhs) in villages within the Rahad scheme, the researcher cross-checked whether sheikhs are members of public committees and perform the duties of these committees (interview 29, paragraph 95; interview 36, paragraph16; interview 35, paragraph 92).

According to sheikhs, their membership in public committees enabled them to practice their experience and wisdom to solve complicated issues in villages. However, sheikhs think they are restricted by the authority tailored by the locality. Meanwhile their accumulated experience in the area can be more relevant to livestock keeping and farming within the area. According to one local leader who joined a public committee, *"Sheikhs are gone with the native administration. Yes, we worked to establish villages, but now the administration is in the hands of the public committee. I do not work according to my old position, but if there are problems or a critical situation, I solve it; the sheikh solves it. The sheikh is there because he is someone who has old experience. He can solve the problems more effectively using the experience he got in the old days"* (interview 35, paragraph 92).

Another sheikh who joined a public committee mentioned, *"Ok yes, I am a member of public committees, but let me tell you something, my daughter. It is said, 'two captains will sink the*

ship.' Now this integration of the local administration with public committees is not efficient because they do not know how the problems outside the village should be solved. Maybe they can work within the village, but we are wiser than they. If this locality went back to the decision of sheikhs, no problems would exist" (interview 34, paragraph 16).

Therefore, it can be concluded that although the connection of sheikhs to the public committee exists (the negative comments that have been given by local leaders to their connection with public committees made this connection weak regarding exchange of information on farming.

Public committees – farmers' committees' connection
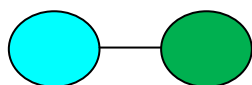
An interesting reality we found was that some members of public committees are the same members in farmers' committee (interview 20, paragraph 27). Interviewed farmers' committee members in village 3 were both members in public committees at the same time. Public committees also represent the political views of the locality, since the locality is described as the political source for the area. *"We are the main political source in the area, and the mayor heads us"* (interview 7, paragraph 12). Therefore, the public committees are an influencing actor in the El Fau locality and can influence the decisions made by farmers' committees, especially in the case of donations by farmers from farm crops to support the social services in the villages.

Members of farmers' committees as mentioned before can be the same members of public committees. The researcher argues that public committees can use their authority to secure the financing of social services by making use of money collected by farmers' committees from farmers.

One public committee / farmers' committee member in village 3 mentioned, *"We used to deduct from farmers' production in cotton to support services, and we used to tell the farmers, so we constructed 13 classes in school B for boys, and we supported students from the area who entered universities by providing them hostels"* (interview 20, paragraph 30).

In regards to farmers' committees' and public committees' connections, the Farmers' Union actor thinks the farmers' committee affect the economic situation in the villages, while the public committees are political bodies. However, public committees cannot be distant from farmers. They are a mixture of farmers, and that is why there is merging between farmers' committees and public committees (interview 11, paragraph 12). As a result, the connection of farmers' committees to public committees in farming is a strong connection (However,

since public committees are politically empowered actors in the Rahad scheme, there could be a challenge that public committees might control other actors in order to put a political spin on activities run within the Rahad scheme (KREBS and HOLLEY 2004).

Public committees – farmers' connection
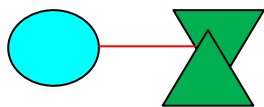
The researcher first explains the opinions of the two interviewed public committees on farming within the Rahad scheme. The first interviewed public committee member evaluates the Rahad scheme as a scheme that was established for relief. In the beginning, only poor people were the ones who had an incentive to migrate to the scheme area. The rich who have more cattle did not like to come, except for only a few (interview 78, paragraphs 5, 6). He continued that cotton planting in the project as a cash crop helped improve social services within the project such as electricity and schools because a small percentage of the cotton harvest was deducted from farmers (interview 78, paragraphs 5, 6). He added that withdrawing cotton planting in the Rahad scheme had negatively affected these services (interview 78, paragraphs 5, 6). The second public committee member expressed that the Rahad scheme created a chance for tenants who were pastoralists to keep their animals, because there used to be fallow spaces within the farms used as grazing areas. After harvest, farmers would also direct their animals to browse the crop residues (interview 28, paragraphs 24, 26). One interviewed farmer who is a member of a public committee expressed the relationship between people and the public committee as an authorizing one. *"People listen to us and do what we ask them"* (interview 37, paragraph 28). Public committee members' opinion on farming indicates the closeness of public committees to farming issues.

Interviewed farmers recognize the role of public committees in solving problems in villages, securing schooling for increasing students, providing potable drinking water, and providing land for housing within a village. However, farmers did not mention public committees in issues related to information exchange on farming (interview 84, paragraphs 26-29; interview 37, paragraphs 25-29). Moreover, some farmers tend to be cautious or hesitant to disclose information about the public committee (interview 24, paragraph 45). The reason could be because the public committee is the representative of the government in the villages. The connection between farmers and public committees does exist, but it is mainly in issues related to social services in villages more than in farming. Therefore, the connection is considered a weak connection

Public committees – women's association connection
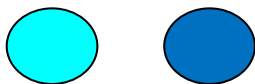
The interviewed public committee members mentioned no connections with women's associations, but rather they consider the Women's Union branches in villages as the representatives of women's activities and thus in their opinion, women's associations are parts of the Women's Union (interview 28, paragraph 16).

Women's associations at the village level think the public committees have no funds, and these associations do not get noticeable assistance from the locality. They conduct their activities using their own finances (interview 30, paragraphs 47-48; interview 48, paragraph 45).

Women's association gets no support, especially from public committees One officially registered women's association mentioned more connections to public committees and security forces in their work such as travelling between villages to conduct training for association members (interview 33, paragraphs 29-31). Other women's associations explained that even when approaching public committees for issues such as registration of their association, they would not help, and thus the women had to approach the locality by themselves. Therefore, a connection between women's associations and public committees does not exist.

6.4.2 Women's association connections

Women's associations - youth clubs connection
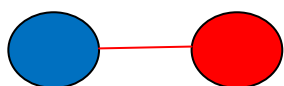
There is connection between women's associations and youth associations, but it depends on the initiative and seeking of help from the women's side (interview 48, paragraph 71; interview 49, paragraph 69). One women's association argued that they know that youth clubs are involved in cleaning campaigns of villages but that certain youth clubs did not clean their suburb (interview 65, paragraph 71). However, in some activities of women's associations, the youth assist them (interview 30, paragraph 29). An example was given that the youth club and women's association in one village participated in the same revolving fund.

According to an interviewed youth club member, he said, *"We do not support these women's associations with a thing unless they ask us for any help. Of course they can ask us for support, but they manage their own activities"* (interview 39, paragraph 24). Another youth club member mentioned, *"We are not connected with them (women's association) through*

our identity as youth, but we as individuals meet and help women in social events, but if we the youth and the women's associations cooperate in a collective activity in the future, I think women can make use of us more than we make use of them, but now there is a big gap between youth and women activitie" (interview 42, paragraph 24).

The connection of women's associations to youth clubs in social issues exists. However, the connection between women's associations and youth clubs in farming is weak because there is no communication between both actors that include farming

Women's associations - sheikhs' connection
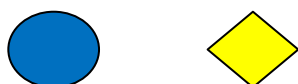
Some women's associations are more connected to religious men in villages than they are connected to local leaders (interview 30, paragraph 34; interview 49, paragraph 134; interview 48, paragraph 18). Religious men in villages are those who teach the Quran to the members of women's associations.

The interviewed sheikh recognized the women's association activities of the revolving fund and Quran learning in the villages. However, the sheikh mentioned that women do not seek help from sheikhs in conducting these activities, so there is no connection between sheikhs and women's associations in the villages (interview 37, paragraph 31; interview 32, paragraph 13)

Women's associations – farmers' committees' connection

Women's associations in the Rahad scheme do not get any support from the farmers' committees. Instead, women of these associations depend on their own funding to run activities with revolving funds or to gather to learn the Quran (interview 33, paragraph 27; interview 30, paragraphs 30-31; interview 48, paragraphs 44-45).

One interviewed farmers' committee member recognized the activities of the women's association in his village but showed no relationship with them (interview 18, paragraph 83). Another interviewed member of the farmers' committee mixed or confused the women's associations and the Women's Union and showed no interest in knowing about women's activities in the village (interview 20, paragraph 34). These opinions indicate no connection between the women's associations and farmers' committees in the Rahad scheme

Women's associations – farmers' connection

We noticed that during interviews mentioning going to farms was always ironically replied to during interviews, especially among women's associations within tenants suburbs, who expressed that they do not go to farms but their men do (interview 65, paragraphs 17, 18; interview 49, paragraph 59). Women mentioned that their duties in the house and looking after children would not allow them to go to farms (interview 49, paragraph 61). However, women would look after small animals inside the house or look after animals when brought home by a shepherd from the grazing areas (interview 65, paragraph 24). In spite of this, women knew and heard about the growing season: the type of crops grown and whether the grown crops are producing or failing (interview 49, paragraphs 48-50).

It is obvious that women within the Rahad scheme still practice traditional gender roles instead of working with the Women's Union, which is working to empower women politically (RAVAZI and MILLER 1995; MOSER 1989).

However, women also mentioned that they do not think they need to get farms on their own. Farms are for their sons and husbands; they just go and help them. However, women in some discussions expressed more need for assistance in their social work of illiteracy classes and Quran lessons (interview 48, paragraph 25).

The officially registered women's association in village 10 that had members working on farms managed to contact the village 10 extensionist, who helped them share 0.8 hectares and plant it with sweet potatoes. According to the interviewed association, the women succeed in having good produce from farming the land, but they could not continue this activity because the responsible extensionist was moved to another section of the scheme (interview 33, paragraph 59).

Women's associations can be said to be unconnected to farming activities or the major decisions in farms: what crops to grow in which space and how produce of the farm should be managed. However, ELLIS (2000) argued that the role of women in farming is heterogeneous and differs according to ethnicity, wealth, and level of income. The role of women in farming can also change over time when new opportunities are created in a community. For the present time, women's associations in the Rahad scheme have no connections with farming and thus to farmers. However, the connections or the relationships in the Rahad scheme can be networked by finding the relevant actors or the strategic actors those women's associations can connect to.

Farmers expressed that they either have never heard of women's activities in villages, including women's associations, or they refer to activities of the Women's Union but do not following what is going on (interview 83, paragraph 84; interview 56, paragraph 39; interview 84, paragraph 40; interview 24, paragraphs 57-58). Therefore, there is no connection between farmers and women's associations in the Rahad scheme

6.4.3 Sheikh connections

Sheikhs – farmers' committees' connection
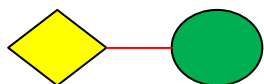
The researcher identified two cases where a local leader is a member on a farming committee (interview 57, paragraph 3; interview 59, paragraph 6). One interviewed sheikh mentioned, *"I am also a member of a farmer's committee. I solve problems according to my knowledge of people in the village here. If there are animals intruding on farms, we see who is the owner and we find out how to compensate him. The basics of problem solving or the way how decisions are made working so far, and it is according to our traditions"* (interview 57, paragraph 7). According to information in interviews, at the present time local leaders generally are not involved in major or sensitive decisions in the scheme, which was not the situation during the initial years of the Rahad scheme. Unless the local sheikh is a member of a farmers' committee, the sheikh is not involved in farming issues.

Farmer's committee members who were interviewed appreciated the sheikhs as a formal, powerful authority in the area. Moreover, the cases where sheikhs are members of farmers' committees were also positively commented on (interview 59, paragraph 6; interview 23, paragraph 53; interview 20, paragraph 32). Moreover some interviewed farmers' committee members viewed sheikhs as the ones who solve family issues or tribal problems but are not involved in farming activities unless they become members of farmers' committees, according to this theory, unless sheikhs become involved in a transaction or discrete network (CONWAY and STEWARD 1998; BORGATTI 2009) (interview 21, paragraph 37). Therefore, the researcher considers the connection of farmers' committees to sheikhs in farming to be a weak connection

Sheikhs – farmers' connection
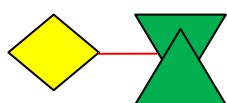
Local leaders expressed their involvement in establishing the scheme and explained how people migrated. One leader in the south of the scheme explained how the decision to migrate

to the scheme area was forced, and people did not want to come. *"Our place was wealthy Aamir, and when we came here, it deteriorated. The Rahad Agricultural Corporation closed water from it, although some people did not like to come here. They were not convinced because they already had their farmland in Bildat. Why should they come here? However, they were forced by the situation itself and later came. We stayed and planted cotton, which we learned about here. We did not know about it before"* (interview 37, paragraph 17).

Another sheikh from the northern part of the scheme area expressed the movement to the scheme positively. *"When the project started, the Awladown, who are branch of Bataheen, were moved to village 37. The Shukria and Arakeen were also moved to the same village. So the project started with very good harmony. At the time of project establishment people did not like to leave their homeland, and they called it immigration. The villages made use of the project, and even women who worked on farms made money"* (interview 36, paragraph 6).

Some interviewed local leaders were given farms within the project and got more closely engaged in farming issues. They added new information to the knowledge they already had.

"Irrigated farming is different from farming in rain areas. In irrigated farming there is a regular water source. Your irrigation is from canals, but in rain-fed farming, you prepare the land and come every now and then to see if it got rain or not. You are at its mercy" (interview 29, paragraph 44).

Some local leaders mentioned future views or ideas for farming within the area. Some of them suggested farming zea maize and sunflowers instead of sorghum because sorghum and groundnuts are of no benefit (interview 57, paragraph 43). Others expressed and evaluated that irrigated farming is now the suitable solution for their lives. *"Livestock can benefit the people who have lots of animals, but irrigated farming can benefit everyone"* (interview 35, paragraph 88).

The interviewed farmers think the authority of local sheikhs is now being over taken by public committees. They also mentioned that in villages farmers do not notice or observe any kind of activities for sheikhs in farming unless the sheikhs are involved in farmers' committees (interview 84, paragraph 36; interview 83, paragraph 78). For example, one farmer mentioned, *"My relationship with the sheikh in the village is OK, but I do not tell him my farm problems. He has no relationship with it"* (interview 24, paragraph 51). Some farmers' think even the sons of the local leaders now are not supported or surrounded by people (interview 56, paragraph 33). Others ironically have commented that the leaders of public committees now are the new sheikhs of villages (interview 84, paragraphs 31, 34).

Accordingly, the connection between local leaders and farmers on issues of farming is weak

Reviewed literature proved that local leaders can affect members of social systems to make a decision about innovations (ROGERS, 2003). Others have proved from a social network point of view that if a certain network is to flourish with new ideas, there needs to be an optimum size of a network with an optimum number of weak ties connecting actors from diverse organizations (BAER 2010). This certain network would flourish with new ideas if its actors scored high on openness to personal experience (BAER 2010). According to these assumptions, the researcher is considering local leaders in the Rahad scheme to be people with experience in farming. Therefore, including local sheikhs in the Rahad scheme network might result in an improved sharing of farming and livestock practices within the Rahad scheme.

Sheikhs – youth connection
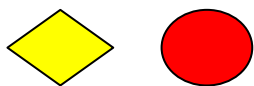
Some local leaders expressed that they do not know what is going on in youth clubs. They do not go there but they hear youth shouting during football matches! Accordingly sheikhs think the youth are more engaged with their clubs than with farms or helping their fathers. One leader mentioned that if the youth were convinced of their significance, they could have a big role in villages (interview 37, paragraphs 27, 29). Other sheikhs thought the youth would consult him on their issues, for example, they informed him about establishing their club (interview 57, paragraph 25).

Another one believes the youth do not know the *aurf* (chapter 5) and are not familiar with what local sheikhs can do and what their social role in the community is. This situation is so because the authority in the village is now the public committee. He said that during the time of the native administration (chapter 5), people used to be more affected by sheikhs and would communicate with them because they used to communicate with people whom they were serving (interview 36, paragraph 16).

Other sheikhs recognized the activities of youth such as cleaning of villages. However, the sheikh thinks that in order for youth to be more effective in villages, all sectors or actors in villages should support or help them in their work, especially the Farmers' Union and locality (interview 29, paragraphs 55-57).

Interviewed youth clubs think the leadership of local leaders (sheikhs) is something that used to be valid in the past but now public committees are the leaders in the villages (interview 41, paragraphs 7, 8; interview 42, paragraph 14). Other youth clubs expressed that the sons of local sheikhs are now members in public committees, so they still affect the community

(interview 31, paragraph 27). A third youth club member mentioned good social connections to the sheikh in their village. *"Our village is small, and we communicate with each other. Even the sheikh participates in our work"* (interview 38, paragraph 37). The youth did not mention discussing farming issues with their sheikhs.

Based on this information, the connection between sheikhs and the youth is considered weak on social issues, but there are no connections in farming. However, the suggestion given by the local sheikh that other actors within the Rahad scheme need to support youth clubs in order to be more effective is in line with what is suggested by this thesis: that relationships and connections of actors within the Rahad scheme need to be created or strengthened by producing what is called multi hubs network model (KREBS and HOLLEY 2004).

6.4.4 Farmers connections

Youth clubs – farmers connections
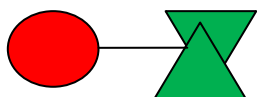
Youth declare their closeness to farmer as intracommunity ties, "the ties that give families and communities a sense of identity and common purpose" (ASTONE et al. 1999) cited by (WOOLCOCK and NARAYAN 2000). The youth consider themselves as farmers and sons of farmers who work on farms, and sometimes they join in the harvest to support their club activities (interview 31, paragraph 52; interview 42, paragraph 34), but some interviewed youth club members think they are detached and away from pastorals and farming activities (interview 38, paragraph 31;interview 42, paragraph 34).

Interviewed youth club members think that they can achieve their hopes through working in farming. However, they think that the youth generally are not listened to on farming, and that is why they leave farms to go to big cities to seek work (interview 42, paragraphs 72, 71; interview 31, paragraph 39).

Some youth have even mentioned personal experience with farming in which they failed to get any benefit due to the high cost of production and low amount of irrigation water in the scheme (interview 42, paragraph 72).

Others managed to give opinions and explain that farmers would lose the benefits from their production due to agricultural planning or policies in the country. *"When we started the farming of season, the sack was 100 SDG, but now after harvest it is 50 pounds. Where is the profit? Even in making use of strategic stores they (the government) buy it at a low price from us and sell it later at a higher price"* (interview 31, paragraph 39).

Other interviewed youth club members only explained their connection to farming activities

at a level of participating in helping poor people with harvesting (interview 38, paragraph 30). Interviewed farmers appreciate the fact that there are clubs within villages for youth; they also appreciate the activities of the clubs such as forming football teams or watching TV (interview 27, paragraph 118). Other farmers are included in youth meetings on how youth can enlarge their activities in the villages (interview 26, paragraphs 51-54). Farmers agree that the youth are distant from farming activities or distant from being involved in farming issues because working on farms is not an attractive activity for youth these days (interview 18, paragraph 53). Therefore it can be said that youth club members are looking to improve their present kinship or continuous network with farmers into more of a transaction network Therefore, the connection between youth clubs and farmers in exchanging information on farming is considered strong

Farmers' committees – youth clubs connection
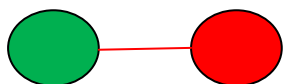
Youth clubs within the scheme area get financial support from farmers' committees to pursue their activities in the clubs. However, according to interviewed youth clubs, this support is not regular and is sometimes shifted to other services in villages (interview 42, paragraph 12; interview 31, paragraph 12).

Some farmers' committee members believed that the village cleaning and health campaign organized by the youth did not sufficiciently meets the needs of the villages, and there is more to be done from youth clubs (interview 21, paragraph 35).

Therefore, farmers' committees and youth clubs are socially connected. However, there is no connection between the two actors in implementing faming activities. Therefore, it can be considered that the connection of youth clubs to farmers' committees in farming within the scheme is a weak connection.

According to the interviewed youth clubs members, the youth expressed a need to participate in organizations such as farmers' committees and public committees. *"People here are our relatives, uncles and grand fathers. We should not go away from them. In end they will listen to us. The youth should go into farmers' committee and public committees; youth here are originally farmers who possess farms"* (interview 31, paragraph 52).

In this regard, youth clubs actually want to develop their intracommunity ties to farmers, "the ties that give families and communities a sense of identity and common purpose" Youth think that they can develop their ties to farmers by strengthening their weak intracommunity ties to

farmers' committees. Strengthening the ties will give the youth access to information and ideas held by different actors in the scheme.

Farmers' committees - farmers' connection
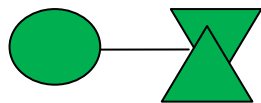
Interviewed farmers' committees mentioned that their relationships to farmers were close. Interviewed farmers' committee members mentioned that their role in the farmers' committee is to link farmers to the administration in the Rahad scheme by communicating information about the type of crops planted, the time of planting, and the spaces to plant to farmers. *"Our role is to link farmers with the administrators, or we are mediators between the farmer and the administrators, and then we deliver the extension message from the administration to the farmers"* (interview 23, paragraph 8).

Others expressed that they connect farmers to administrations in the section and the Farmers' Union. *"With the administrators in the section, we plan for farming of the season: what to plant at what time and in what space. We are close to farmers and communicate information from the section or union to them, and we follow the farming and watering"* (interview 21, paragraph 6).

Interviewed farmers' committees mentioned that their connection to farmers is also to help them seek sources of financial inputs and management of the finances (interview 21, paragraphs 8, 9; interview 21, paragraph 6). Farmers' committees mentioned that they would communicate with farmers in mosques; markets, houses, or farms (interview 21, paragraph 27).

One interviewed farmers' committee member commented negatively on farmer management of finances either delivered by the government or banks. He thinks most farmers in the Rahad scheme do not pay back costs of inputs to the financial institution because farmers think the finance was a gift from the government (interview 59, paragraph 4).

Interviewed farmers' committees commented that farmers in the Rahad scheme have enough information on how to perform irrigated farming. *"The farmer of Rahad has been a farmer since 1977, so he is saturated with farming information. The farmer himself can be an extensionist. He can do his work and does not need more information"* (interview 21, paragraph 24: interview 23, paragraph 20).

Since the interviewed farmers' committees have declared a close connection to farmers, the relationship between farmers' committees and farmers in farming issues is strong

One interviewed farmer mentioned, *"We meet as farmers and form a farmers' committee. We*

select farmers to be our committee, but they fail us" (interview 24, paragraph 89). According to him, farmers' committees are distant from farmers. He thinks this is because farmers' committee members' work is in the office. They are not connected with farmers in the field and only care to increase their social status. Others have mentioned, *"The farmers' committee in the village would go to El Fau city and meet the union. We do not know them; we cannot ask them what they do; they do not tell us what's in the meetings"* (interview 83, paragraphs 112-114).

Others have described farmers' committees as individuals who are not successful in their work, especially in planning the farmland (interview 56, paragraph 29; interview 37, paragraph 24; interview 24, paragraphs 91, 92, 94).

Another one interviewed thinks that farmers' committees will talk to farmers or instruct them only in cases of cotton farming, which is a cash crop, but not about consumption crops such as sorghum (interview 16, paragraph 20).

Some interviewed farmers think they do anything in their farm without asking the farmers' committees (interview 18, paragraph 64). They mentioned, *"The production (farmers') committee is only useful in estimating damages caused by animals on farms. Farmers would share or ask the farmers' committee about this according to the* aurf, *if someone is in the farmers' committee; it means he is from good people in the village. Therefore, we go and ask them to help. In the past we used to ask the farmers' committee about technical things such as watering crops"* (interview 18, paragraph 65).

According to the views brought by farmers, they express their relationships to the farmers' committees as irregular contacts on the farm and thus indicate that the role of farmers' committees as extensionists on the farms is not well-evaluated. Farmers also brought their opinion on the farmers' committees' involvement in decision making on farming. However, according to the approach the researcher used in analyzing weakness and strength of the ties, she would consider the relationship between farmers and the farmers' committee in farming to be strong, since both actors do communicate on farming issues.. A strong connection between farmers and farmers' committees can be useful as argued previously in fostering information exchange in the Rahad scheme, especially if new connections within the scheme are to be considered or created.

6.4.5 Summary of local connections

 1- Public committees are the main actors who influence the social issues in the villages.

 2- Farmers' committees and farmers are the main actors engaged in farming in the villages,

but farmers have expressed a negative relationship to farmers' committees.

3- Women's associations show weak connections to other actors in regards to farming, but more are engaged in the social side of the villages.

4- Youth clubs show weak connections to other actors in regards to farming but are more engaged in the social side of the villages.

5- Local sheikhs who are traditional leaders or rulers are now distant from being decisive actors in farming regardless of their previous experiences pre-settlement in the Rahad scheme.
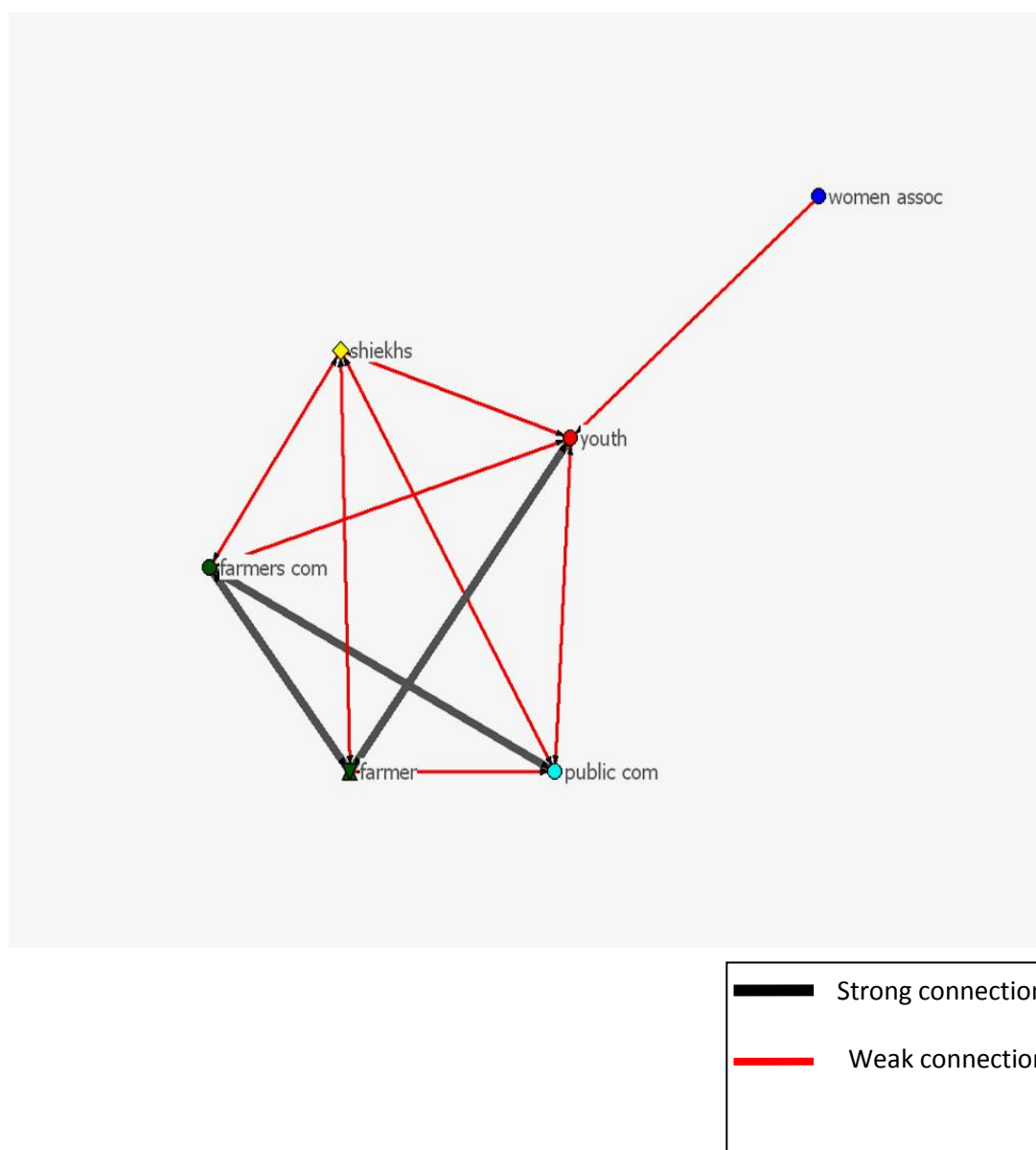
Figure 50: Connections of actors at the village level in Rahad scheme
Source: field data 2010

The figure shows village connections, black lines indicate strong connections between actors in farming; red lines indicate weak connections; women's associations are the most isolated actors at the village level.

6.4.6 Special connections in villages of Rahad scheme

In the Rahad scheme laborers who do the farmwork are settled in village suburbs and form a notable identity in the Rahad scheme (ABDEL RAHMAN 2010). One public committee leader expressed that, *"The labor community in the Rahad scheme used to be refugees who came from western Sudan in the 1980s, and we used to call their residence a* cambo *(camp). But now laborers are becoming integrated here. They come to me seeking services or official documents. They call themselves the western suburb and participate with us in occasions and ceremonies."* He further mentioned, *"Western ones in the beginning were workers on farms or shared the farms. Now they have cars and bought houses in Medani and village 40"* (interview 78, paragraphs 30-31). It's also mentioned that the labor community are represented in the village's public committee by 50%. The public committee leader in one village was someone from a western labor community (interview 28, paragraphs 7, 8). Accordingly, the labor community, or people from western Sudan, is also related to the public committee in villages of the Rahad scheme.

At first glance on labor communities, the one would notice that the laborers in the Rahad scheme have their own youth clubs, their own mosques, religious leaders, their own sheikhs, and their own women's association. This trend of having separate organiziations is self-explanatory because the settled tenants and community laborers are two completely different ethnic groups (ABDEL RAHMAN 2010). The RAAKS team considered these categories in the research study and interviewed labor associations as well. Since the researcher is not concerned with showing or comparing ethnic differences in the Rahad scheme, the opinions of laborers and settled tenants have been merged and analyzed as one category of local actors in the scheme.

However, some interesting communication patterns between the labor community and settled pastoralists are presented separately in the following sections. The community of laborers was referred to as the western suburbs; the community of settled farmers in the Rahad scheme is presented as the tenant suburbs.

How women's associations in the tenant suburbs perceive women's associations in the western suburbs

This connection means the connection of women's associations among the tenants in the Rahad scheme with women's associations in suburbs of western people in the scheme. One women's association member in the tenant suburbs expressed that the women's associations

in western suburbs are good associations because their group members agree with each other. They pay their memberships, so they get good utensils. She added that people in the western suburbs let their women work on farms, so the women can pay the associations' fees (interview 65, paragraphs 66, 68).

Another member of a women's association in the tenant suburbs perceived women from the western suburbs as the ones who work on farms, make money, and can make use of their time and make furniture for their houses (interview 49, paragraphs 56, 63,). The researchers identified one mixed women's association that had members from the western suburbs and from the tenant suburbs. This association had implemented a training workshop on seed handling for western women in Gedarif state (interview 33, paragraph 4).

On the other hand, women from the western suburbs, or labor community, said they went to farms after finishing household duties. They worked on clearing weeds and harvesting the crops (interview 48, paragraph 4). A third women's association within the western suburbs expressed that in order to be more socially beneficial, women who work on farms need to have land for their own, or they need to rent land in order to work and be a benefit to their families (interview 30, paragraphs 40, 57). Therefore, it can be said that women's associations in the western suburbs are more connected to farming activities than those in the tenant suburbs.

How sheikhs in the tenant suburbs perceive people in the western suburbs

Some interviewed sheikhs considered western communities in the Rahad scheme as people helping with the farming or work, but they increased in number and made the village crowded. Visits on social occasions such as funerals and marriages are expressed as the means for integration between western laborers and tenants.

Sheikhs think western people in Rahad are more respectful to their leaders or sheikhs; the sheikhs in western suburbs can judge people, and they accept his judgment (interview 29, paragraphs 118-122). Another interviewed sheikh in the northern part of the Rahad scheme thinks western people are the ones who first settled within *cambos* (camps) but now they enjoy social services and are getting richer in animals just as the Arabs (interview 36, paragraph 6).

How youth clubs in tenant suburbs are related to youth clubs in western suburbs

In the initial years of the scheme, laborers used the clubs that were built by the scheme administration and farmers' committees (interview 46, paragraph 9). Recently due to the

population increase, laborers built their own clubs and tended to develop their own social events at those clubs.

One youth club member in the tenant suburbs added that although the Rasheed club is for western people in the village, the Nile club, which is the oldest club for youth, is the club that represents the village in the locality (i.e. football playing) (interview 41, paragraphs 14-15).

Interviewed youth clubs from the western suburbs promised to coordinate with each other (interview 42, paragraphs 44-48). However, tenants youth clubs, and labor youth clubs showed weak connections in implementing cleaning campaigns

How youth clubs in western suburbs are related to their local leaders

Interviewed youth club members from western suburbs mentioned that they discuss with their local leaders issues and activities of their club. *"Local leaders for us, either traditional sheikhs or those in mosques, are consulted and reached if we needed to conduct any activity such as cleaning of village suburbs"* (interview 39, paragraphs 20, 22).Therefore, the connection of labor youth to their leaders is strong in social issues of their suburbs

Connection of farmers to working laborers in the western suburbs

Farmers in the Rahad scheme either rent some of their land or share crop with individuals from western suburbs (interview 23, paragraph 17). According to one farmer commenting on the farmwork of western people, those in the western suburbs are more patient in farming. He described them as people who can clean the field of weeds very effectively, which is time-consuming for farmers. According to the interviewed farmer, farmers in Rahad practiced farming in rain-fed areas where they just threw seeds and left. However, the farmer mentioned no exchange of practices in farming had taken place between the laborers and the farmers (interview 26, paragraph 30).

For connections in other social aspects, farmers mentioned that they do not have a bad relationship with laborers but do not strongly know each other, meaning that they do not know each other's families and do not visit each other regularly (interview 24, paragraph 74; interview 84, paragraph 83). Therefore, it can be concluded that relationship between farmers and laborers in the western suburbs is a strong one in farming but weak in other social relationships

6.5 Connection between actors at the Rahad scheme level and actors at the village level

Actors at the Rahad scheme level are the 15 actors who were defined by the RAAKS research, namely these actors are the El Fau locality Women's Union, Rahad scheme administration, Farmers' Union, Pastoral Union, Irrigation Administration, Rahad research station, Ministry of Livestock, Ministry of Agriculture, Health Administration, Agricultural School, Zakat Dewan, Agricultural Bank, Savings and Saving and Social Development Bank, and National Forest Corporation. Those actors are the government institutions and farmers' organizations who communicate at the administration level of the Rahad scheme.

Actors at the village level are the individuals or associations who represent the community that is meant to settle, accept, and practice farming in the irrigated Rahad scheme.

Connections between the two different levels of actors were studied based on the weakness and strength of the connection (figure57 shows connections between Rahad scheme level and villages' level). Two actors are strongly connected if they are bound together with more than one tie or relationship; if they are connected through one tie, they are considered weakly connected. If actors expressed less emotional intensity between them, they are considered weakly connected, and vise versa (GRANOVETTER 1973; BAER 2010).

Ties between actors can be financial support, exchange of information on farming, and social services within the Rahad scheme. In this chapter, the researcher discusses the transaction networks that involve discrete connections of flows of information on farming and livestock keeping between actors at the Rahad scheme level and those at the village level (CONWAY and STEWARD 1998; BORGATTI 2009).

6.5.1 Youth clubs

Youth clubs are connected with the El Fau locality and Women's Union but have no connection to the Rahad scheme administration, Farmers' Union, Pastoral Union, Irrigation Administration, Rahad research station, Ministry of Livestock, Ministry of Agriculture, Health Administration, Agricultural School, Zakat Dewan, Agricultural Bank, Savings and Saving and Social Development Bank, or the National Forest Corporation (see figure 51 to note youth clubs' connections).

Connection of youth clubs to the El Fau locality
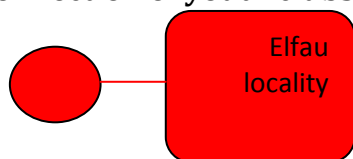
According to an actor of the El Fau locality, *"Since the law of local role in 2006 was formed, we have been entitled to serve many things, we offer work in the health sector through the health office, and we serve the youth with sports)* (interview 7, paragraph 7).

Therefore, youth clubs are connected to the locality through public committees who would inform the youth about activities needing to be done for the villages' cleaning campaigns (interview 38, paragraphs 12-14). Youth activities such as football games are also organized by the locality through public committees (interview 41, paragraph 10). However, youth in a group discussion mentioned their opinion on the locality *"The locality is an area that collects money and resources, but the youth are not benefiting from it"* (interview 31, paragraph 17). Therefore, the connection between youth clubs and the El Fau locality is through the connection of public committees and is mainly represented at formal occasions such as sports. Therefore, the connection could be evaluated as weak

Connection of youth clubs to the Women's Union
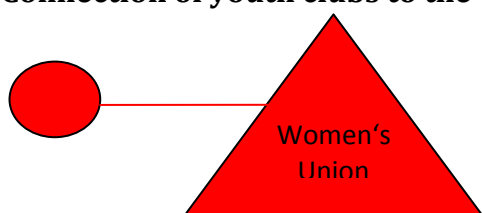
At the village level, the Women's Union could recognize youth clubs and their duties (interview 43, paragraphs 37, 40, 45). In a group discussion with the Women's Union, one women mentioned, *"In our work here with the youth, if we have meetings, the (youth) bring us services such as bringing nets and chairs. Also in cleaning and vaccination campaigns, they help us in this work and organize it"* (interview 43, paragraph 37).

In a another group discussion, the youth could recognize Women's Union activities, but they declared no connection between the activities of the Women's Union and youth clubs in the village; however, they suggested that if there were more cooperation in work, it would be better. The youth mentioned that they presently help Women's Union activities individually but not as a part of the youth club (interview 42, paragraphs 23, 24).

The codes indicate the connection between youth clubs and the Women's Union would vary from one village to another depending on the activeness of both actors in the villages. Therefore, the connection between both actors in farming issues is generally weak

Connection of youth clubs to the Health Administration

Health Administration
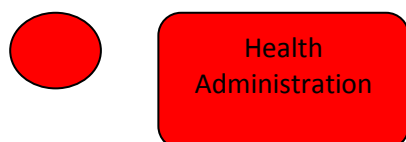
The Health Administration actor trains youth and women's associations in health issues such as malaria control and awareness of AIDS (interview 13, paragraph 35). However, this training seems to be conducted with associations mainly in head sections of the scheme or in El Fau city (RAHAD AGRCIULTURE CORPORATION 2010). Commenting on this issue, the Health Administration actor mentioned, *"Not all villages can be represented. I mainly worked with students and youth; some villages have no active youth"* (interview 13, paragraphs 37, 38).

When we interviewed youth in villages, they admitted that the health situation there is bad in spite of the existence of health staff. *"We have a health observer in the village, but health services and the environment are deteriorating. Animals are slaughtered without veterinary supervision (on land); many people here pee outside"* (interview 41, paragraph 19). However, the youth also give themselves the right and responsibility to improve health and other social services in villages. Interviewed youth clubs did not mention activities that connect them to the Health Administration. Therefore, there is no connection between the administration and the interviewed youth club in the study area.

Figure 51: Youth clubs network
Source field data: 2010

———	Weak connection
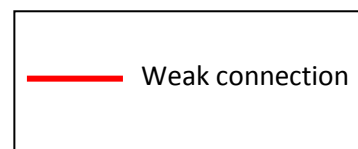
Youth clubs symboled as red circle are weakly connected to Rahad scheme administration, and El Fau locality excutive office. The youth clubs are isolated from most of actors in the study area.

How youth clubs perceive and relate to the Farmers' Union and Pastoral Union

From interviews with members of youth clubs, the RAAKS team learned that youth are interested in sports and social activities (interview 42, paragraph 5; interview 41, paragraph 11; interview 39, paragraph 12; interview 38, paragraph 6). However, we noticed that there is no specific farming or grazing activity practiced by youth clubs in the scheme area. This reality means youth groups have no discussions or connections with the Farmer's Union or Pastoral Union. Therefore, youth clubs are not involved in sensitive decisions made by the Farmers' Union (interview 12, paragraph 33; interview 38, paragraphs 22-23). Some youth clubs have strong opinions about the Farmers' Union as an organization of leadership. They

think representatives of Farmers' Union are not qualified in terms of academic education but that they are mainly selected for their political loyalty, and therefore the voice of the youth on farming is not listened to (interview 31, paragraph 44). According to interviewees, youth should be given room to participate in organizations such as the farmers' Union, public committees and Pastoral Union (interview 31, paragraph 44). *"People here are our relatives' uncles and grandfathers. We should not go away from them; in end they will listen to us. The youth should join farmers' committees and public committees; youth here are originally farmers who possess farms)* (interview 31, paragraph 52).

However, the representative of the Farmers' Union had a critical opinion of youth organizations and the types of activities initiated by them. According to him, the youth are scattered in different clubs and associations. There must be one organizing body for youth work according to agreed regulations or laws. Moreover, the youth should plan activities that respond to local needs such as adult education and hygiene education (interview 11, paragraph 24).

From the different views above, there is a need for the Farmers' Union and youth bodies to maintain regular contact and continuous connections in order to share each other's views.

Interviewed members of youth clubs had expressed that the youth in the future should engage in organizations such as the Farmers' Union, Pastoral Union, and public committees in order to be closer to the decisions made in these domains (interview 31, paragraph 52). As found by WOOLCOCK and NARAYAN (2000), the youth are looking to improve their bonding relations with farmers in order to have bridging linkages with farmers. This could be achieved through strengthening the youth's weak ties to farmers' committees and public committees

6.5.2 Women's associations

Women's associations are connected to the Women's Union and the Savings and Saving and Social Development Bank, but they have no connection to the Irrigation Administration, Rahad research station, National Forest Corporation, Ministry of Livestock, Ministry of Agriculture, Zakat Dewan, Pastoral Union, Farmers' Union, Agricultural School, Agricultural Bank, Rahad scheme administration, Health Administration, or El Fau locality, (figure 52 shows women's associations' connections)

Women's association connections to the Savings and Saving and Social Development Bank
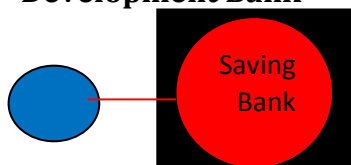
The Savings and Saving and Social Development Bank in El Fau locality finances either individual's micro-projects or groups' micro-projects of farming and animal raising (interview 4, paragraph 31). According to the actor, financing through groups is easier to manage because they can guarantee payback or receive payment (interview 4, paragraph 42).

Most of the associations financed are pastoral associations and women's associations; there are around seven pastoral associations and only one women's association for working women called Amna Eltyeb (interview 4, paragraph 53). The Saving and Social Development Bank actor aims to have 60% of finance projects go to women, because women are more affected by poverty (interview 4, paragraph 53).

Due to a lack of awareness of financing through projects and a lack of information on the market (interview 4, paragraph 84), some projects run by the associations are failing. *"The problem is that local people understand the financed project as relief but not as money to develop them* (interview 4, paragraph 88).

According to results from interviews with women's associations, we found that only one such association contacted the bank to get micro-projects financed for farming and animals. However, the association could not continue the financing process because it was asked to provide a guarantee of 20 million from the locality. According to the women's representative, *"The locality would not give us the 20 million, and I cannot guarantee all of them, so we dropped the project"* (interview 33, paragraph 65).

Some women's associations were not aware of micro-finance projects held by the bank, for example, in a group discussion, when RAAKS asked whether members of the association knew about micro-finance projects offered by the Savings and Saving and Social Development Bank, they found that not all women in the association knew about them (interview 48, paragraph 41). Therefore, information about activities of the bank is not equally shared among women, though many ideas of micro-finance projects had been expressed by women in group discussions.

The Saving and Social Development Bank actor thinks the community needs awareness on handling micro-projects, and awareness is acquired from society; however, his institution can bring the service (interview 4, paragraph 88).

The Saving and Social Development Bank actor suggested actors such as the locality can help increase awareness of handling micro-projects by conducting workshops and seminars, especially for agents or associations (interview 4, paragraph 56). The connection between the women's associations and the Savings and Saving and Social Development Bank existed with one women's association, moreover information and awareness of the bank's activities is not known or shared by all women in the associations. Therefore, the women's associations and Saving and Social Development Bank are weakly connected together .From other results, we found that the Saving and Social Development Bank is somewhat strongly connected with the El Fau locality; both actors meet once monthly to discuss micro-finance projects run by working staff in the locality (interview 77, paragraph 15; interview 75, paragraph 45). Therefore, the suggestion given by the Savings and Saving and Social Development Bank actor that the locality can enhance the awareness of local people on micro-finance projects gives the El Fau locality the role of being a local bridge However; women's associations have no connection to the locality unless they are officially registered. As a state of the art, the researcher suggests mapping the Rahad scheme actors and discussing this mapping so that actors can understand their networks of contacts and with whom actors can share relationships and mutual benefits Within women's associations there has been no trend to approach farming activities for women (interview 30, paragraph 57; interview 48, paragraph 25). There is an exception of one women's association that sent some members to Gedarif state to get training on seeds.

Therefore, there is no connection between the Rahad scheme and farming activities of women's associations. In this regard, the researcher suggests that the extension department in the Rahad scheme needs to map activities of different actors in the scheme area and then provide direction to women's associations in order to form better connections and networking to perform their activities in the area (KREBS and HOLLEY 2004).

Connection of women's associations to the Women's Union
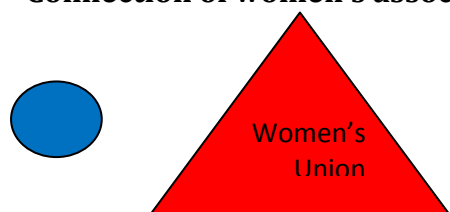
The Women's Union representative expressed that the union's relationship with women's associations in villages is to borrow or use some belongings of those groups *"For us, the union, if there is a political meeting, we go and take or borrow the utensils from the groups, and then we pay the executive incentives"* (interview 8, parsgraph 8).

Women's associations were asked whether they coordinate with the Women's Union. One women's association considers their groups to be independent from the Women's Union *"It is good that we gather and read the Quran. In the election time, they came (Women's Union) and promised us many things, but they just came to gain support from us, and then we saw nothing"* (interview 48, paragraph 56).

In other cases, the Women's Union and women's associations have contact with each other. One women's association mentioned coordinating with the Women's Union and used an example of religious occasions *"On the religious occasion of the Badr battle, we met with the Women's Union and celebrated, but usually we have the development activities we work on"* (interview 33, paragraph 44).

The Women's Union managed to contact the Saving and Social Development Bank in El Fau to finance some registered women's associations. The aim of the financing is to increase women's income through projects of animal raising and small trading enterprises (interview 60, paragraphs 8, 38). This registration took place in October 2011 during the second field trip. Unfortunately, the RAAKS team has no information about whether any of the interviewed women's association had been financed by such projects through the Women's Union. Therefore, it cannot be judged whether women's associations coordinate with the Women's Union in microfinance projects on farming and animal keeping However, joint implementation of activities such as political or religious meetings sometimes exists between the Women's Union and women's associations (SWGU 2010). Ties between the Women's Union and women's associations in the Rahad scheme cannot be directly worked out; most associations interviewed had a sense of independence from the Women's Union activities, while the Women's Union expressed closer connections and had sense of ownership over the women's associations. Moreover, other interviewed actors refer to women's activities in villages as Women's Union activities (see page 196). This researcher has varying opinions on which category women's associations and the Women's Union relationships can fall into.
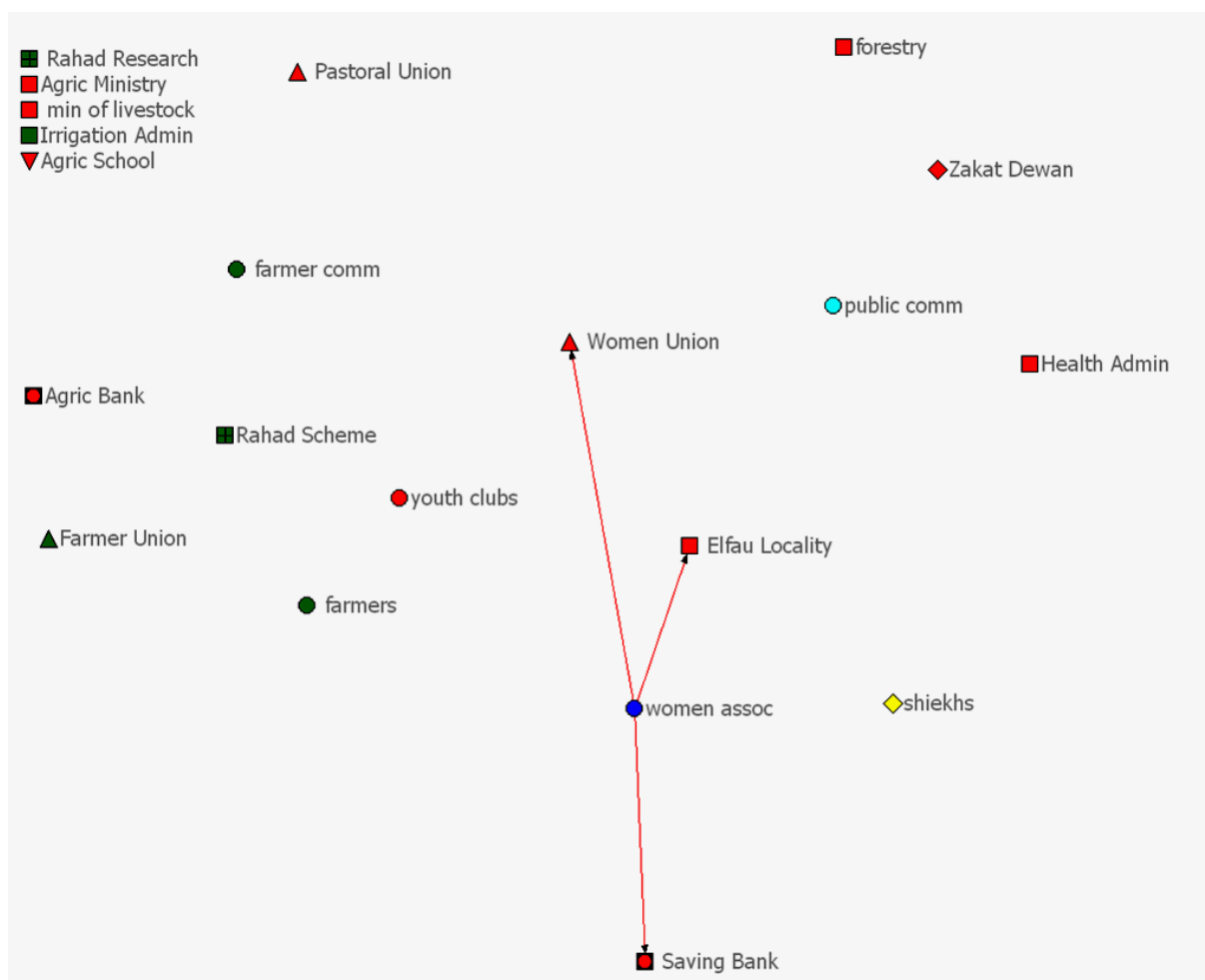
Figure 52: Women's associations' network
Source: field data 2010
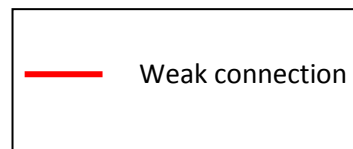
——	Weak connection

Women's associations symboled as blue circle perform weak connections to El Fau locality and Saving and Social Development Bank

6.5.3 Local leaders / sheikhs

Local leaders or sheikhs are connected with the locality. Sheikhs have no connection with the Rahad research station, Ministry of Agriculture, Ministry of Livestock, Irrigation Administration, National Forest Corporation, Health Administration, Farmers' Union, Pastoral Union, Zakat Dewan, Women's Union, Agricultural School , Savings and Saving and Social Development Bank, or Agricultural Bank (see figure 53 to note shiekhs' connections).

Connections of sheikhs to the El Fau locality

El Fau locality
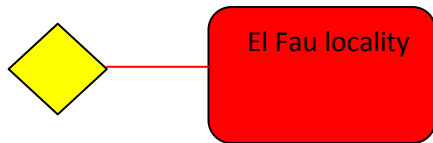
The locality is responsible for officially appointing local leaders/sheikhs, who are suggested by their tribes (interview 7, paragraph 34).

The present appointment of local leaders/sheikhs goes like this: the tribe meets and nominates someone to be the Omda. Then a letter is released by the tribe and brought to the locality. The locality will appoint people to survey the candidate Omda, they will inquire about his ethics, his loyalty to political parties, whether he was involved in previous crimes, or any other misbehavior (interview 7, paragraph 34).

The locality gets involved in the process of appointing sheikhs according to the act of local ruling (2006). In this act the local administration as a previous form of authority is recognized again (ABDEL RAHMAN 2010). According to an interviewed actor from the locality, *"The local law decided the role of public committees, that they are responsible for local problems. The local leader will not come and say, 'I want to plan to establish a school.' It is the role of the public committee now"* (interview 7, paragraph 51).

The general consensus among interviewed local leaders was critical of the locality or the politics in the country in general for using elected public committees as the representative of government. According to one local leader who joined a public committee, *"Sheikhs are gone with the native administration. Yes, when we were working we established villages, but now the administration is in the hands of the public committee. I do not work according to my old position, but if there are problems or a critical situation I solve it. The sheikh solves it. The sheikh is there because he is someone who has experience. He can solve the problems more effectively. He got this from the old days"* (interview 35, paragraph 92).

Some interviewed sheikhs also added that they are distant from the decisions made by the locality, especially on issues of farming. He mentioned an example of how the locality gives release to private farms in areas of pastures (interview 57, paragraph 10). This situation is a result of the changes on land tenure in Sudan from common property to open access (KIRK 1993)

He also added that the decision in the locality is made by young people who are not experienced. *"We should enter the locality. We are not in localities, but young people who do not have experience are. The ones who are working and making decisions do not have the knowledge we have, and most of them are people who have personal interests"* (interview 57,

paragraph 17). There also could be some sheikhs who are closer to the locality but mostly receive personal incentives or benefits. One local leader who mentioned working with the locality although he is not getting a salary, but the mayor can facilitate him with some services such as free fuel for his car (interview 36, pargraph 12). Therefore, sheikhs are politically and institutionally connected to the locality, but according to some interviewed sheikhs, this connection did not result in an exchange of knowledge and experience on managing grazing areas etc. Therefore, the connection between both actors is weak. Sheikhs in the Rahad scheme generally seem to be out of the theater of innovations (ENGEL 1997). However, according to Baer (2010), the researcher argues that the creativity among the Rahad scheme actors can be elevated as the network gets more connected to actors who have personal experience or hafe "openness to experience the personality dimension." Such persons have the ability to absorb and synthesize diverse information and ideas.

Figure 53: local shiekhs' network
Source: field data 2010
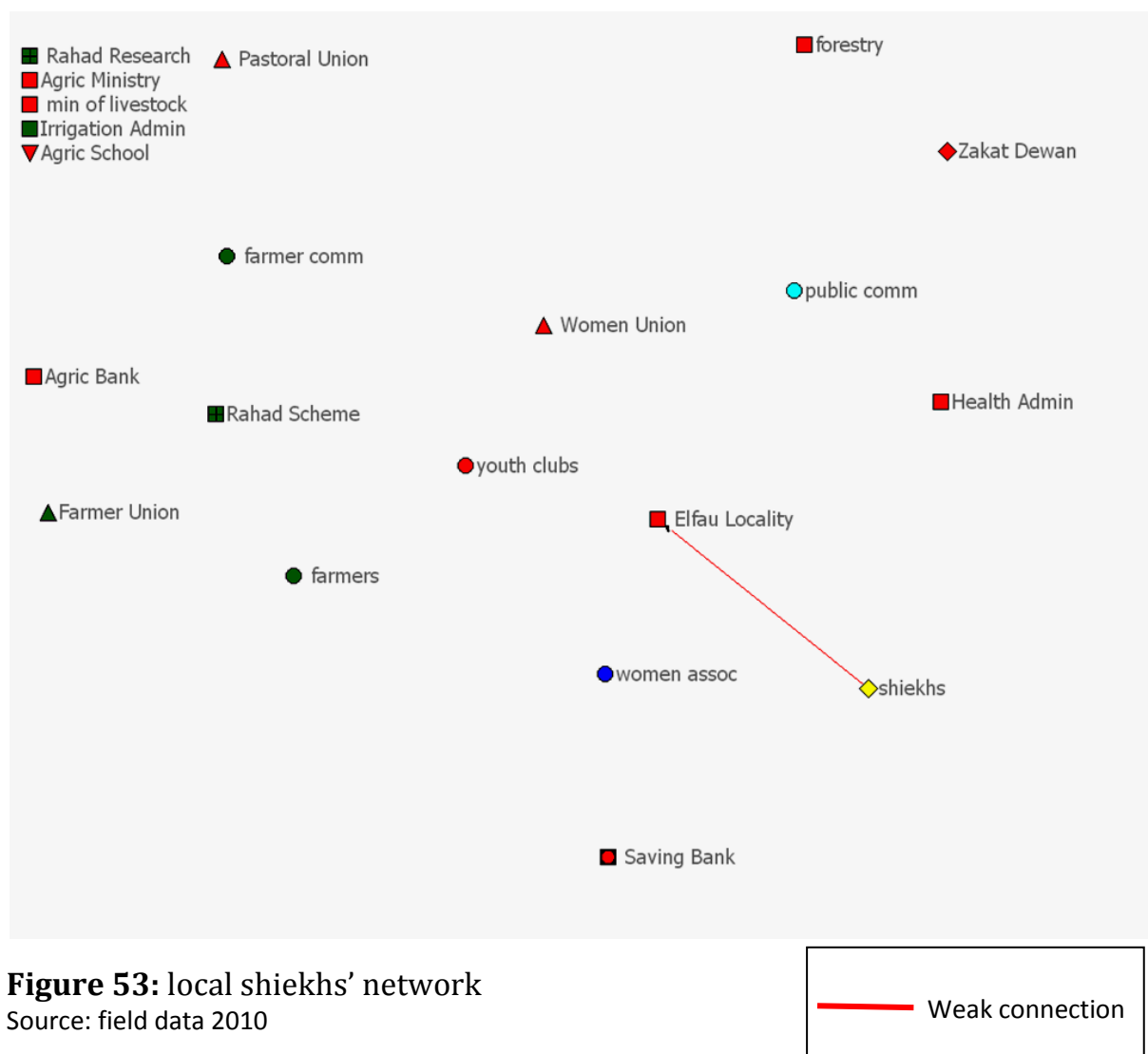
Sheikhs symboled as yellow diamond are isolated from the network of relation in Rahad scheme; they also keep weak connections to their main contact, El Fau Locality Excutive office.

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How local sheikhs perceive their connection to the Pastoral Union and Farmers'Union

The RAAKS team posed questions to local leaders in the scheme area in order to find out their thinking about the Pastoral Union. In spite of the accumulated experience of local leaders in the area, especially their knowledge of animal grazing, they reported that they are not consulted by the Pastoral Union in discussions of grazing issues ((interview 36, paragraph 14; interview 57, paragraph 12; interview 29, paragraphd 61-62). Of course the distance of local leaders from being officially involved in farming or animal keeping not only in the research area but also in the whole of Sudan is a result of political changes in authority, which previously were entitled to local leaders (ALNAEM 2010; SAAD 2010). Therefore, their distance is not due to intended acts from actors in the area; it is the present situation and role of sheikhs in the area.

According to a representative of the Pastoral Union in the El Fau locality *"We as pastoralists think the native administration is more suitable to us because local leaders know us. They know the thieves, they catch them, and punish them, but now there are no sheikhs because the public committees do everything"* (interview 5, paragraphs 31-32).

In the following paragraphs are examples of local leaders' thinking on issues regarding pasture management.

Local leader in the old days said that there used to be a space of 0.2 hectares closer to rained farms called *darb almal*. Farmers should not farm on it because the cattle would be taken through. *Darb almal* was founded under the English. Unfortunately it is now covered with farmland. This encroaching of farming is a new thing that happened, and people do not care about animals (interview 57, paragraph 10).

He further mentioned the different localities. "Mahliat" gives permissions for people to plant private farms. Those farms are encroaching on the grazing space on the old *masarat* "pathway" (interview 57, paragraph 10).

Local leader 2 commented on taxes imposed by the government for animal grazing on the boarders of localities, "*Since the old days there have been tribes sharing grazing land in Butana with the Shukira, 'the dominant tribe in Butana,' and those tribes come to Butana seasonally. We suggested in 2004 that they should not pay taxes, but the Pastoral Union interfered, and the taxes were not exempted. The situation is the locality takes taxes from farmers and animal owner, but they do not really have that much*" (interview 36, paragraph 14).

The above comments indicate that the sheikhs still have a lot of knowledge on animal grazing that can be discussed and negotiated in order to decide relevant measures and actions on better practices and performance of animal grazing and the livestock sector. However, local leaders express that they will not donate or share their experience unless they were asked to (interview 36, paragraph 14; interview 37, paragraph 14). In other words, contacts and connections needed to be created between sheikhs and the Pastoral Union if sheikhs are to be given a chance to become members in the Pastoral Union so that they can form a transaction network with the union (This researcher thinks that by mapping the network of the Rahad scheme, a network weaver can work to create ties and maintain weak connections in the network so that more knowledge about farming can be created within the Rahad scheme (KREBS and HOLLEY, 2004).

From discussions with the Farmers' Union's representative, we understood that local leaders played a vital role during the years of establishing the Rahad scheme. Leaders were asked to work on planning the new residential villages within the scheme (interview 11, paragraph 10). According to the Farmers' Union actor, involvement of sheikhs in planning the scheme was one of the reasons that made the social life in the Rahad scheme peaceful and with no major conflicts. The actor continued that only lately in 1990s, some problems appeared as people from western Sudan migrated to the scheme area. Some of them brought problems, but people could harmonize with them (interview 11, paragraph 10). According to one of the local leaders, mentioning the names of some tribes that moved to the project area, he indicated that the local leaders were truly involved in settling the tenants. *"When the project started, Awladoan, Shukria, and Arakeen were moved into village 37. Therefore, the project started with very good harmony"* (interview 36, paragraph 6).

According to the Farmer's Union actor, local leaders are given respect and considerable status in the scheme. However, according to local leaders commenting on their involvement in the Farmers' Union and Pastoral Union, *"There is no room for the local administration here unless someone joins individually. We could also be members in banks, but we would say let us leave the chance to the others. The problem is the Farmers' Union was mainly interested in collecting taxes more than development"* (interview 36, paragraph 14).

Local sheikhs can also play the role of catalysts in raising awareness and demonstrating about micro-finance projects that can be provided by the Savings and Saving and Social Development Bank (Rogers, 2003; Canright et al., 2004). This role was suggested by an actor of the bank because he thinks local people do not understand the idea behind micro-finance projects. There is a need to establish and strengthen the connection between the Saving and

Social Development Bank and local leaders here. Local leaders can be local bridges that connect people to bank activities.

6.5.4 Public committees

Public committees are connected to the locality, Women's Union, Zakat Dewan, Irrigation Administration, National Forest Corporation, and Health Administration. The public committees have no connection with the Rahad research station, Ministry of Livestock, Ministry of Agriculture, Pastoral Union, Farmers' Union, Agricultural Bank, Savings and Saving and Social Development Bank, or the Agricultural School (see figure 54 to note public committees' connections) .

Connection of public committees to the El Fau locality
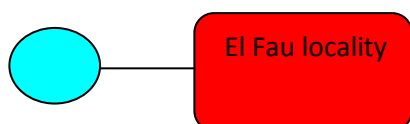
Public committees, also known as the public committee for control and services, resembles a micro-government responsible for controlling any illegal or intruding problems in the village and reporting them to the executive institutions, which are the police and the locality. The public committee are the delegates of the villages who seek sources and organize for the provision of water, electricity, schooling services, health services, etc. (interview 7, paragraph 18). Therefore, the public committees are responsible for the official and organizational side of providing social services. The finances of social services in the villages are secured from the locality and from specific cut-offs from farm produce (interview 78, paragraph 14).

According to an interviewed actor from the locality, *"The locality in the villages deals with locals through the public committees because they help us serve the communities, especially in collecting fees from services, and they are our eyes in the community"* (interview 7, paragraph 18)

The interviewed actor from the locality thinks the connection with local communities through public committees is a suitable link. Including other linkages within communities (he means sheikhs) will broaden the cycle of communication with local people, and that can create problems in the work (interview 7, paragraph 38). However, he believes public committee members miss many developmental skills, and capacity building is needed for them, especially assessment, planning, and monitoring of development projects (interview 7, paragraphs 38, 39).

Interviewed members of public committees have defined their connection to the locality by mentioning the duties and responsibilities assigned to them by the El Fau Locality (interview 28, paragraph 4; interview 78, paragraph 12). Therefore, a connection between public committees and the locality is strong in social issues of the villages.

Connection of public committees to the Women's Union
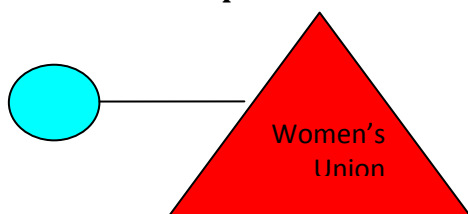
Interviewed public committee members recognize their connection with the Women's Union. According to one, the selection of the public committees goes by the participation of community organizations such as the Women's Union. He also added that the activities of the Women's Union are organized or legalized by the public committees (interview 28, paragraph 16; interview 78, paragraph 24). However, another member of the public committees commented that he is not aware of what women are doing in the village. Moreover, he added that women would be better involved in education activities rather than getting involved with men in meetings, because villagers here are shy. *"The head of the Women's Union in village 3 is also a member of the public committee and follows the ruling party. When meetings are announced, she would not participate. We dominate the work, and usually meetings will be in the market. How can women come and join a meeting in the market"* (interview 20, paragraph 34). Therefore, a connection between the public committee and the Women's Union exists in the form of supporting the legitimacy of the Women's Union in villages. It also seems that both are involved in expressing political ideas or views of the locality or the government (interview 28, paragraph 14). Therefore, a connection between the Women's Union and public committees is a strong connection

Connection of public committees to Zakat Dewan
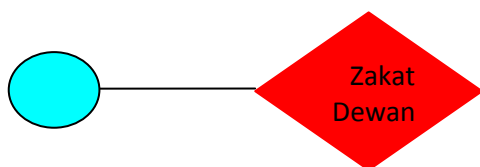
According to the Zakat Dewan actor, the identification of needy individuals or families for *zakat* is facilitated by *zakat* committees at the level of villages *Zakat* committees consist of imams from mosques, public committees, women's committees, and youth (interview 14, paragraph 7). According to discussions with villagers, the public committees are the main members of *zakat* committees. The *zakat* committees report people in need of *zakat*, and then the committee contacts Zakat Dewan (interview 65, paragraph 46).

However, the Zakat Dewan actor and interviewed actors negatively commented on the involvement of public committees in identifying needy people for *zakat*.

To approach the community with *zakat* money, Zakat Dewan has individual projects for individual people or individual households, including animal raising projects and vocational projects (interview 14, paragraph 19).

According to the actor of Zakat Dewan, some of the problems in *zakat* distribution are the behavior of certain tribes. They attempt to take projects for their tribes or relatives when distributing them (interview 14, paragraph 38). Another woman in a group discussion agreed to this, *"The* zakat *would come but the ones responsible for it would take it for themselves"* (interview 48, paragraph 53).

The mentioned statements indicate strong connections between Zakat Dewan and the public committee in providing *zakat* to local people

Connection of public committees to the National Forest Corporation
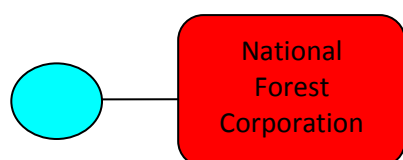
In connections with local communities within the Rahad scheme and El Fau locality, the corporation is represented by facilitating the planting of public places and forests In regards to planting activities, the corporation connects with public committees at the level of villages and El Fau city (interview 9, paragraphs 8, 13). The job of public committees is to medidate communication between the forest corporations and beneficiaries of planting; sometimes public committees facilitate the provision of water for seedlings (interview 9, paragraph 11). The public committees also facilitate the running of surveys for seed production (interview 9, paragraph 11). Therefore, the connection between public committees and the National Forest Corporation is strong

Connection of public committees to the Health Administration

One interviewed public committee member described the role of the public committee saying, "It is the delegation of the villages that seeks sources and organizes for the provision of water, electricity, schooling services, health services, etc" (CONWAY and STEWARD 1998; BORGATTI 2009) (interview 28, paragraph 4).

According to the Health Administration, locals come to the office to complain about negative health situations, or they come to ask for services (interview 13, paragraph 19). If the

administration is planning to provide a service to locals, the contact begins with leaders of mosques and community, but mainly our contact is with students (interview 13, paragraph 21).

The Health Administration actor believes that youth, especially students, are more active and effective in the community than leaders of the community, *"In the past it used to be the local leaders who influenced the community, but I find students and women are more effective and active in the community. Students are a large slice of the community; once they come together, they can work. Some leaders are not effective and others are busy"* (interview 13, paragraphs 32, 33).

When RAAKS interviewed the youth in villages, they admitted that the health situation there is bad despite the existence of a health staff. *"We have a health observer in the village, but health services and the environment are deteriorating, animals are slaughtered without veterinary supervision (on land), and many people here pee outside"* (interview 41, paragraph 19).

Another interviewed teacher commented on the deteriorating health situation in villages. *"The yearly survey for students finds that 90 percent of them are affected by bilharziasis. We also have malaria outbreaks. The project is connected with irrigation and that creates a good environment for diseases. There are decent no hospitals; we have one hospital that is not well-staffed enough to receive the whole number of people"* (interview 25, paragraph 69).

Negative comments on the level of health services in villages indicates the weakness of the reciprocal services that both the Health Administration and public committees are entitled to Therefore the connection between the two actors is considered weak .

Connection between public committees and the Pastoral Union
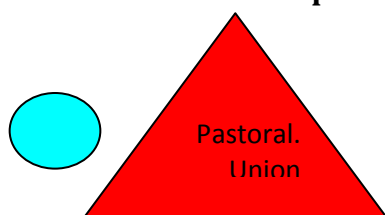
During data collection, the RAAKS team encountered two members of the Pastoral Union who were also members of public committees. However, the data revealed no transaction relations between public committees and the union (interview 51, paragraph 1; interview 23, paragraph 7).

Throughout the research study, public committees had been described as the representative of the government in monitoring and controlling of social services in the villages. As showed above, most connections of public committees have been evaluated as ineffective due to a

lack of resources, mainly financial and logistic means. This research does not aim to seek or invent proper ways to raise funds in order to go about facilitating social services in villages. It rather works on finding approaches or methods on how the people meant by the agriculture innovation in the Rahad scheme can properly exchange information through a network of relationships, hoping that this networking would positively reflect on the performance of all actors within the scheme. Public committees in the Rahad scheme area can be local bridges between weakly or poorly connected actors. For example, the public committee can connect youth clubs to the Rahad scheme and connect the Women's Union to the Rahad scheme.

According to an El Fau locality actor, public committees need capacity building on need assessment planning and implementation of projects. Mapping of the Rahad scheme network can help define strategic actors that can help increase skills and potentials of public committees.
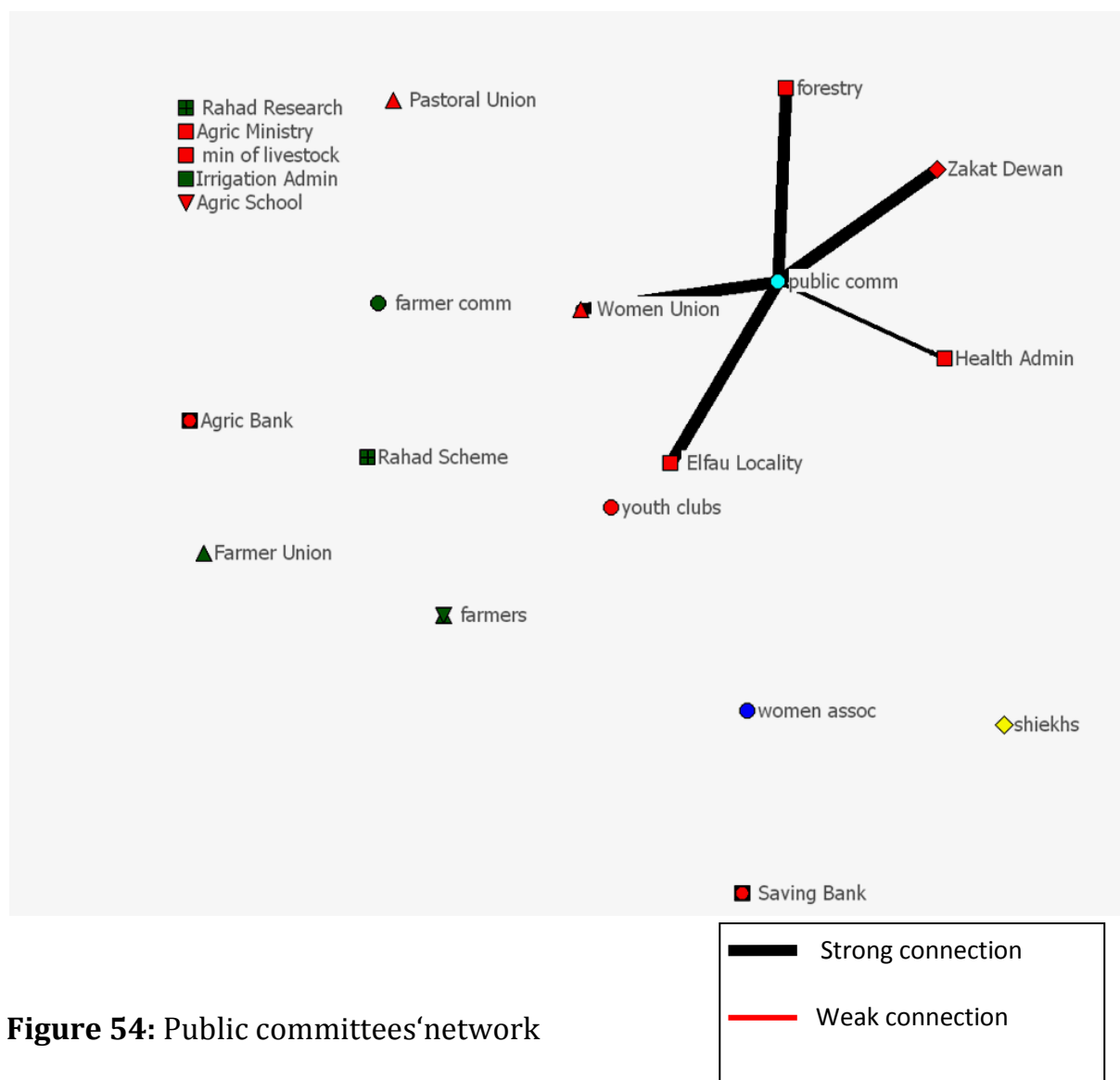
Figure 54: Public committees'network

Public committees symboled as light blue circle, the diagram shows that public committees in villages are keeping strong connections to different actors at level of Rahad scheme.

6.5.5 Farmers' committees

Farmers' committees are connected to the Rahad scheme administration, Farmers' Union, Women's Union, Pastoral Union, Agricultural Bank, and El Fau locality. There is no connection to the Health Administration, Irrigation Administration, Zakat Dewan, Ministry of Agriculture, Ministry of Livestock, Agricultural School, National Forest Corporation, and Saving and Social Development Bank, or Rahad research station

Connection of farmers' committees to the Rahad scheme administration
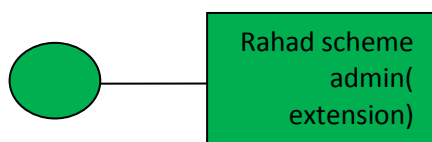
Farmers committees are connected to the Rahad scheme administration through their connection to extension agents (figure 55 shows farmers commitees' connections). The farmers' committee described its role as a link between extension in the scheme and the farmers or local bridges (EASELY and KLEINBERG 2010) (interview 53, paragraph 5; interview 21, paragraph 6). One farmers' committee member mentioned, *"Our role is to link farmers with the administrators, or we are mediators between the farmer and the administration, and then we deliver the extension message from the administrators to the farmers)* (interview 23, paragraph 8). This quote reflects a classical view of extension as a message to deliver. Meanwhile extension can be looked at as advisory work in problem-solving situations as in HOFFMAN et al. (2009). The extension role has also been thought of as a facilitator for innovations in order to achieve innovation objectives (LEEUWIS 2004; CRISTOVAO et al. 2012). In this regard, extension can be a knowledge broker working in a platform that collects actors involved in the agricultural innovations in the Rahad scheme.

They also expressed that they not only communicate information to farmers but also help farmers get financing from banks, as farmers' committees personally guarantee farmers (ref. group finance from the Agricultural Bank) (interview 23, paragraph 9).

Farmers' committees are also connected to the Rahad scheme through their connection to the administration of social development. The administration is a sharer with the Farmers' Union and Rahad Corporation scheme. It is financed by the Farmers' Union and Rahad Corporation. The Rahad Corporation is responsible for the staff and running cost of offices, cars, and fuel while the Farmers' Union is supposed to cut from farm produce to finance social services around 5 pounds (80 cents) from every farmer. The administration coordinates with farmers' committees the assessment of social services needed by the villages (interview 46, paragraph 3).

In this connection, farmers' committees are the direct contacts of the Farmers' Union who deal with the section to decide what money each village would need. The section delivers the money to the head of the farmers' committee to use it (interview 46, paragraph 5).

Villages mostly decide to build schools and mosques, unless there are problems coming up. Most people decide to have schools and mosques; others prefer kindergartens and women's centers (interview 46, paragraph 5). Accordingly the connection of famers' committees to the Rahad scheme is a strong one. Reviewed literature has also proved that strongly connected actors are also important in sharing information within the networks. According to GRANOVETTER (1983), the speed of information flow and credibility of information are greater through strong ties. Therefore, the researcher argues that since farmers' committees have connections with more actors in the network, more information can be accessed from them. For example, creating a relationship between the Pastoral Union and farmers' committees can lead to access to more information and better possibilities for animal keepers within the Rashad scheme.

Connection of farmers' committees to the Farmers' Union
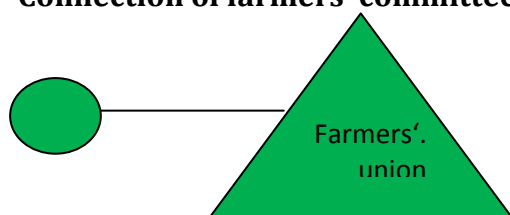
Interviewed farmers' committee members have expressed themselves as people who communicate information from the extensionists or Farmers' Union to the farmers (interview 20, paragraph 25; interview 21, paragraph 6) (CONWAY and STEWARD 1998; BORGATTI 2009).

The following code was made by a farmers' committee member explaining their role, *"We are close to farmers in order to communicate information from the section or Farmers' Union to farmers. We follow the farming and watering, and if there are emergencies, we follow them. In the end we follow the harvest with farmers as well. We sometimes connect the farmer with farm administrators, i.e. if there are problems; we solve them with administrators or the Farmers' Union)* (interview 21, paragraph 6).

Accordingly the connection between the Farmers' Union and farmers' committees is considered a strong connection However, from other interviews with farmers and farmers' committee members the RAAKS team understood that the farmers' committees are not always informed of decisions made by executives of the unions. One farmer mentioned, *"The Farmers' Union is distant from production committees. When they went to meet them for*

some issues or problems related to farming, they would not find them. The Farmers' Union is busy with its own issues" (interview 18, paragraph 60). Analysis of the results on actors at the Rahad scheme level found that the Farmers' Union is a central actor in the network (in-closeness: 73.6, out-closeness: 73.6) (FREEMAN 1979) cited by (SCOTT 2000). The high centrality of the actors was an indicator of actors' power effects in the network (HANNENMAN and RIDDLE 2005). Therefore, the researcher assumes that power issues dominate the relationship or the connection between farmers' committees and the executive of the Farmers' Union.

Connection of farmers' committees to the Women's Union
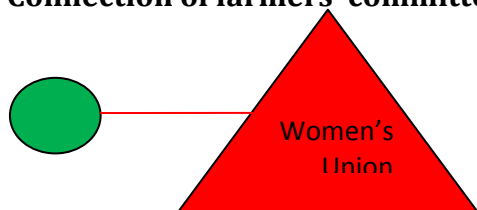
One farmers' committee member mentioned that the Women's Union in villages would contact farmers' committees to get support for cleaning the village or support for their educational activities .However, he added, the Women's Union does not contact the farmers' committees for work in farming because women in the Rahad scheme generally do not work on farms (interview 21, paragraph 31). Another interviewed farmers' committee member mentioned that the activity of the Women's Union in villages is to establish women's associations for renting utensils, but he did not confirm whether the Women's Union consults the farmers' committee in the village (interview 53, paragraph 19).

Someone interviewed from the Women's Union in the villages mentioned that farmers' committees can help them in some social services such as paying fees for receiving guests, meaning visits of political leaders or authorities. Some Women's Union members think their connection to the farmers' committees in villages is through the work of the farmers' committees in social services such as the support of school building (interview 43, paragraph 17).

Generally, women's social activities are perceived by some interviewed farmers' committee members to be education or teaching activities rather than engaging in activities that require mobility or contact with men (interview 21, paragraph 32). Since contact to exchange information on farming is not taking place between the farmers' committees and the Women's Union, their connection is considered weak.

Connection of farmers' committees to the Pastoral Union
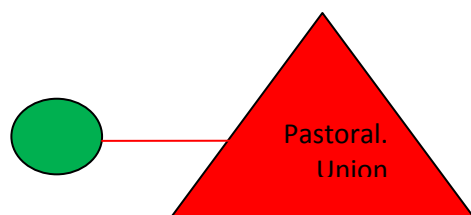
One interviewed farmers' committee member was asked about his opinion of the Pastoral Union. He mentioned, *"Animals are grazing in farms of the scheme according to certain instructions developed by the scheme administration. The Pastoral Union does what it can to get involved in this or to re-organize the animals grazing"* (interview 21, paragraph 53). This statement indicates no negative feelings from farmers' committees towards the role of the Pastoral Union in the scheme, in contrast to the views of the Farmers' Union representative on the Pastoral Union.

Another interviewed farmers' committee member knew about the Pastoral Union in the village but did not know exactly what they are doing (interview 53, paragraph 25).

Another interviewed farmers' committee member in a group discussion said the relationship between people or farmers with larger amounts of animals and farmers with fewer animals in the Rahad scheme is good because the owners of animals can buy crop residue (interview 23, paragraph 47).

Pastoral Union members have admitted the complementary relationship of pastorals' and farmers' activities on farms, but they negatively comment on the Rahad scheme administration on issues of animal grazing within the scheme farms (interview 23, paragraph 49; interview 5, paragraph 12; interview 44, paragraph 6).

A member of the Pastoral Union at the village level who was a brother of a farmers' committee member mentioned, *"In order to better coordinate or organize the relationship between farming activities and grazing activities in scheme farms, the Pastoral Union should be involved or represented in farmers' committees."* According to him, pastorals were never represented in the administration of the scheme (interview 44, paragraph 18).

Therefore, it can be argued that at the farm level, the relationship between farmers' committees and the Pastoral Union is not expressed as a negative relationship, but there are no official connections between them. Moreover, farmers' committees are not fully aware of Pastoral Union issues or what the Pastoral Union exactly is doing. Therefore, the connection of farmers' committees and the Pastoral Union is weak .The Pastoral Union actor mentioned the necessity of getting his union to participate in work of farmers' committees at the village level. This could be a first stage to build connections between the Pastoral Union and farmers'

committees in organizing grazing activities within the Rahad scheme. This suggestion as discussed in other sections can be an idea of creating a connection between actors to get access to diverse information in the Rahad scheme.

Connection of farmers' committees to the Agricultural Bank
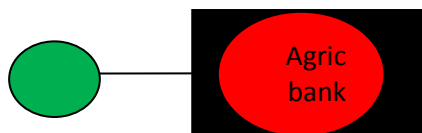
Farmers' committees and the Agricultural Bank have mentioned a connection to each other in the case of facilitating the financing of production costs to farmers in the Rahad scheme. The Agricultural Bank finances irrigated scheme farmers and rain-fed farmers in all type of crops. For example, for cotton crops the bank finances all farming operations by supporting the input of seeds, fertilizer, and the cost of spraying cotton with pesticides (interview 4, paragraphs 2, 3).

The bank will monitor this financing through control groups. Farmers are divided into groups; every group will be headed by a farmer, usually a member of the farmers' committee. The farmer receives the inputs on behalf of his group and hands it to members. The bankers in the finance section report the costs of financing for every group, and then the head of the group will be the contact person (interview 4, paragraph 2). The bank decides the amount of money needed from the head of the group. Money will be collected from the groups of the farmers. The bank will calculate its cost. For farmers who managed to repay their input costs and make a profit from their produce, the bank will return their profit. Farmers who produce in amounts that fail to make profits will be forced to repay the cost of inputs (interview 4, paragraph 2).

The actor of the Agricultural Bank mentioned that in the first years of running the financing, the local people would not or could not recognize what the bank was and what it was doing. *"In regards to local people in the villages, the actor thinks the Arab people here migrated from outside to the scheme area. They did not even understand exactly what the bank was doing"* (interview 4, paragraph 13).

The actor of the Agricultural Bank further commented that even the heads of groups were not fully aware; they had difficulties understanding what was written in papers (interview 4, paragraph 13). The bank had difficulties making them sign; the farmers who belonged to different groups in most cases also did not trust the head of the group. On the day of financing, all farmers would come to witness the signing of papers (interview 4, paragraph 13). The mentioned comments indicate a problem of mistrust among farmers in regard to dealing with finance and resource handling.

One farmers' committee member expressed the connection between committees and the Agricultural Bank in processing the financing thus, *"We also guaranteed the finances of farmers in a personal way through guaranteeing a group's financing. Every member of us would guarantee a certain group of farmers and take responsibility of all farm operations from land preparation until harvest. We suffered from it a lot All these mistakes based on bad finance politics ruined the scheme"* (interview 23, paragraph 9). Another interviewed farmers' committee member added, *"Sometimes the country invested a lot of money in farming, but most farmers do not pay back the cost of inputs. They think it is a gift from the government, although there are farmers who are serious and return the cost of inputs. Either to banks or others, they would pay back the cost of fertilizers or watering, but the majority does not. That is why the country decided to change the financing of farming to solve this problem, and one shape of it is the investing of the company"* (interview 59, paragraph 4). This quote indicates that processing financial aid from the Agricultural Bank was a challenge due to the behavior of farmers and their concept towards financing. However, it also showed the closer connection and involvement of farmers' committees in the process, regardless of its outcome. Therefore, the connection of farmers' committees to the Agricultural Bank is a strong one. The researcher thinks that making use of this strong connection between farmers' committees and the Agricultural Bank can help share information on services delivered from the bank to other actors in the scheme such as the Pastoral Union, and youth clubs. This share can be achieved by activating the weak connections between farmers' committees and youth clubs and the weak connection between farmers' committees and the Pastoral Unio.

Connection of the farmers' committee to the El Fau locality
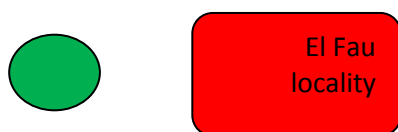
There is no systematic connection between the locality and the Rahad scheme when it comes to the farming sector, but the locality is responsible for the rain-fed farming areas through the supervision of the Ministry of Agriculture (interview 7, paragraph 12). The locality does not follow the technical work of the scheme, nor does it follow the farming activities of the scheme. Accordingly there are no connections between farmers' committees and the locality in regards to farming issues. However, the researcher suggests that in the future there can be information sharing about rain-fed farming within actors of the Rahad scheme, especially farmers within the irrigated scheme and rain-fed farmers. This sharing can be achieved if the Rahad scheme builds connections with rain-fed farming through maintaining connections

with the Ministry of Agriculture or building a core/periphery network (KREBS and HOLLEY 2004).

Figure 55: Farmers' committees' network
Source field data: 2010
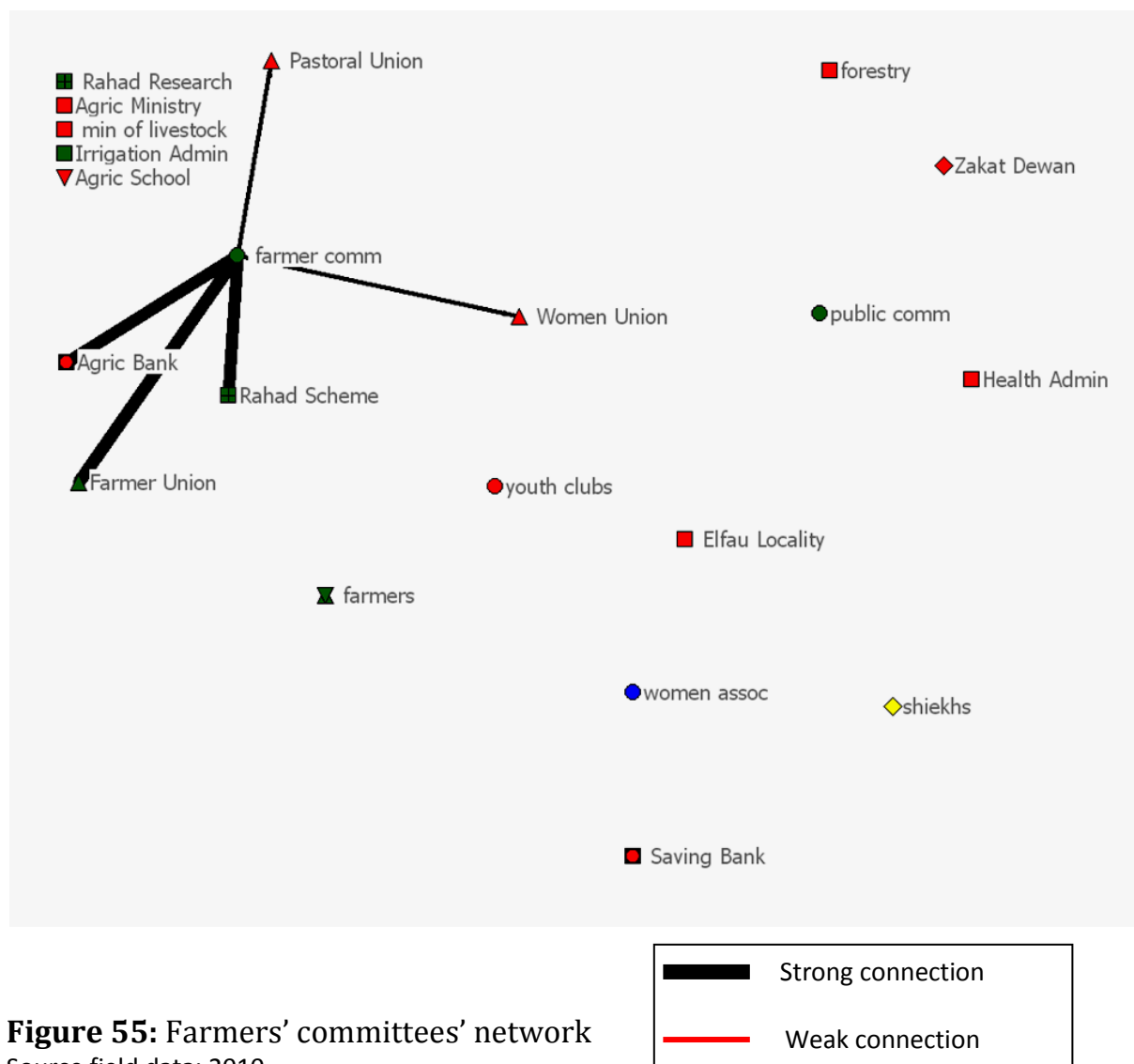
Farmers committes symboled as green circle have strong connections to Farmers' Union, Rahad scheme administration and Sudanese Sudanese Agricultural Bank, the committees also keep weak connections to Women's Union and Pastoral Union

6.5.6 Farmers in the Rahad scheme

Farmers are connected to the Rahad scheme administration. They are indirectly connected to the Irrigation Administration through water guards and to the Farmers' Union through farmers' committees. There are indirect connections of farmers to the El Fau locality through public committees and an indirect connection to the Agricultural Bank through farmers' committees. Farmers are not connected to the Women's Union, Pastoral Union, Health Administration, National Forest Corporation, Ministry of Livestock, Ministry of Agriculture,

Rahad research station, Zakat Dewan, Savings and Saving and Social Development Bank, or Agricultural School (see figure 56 to note farmers' connections).

Connection of farmers to the Rahad scheme administration
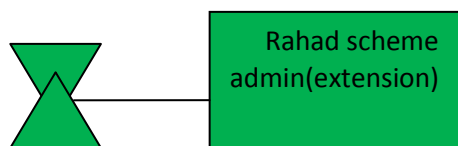
In the research study, extension has been understood as the connection between farmers and the Rahad scheme administration in farming because all sections of the scheme contact the farmers through the extensionists (EL HASSAN 2004; RAHAD AGRCULTURAL CORPORATION 2010).

The extensionists form a transaction network of information exchange on farming with farmers. In the following we present tenants' views on extension work in the Rahad scheme as well as extensionists' opinions on the farming practices of farmers.

One farmer mentioned, *"There was an extensionist, Ahmed Mirgani, who told us the space between holes should be 70 cm in sorghum and 25 cm for groundnuts, the sorghum seeds should be 5 per hole and groundnut seeds should be 2 per hole. They told us to use threshed groundnut seeds because we were using the raw seeds. We were throwing seeds on the ground and then burying them using tractors"* (interview 18, paragraph 26).

Others recalled, *"Extensionists held debates and told farmers how they should plant and at what time, how many times they should irrigate the crop, and when to harvest"* (interview 21, paragraph 24).

We noticed that during interviews farmers could recall extension work as debates or farmers' field schools. However, according to EL HASSAN (2004), extension meetings, demonstrations, participation in extension programs, extension lectures, and pamphlets were the main communication methods used by farmers under the FFS and T & V approaches.

Others describe extension work as not useful. *"There were always extensonists in the farms, and they told us to do this and do that, but we thought we knew more, for example thinning sorghum: we knew it from before. We would say 'yes, we will do it,' but I do what I learned from before from my father and grandfathers* (interview 16, paragraph 16).

Another farmer mentioned attending extension debates and said the *"extensionist would come to the field and tell us how many seeds in holes we should throw, but farmers on their own already had learned how many seeds to throw. The extensionist would come and find we already had thrown the seeds our way."* When the interviewer tried to ask the farmer whether he remembers how many sorghum seeds the extenionist asked him to throw he answered *"I*

forget what the extenionist told me, but I know our own estimation" (interview 83, paragraphs 35-42).

Farmers' statements agree with the results achieved by EL HASSAN (2004) in his study evaluating the extensional approaches used in the Rahad scheme. EL HASSAN found out that 85.5% of his studied respondents had a lot of experience with farming and possessed vast knowledge in this regard. In the researcher's opinion, it could be necessary in the future to connect farmers in the Rahad scheme to updated research on rain-fed farming. This connection is important in order to diversify information within the scheme area (KREBS and HOLLEY, 2004). According to the literature reviewed, the researcher found that agricultural research in Sudan was mainly concentrated on irrigated farming. This trend took place as policies of the country focused on producing cash crops within irrigated schemes (BEINTEMA et al. 1995). The traditional rain-fed sector proved to be sustainable in a low density setting, and farmers within this sector have more of a tendency to perform more timely and frequent sowing, weed more, and have higher sowing rates than in mechanized rain-fed farming areas of Sudan (CFSAM 2011). Our findings from the field work that farmers still believe in and apply their inherited practices of rain-fed farming opposes the importance of changing research practices and policies in the country.

Others described extension activities in the Rahad scheme as irregular activities. *"Extension did not previously come to us regularly, but people here learn how to farm from their fathers, and there are others who learned from the farmers' school"* (interview 18, paragraph 28).

Some farmers also believed that they were educated enough in farming. As one tenant put it, *"At the beginning we did not know farming, but after staying for more than 15 years, we have learned from repetition and practice. Before, we did not even know how to open the canal to irrigate the field, but later farmers became good at everything"* (interview 26, paragraph 16).

When the RAAKS team interviewed other actors in the community, they disagreed with this assumption. One teacher believed that this argument could not be true, and farmers still need further extension work on farms (interview 25, paragraph 54).

Some farmers positively commented on extension work and their connection to extensionists in the Rahad scheme. One farmer mentioned that the extensionist was very important. "He gave us good information on farming," said the farmer, recalling how the extenionists insisted on the importance of weeding the crops (interview 84, paragraph 42).

Another farmer who explained how farmers' schools were organized said, *"Out of every three farms, one farmer would be selected as a khabeer (*expert*). The* khabeer *were trained and sometimes sent to outside places to get trained. Remarkably, farmers were trained on using*

pipes for irrigating the farms." He further mentioned, *"My relationship and connection to the extensionist in the village was very good. We were friends, and actually our friendship continued after he was transferred to other section in the scheme"* (interview 56, paragraphs 35, 37). EL HASSAN (2004) found that the FFS approach had motivated and encouraged farmers to adopt technologies suitable to their situations through farmer-to-farmer extension. Moreover, activities of the FFS offered a participatory way for farmers to identify their farm problems. Therefore, the statement of the farmer describing his relationship to the extensionists as friends can explain the participatory effect of FFS at the time of its conduction (ABDEL RAHMAN 2003).

Connection of extension to Rahad farmers

Researchers collected information on the relationship or connection of extensionists to farmers. These views are given through evaluating the performance of farmers according to the three extension approaches used in Rahad (EL HASSN 2004).

Comments on farmers' performance based on the commodity approach

Rules and regulations were the first communicational way between newly settled nomads and the Rahad scheme's staff, the field inspectors, or "the name of the position of staff members" used to visit tenants on farms and direct them (EL HASSAN 2004). The scheme depended on this method because they wanted farmers who were originally nomads to obey instructions on farming, and tenants tried to avoid mistakes and obey orders (interview 17, paragraph 8). In this type of relationship, the extensionists thought of farmers or "tenants" as inventors, the majority and reluctant (interview 17, paragraph 8). According to the extensionist, the majority who obeyed and understood farming and it is economic benefits were the ones who socially benefitted more now (interview 17, paragraph 8). The interviewed extensionist referred to the innovativeness or the relationship between time and adoption of an innovation. Innovativeness in diffusion research was calculated to show the degree to which an individual or unit of adoption is relatively earlier in adopting new ideas than other members in the system. In accordance with innovativeness, individuals or units of adoption had been classified as adopters, early majority, late majority, and laggards (ROGERS 2003). In this way, the extenionist views innovation in the Rahad scheme as farming in accordance with the economic profitability of crops planted in the scheme. Viewing innovations as individual performance was widely used to search for agricultural development in the third world (GERMAN et al. 2006; GLENDINNING 2001).

The extensionist considered tenants interests in producing fodder for animal feeding as economically irrational (interview 17, paragraph 8); planners for the Rahad scheme had calculated the economic visibility of the scheme according to cash crop production (Benedict et al., 1982). However, in our thinking this categorizing of farmers underestimates farmers' experience and local practices. Settlement in irrigated schemes in theory had been considered as a factor creating a form of agro-pastoral communities combining livestock keeping with cropping of sorghum, groundnuts, and cotton (EL SAMMANI and SALIH 2006).

Therefore, innovation in the Rahad scheme needs to be viewed as a setting of different actors who can have different roles and thus can enter into a different network of relationships (ENGEL 1997) Viewing the Rahad scheme in this way can be complementary to the classical consideration of innovations as linear performance (VALENTE 1995; RAINI et al. 2005).

In the early years of the Rahad scheme, farming in some sections was mechanized. Land preparation, weeding, and harvesting were done by machines, especially in the southern section (BENEDICT et al. 1982; EL HASSAN 2004). This mechanization is perceived by another interviewed extensionist as a reason that delayed educating farming skills for the newly settled nomads. *"Technology in the Rahad scheme did not go hand-in-hand with the education. The extensionsist was giving orders but not convincing. Money that was invested in machines should have been invested in educating farmers"* (interview 22, paragraphs 6, 7). According to the study carried out in the Rahad scheme by EL HASSAN in 2004, the interviewer referred to the commodity approach in the Rahad scheme in which extension programs were designed top-down without any participation from the farmers (DORAN 1980; EL HASSAN 2004).

According to the interviewee, if farmers were educated in farming, their production would have increased (interview 22, paragraphs 6, 7). The extensionist further added that delaying extension in the Rahad scheme led to the deterioration of the mechanized operations on farms. His argument is that if tenants had been taught how to deal with the machines, some mistakes in machine function would have been avoided (interview 22, paragraphs 6, 7).

Another extensionist interviewed from the northern section of the scheme disagreed with the above opinion and mentioned that farmers in the scheme need regulations because rules are not punishments; they are monitoring tools (interview 17, paragraph 10).

According to him, the reasons that led to the deterioration of the Rahad scheme are not only technical failure but also farmer failure; he gave an example of water unavailability. *"It is true that pumps were not maintained, but farmers did not regularly clean the canals. It is a work of active farmers"* (interview 17, paragraph 10).

The extensionist further argued that now due to the age factor and money disabilities, sons of farmers are not connected to farming; farmers are becoming unable to manage their farms. Therefore, he thinks the farmers of the scheme need regulations and orders more than extension (interview 17, paragraph 10).

Comments on farmers' practices based on the T & V approach

Interviewed extensionists thought the T & V approach was more accepted by farmers and successful due to the logistics and facilities made for that approach (interview 22, paragraph 12). This argument is in line with EL HASSAN (2004), who concluded that the T & V approach was successful in improving vehicles, machineries, and equipment within the Rahad scheme as far as the availability of facilities is concerned.

Another extensionist mentioned that farmers still need to learn more in farming skills because with their present farms management skills, they produce less than the optimum amounts per hectare, so farmers cannot work alone. They still need extension (interview 17, paragraph 13). Moreover, due to the fact that some farmers had either rented or shared their land with laborers in the scheme areas, farmers were absent from their farms, and extension messages were not reaching them (interview 1, paragraph 16).

Therefore, the extensionist thinks that from 1992 until the now there has been no extension work in the Rahad scheme (interview 22, paragraph 10). The extensionist overlooks the FFS approach; this could be due to the fact that extensionists within the T & V approach in the Rahad scheme had an advantage with equipment and outside training (EL HASSAN 2004). Missing some of these advantages in the FFS might lead to this biased opinion among extensionists to the T & V approach. From reviewed records, it was found that the most popular extension approach in the Rahad scheme after FFS was the commodity approach (EL HASSAN 2004).

Tenants in Rahad used to share farm work with working laborers. The laborer would do all the farming work from planting until harvesting. At the end, the tenant and farmer would share production costs and net product half and half.

This issue of sharing is a matter that pushed farmers away from extension because tenants became less active on farms, and the sharer would be the one who had to do the work. According to the interviewed extensionist, *"Another big problem we had is the agreement between the tenants and the farmers; this led to a low adoption of information. The Farmers' Union would deny it, but in reality it is the truth. If the extensionists do not find the farmer in the farm they would find someone who is not the farmer. He does not want to listen*

to me and works in many farms at the same time in order to maximize his share, while the farmers are deteriorating" (interview 17, paragraph 10).

The extensionist believed that the farmer has the desire to know, and when a certain crop or crops bring him good income, he would need to seek more information and he would seek for the extension. However, if he does not make a profit, or the crops do not benefit him, he would react differently. He would say, my farming is not profitable anyway. Why should I listen to or go to the extension (interview 22, paragraph 10). He also thinks productive farmers are more connected to extension and want to know more, but poor or less productive farmers are away from it, although they are the ones who need more work and effort from extensionists (interview 22, paragraph 10).

From comments given on the connections of both to extension in the Rahad scheme and farmers, it can be argued that the tie or the relationship varied according to what was considered an active farmer and good farming practices. From the extension viewpoint, farmers who produce economically are the well-connected farmers, and thus their relationship with them can be considered strong. However, less productive farmers who are interested in fodder farming more than the cropping decided by the scheme are less connected or weaker. In this way extension and farmer relationships are perceived as a reciprocal service (GRANOVETTER 1973). On the other hand the connectedness of farmers to their previous knowledge in farming has been expressed as the reason that weakened farmers' relationships to extension activities. In this regard the researcher considers the less intimate expressions given by some farmers on extension as an indicator of a weak connection to extension. On the other hand, farmers who expressed a positive view of extension are considered strongly connected to extension.

Extensionists are suggesting new extension methods in the Rahad scheme; however, the researcher is interested in generally improving the network of relationships in the Rahad scheme, meaning that connections between actors of the Rahad scheme need to be recreated or activated.

Reviewed literature has proved that communication of information can be limited among actors that they know each other well. Therefore, information can be stagnant within the strong connections (GRANOVETER 1973; GRANOVETTER 1983).

Our findings in this study have proved that farmers who are strongly connected to extension in the Rahad scheme declared that their sources of information in irrigated farming were extension debates and the farmers' field school implemented by extensionists in the Rahad scheme. Another reviewed literature proved that both the T & V and FFS approaches used

diversified extension communication methods for diffusing recommended agricultural packages among farmers (EL HASSAN 2004). He also found that most farmers under the T & V and FFS approaches are satisfied compared to those under the commodity approach (EL HASSAN 2004). In our view, implementing T & V and FFS was paralleled with successful logistical and financial facilities provided by international programs that initiated and supported both approaches in the Rahad scheme (EL HASSAN 2004). From a perspective of diffusion research, these approaches focused on the performance of the individual farmer as an indicator of its efficiency (LEEUWIS, 2004). However, from the point of view of the social organization of innovation, innovation is defined as a complex social process that occurs among a variety of actors who search for ideas and information and not only a matter of transfer of technology (ENGEL and SOLOMON 1997; NEUMEIER 2012).

Therefore the successful performance of extension in the Rahad scheme is based on the successful relationships that connect actors of the scheme (Strongly connected actors need to recognize the weakly connected actors within the network. Then ideas on how to activate or improve connections between weak actors within the different network at the Rahad scheme need to be put forward. Implementation of this step could be a tool of phase C of RAAKS (ENGEL 1997)

Connection of farmers to the Irrigation Administration
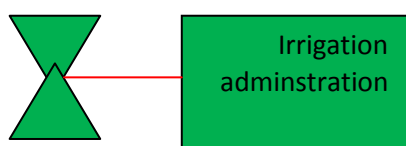
According to the actor of the Irrigation Administration, the administration provides a room for local people to participate in providing water requirements for the scheme farms (interview 12, paragraph 11). This participation is being achieved by units or sections established inside the scheme (interview 12, paragraph 12). There are almost six sections in the scheme; in every section there are two or three sessions, and every session has a water engineer, technician, and one staff from local people (the water guard) (MINISTRY OF IRRIGATION 2007). Every village has many water controllers distributed along the canal. This combination of staff is found at the level of the villages or points (interview 12, paragraph 18). According to the Irrigation Administration actor, *"We do not have direct contact with farmers, but there are farmer extensionists who deal with them. We provide the water, and we should control it to avoid its loss"* (interview 12, paragraph 18).

The RAAKS team interviewed one water guard, who described his work thus, *"My work starts as the water comes from the major canal. Then I follow the direction of the water to the*

double (sub majors), and from the doubles it goes to the Abu20 (a canal connected to the farms). From there to the field, during the harvest we stop it (the watering). I track who watered his farm or not, and then I give the report to the extensionist" (interview 19, pargraphs 10-12). The water guard mentioned that farmers sometimes quarrel in watering intervals during times of water shortages (interview 19, paragraph 12). Since farmers are not directly connected with the Irrigation Administration, it can be argued that their connection to the Irrigation Administration is weak .The Irrigation Administration mentioned that there are some problems in using irrigation water in Rahad. He mentioned that animals grazing outside the scheme area are brought to the scheme in the summer. Pastorals might use any part of the canals, which can cause damage to these irrigation waterways. The statement given by the Irrigation Administration actor and water guard indicate the necessity for more extension work to improve water management in the Rahad scheme, either with farmers within the scheme or pastorals outside the scheme. Therefore, there is a need to create new connections between irrigation in the Rahad scheme and farmers as well as pastorals. This can be possible if extension in the Rahad scheme works as network weaver.

Connection of farmers to the Farmers' Union
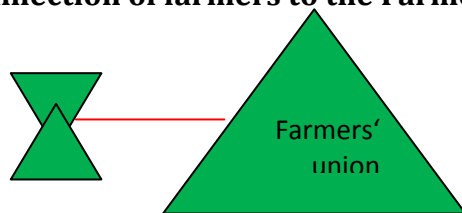
According to the Farmers' Union actor, the connection between farmers and executives in the Farmers' Union goes through farmers' committees. These connections include an exchange of information on farming within the Rahad scheme.

To present the Farmers' Union's connections to farmers, we decided to gather different views from farmers on the Farmers' Union. One farmer assesses the Farmers' Union members as people who have a high social status, who do not talk to farmers, and who do not know anything about farmers. *"The space between the base and the leaders is very far; they do not know anything about farmers. If I wanted to talk with them, they would not listen to me. They have high social status and would not listen"* (interview 24, paragraphs 85, 87).

Another farmer expressed his connection with the Farmers' Union from events that happened in the past. *"The president of the Farmers' Union in the past used to come and talk to the head of the farmers' committee in the village, when he came we knew about it"* (interview 16, paragraph, 23).

Another described the Farmers' Union as people who make different decisions about farming. They are people who do good things sometimes and bad things sometimes, but they do not consult farmers on any case (interview 26, paragraphs 45, 50).

Since farmers have negatively commented on the Farmers' Union, the connection between two actors is weak.

In literature it is argued that not every weak relationship is important or really needs to be developed (EASLY and KLEINBERG 2010). The connection between farmers and the Farmers' Union can remain as it is, but at the same time there are other weak relationships between actors of the scheme that need to be developed or activated. Strengthening other relationships can improve the network of relationships in the scheme and maybe in the future a more positive opinion towards the Farmers' Union can develop.

Connection of farmers to the Sudanese Agricultural Bank

There are no direct connections between farmers and the Agricultural Bank; however, both actors are connected through farmers' committees in the process of financing production inputs

The actor from the Agricultural Bank mentioned that in the first years of running the financing, the local people would not or could not recognize what the bank was and what it was doing. *"In regards to local people in the villages, the actor thinks the Arabs here migrated from outside to the scheme area. They even did not understand exactly what the bank is doing"* (interview 4, paragraph 13).

Although the bank had been financing farmers in the El Fau locality since the 1990s, fewer people from villages came to make use of its services in relation to the agents from El Fau city (interview 4, paragraph 13).

A farmer expressed financing from the bank as a negative side of farming in the scheme. The farmer explained that he repeatedly failed to repay the bank. *"Once we planted wheat it failed, and we failed to pay the bank. For the last farming season we planted cotton. It also failed due to draught, and now farmers are responsible for repaying the bank. Shikan is our insurance company, but I do not see them paying for us"* (interview 53, paragraph 28).

The actor from the Agricultural Bank thinks that in order to gain more connections between local people and the bank, the bank needs to establish branches or offices in the villages. These offices will make bank services closer to local people; locals can also be trained on

how to manage projects the bank is financing and how to deal with financial issues. In this way individuals or families would be well-monitored or followed in financing. He further explained that prior to establishment of bank offices, a socioeconomic survey of families could be conducted to build a base of information on clients and their resources.

The connection between farmers and the Agricultural Bank is weak, but it can be activated. The actor from the Agricultural Bank already gives ideas on how this connection can take place. The strong connection between farmers' committees and the bank can play a role in this idea. Farmers' committees can help disseminate information to farmers, and they can facilitate the work these branches do on the ground.

We noticed that farmers have no connections to the Agricultural School in the scheme. However, the school itself had been weakly connected to most actors within Rahad. According to results from the Rahad scheme network, it is found that the El Fau Agricultural School, Health Administration, and Women's Union are peripheral in the the Rahad scheme formal network; they have fewer connections within the network of the scheme but are connected with other circles outside the scheme's formal network. Therefore at the beginning, there is a need to activate connections between the school and the other actors within the Rahad scheme network. Then at the next stage, the connections of the school with farmers can be reworked.

How farmers in Rahad view their connection to the Pastoral Union
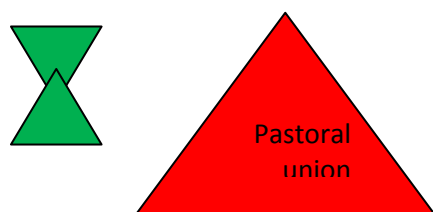
Farmers were asked their opinions on the Pastoral Union and its roles in order to understand how both are connected. Although tenants within the scheme had heard about the Pastoral Union, they generally had no exact information on what the Pastoral Union should be doing or what its responsibilities were. Instead, they just probed many possible responsibilities for the union (interview 24, paragraph 96; interview 26, paragraphs 40, 43; interview 37, paragraph 22; interview 53, paragraph 24). This lack of information about the Pastoral Union could be due to the fact that the union is a relatively new organization in the area (interview 45, paragraph 4).

Other tenants had a strongly negative opinion of the Pastoral Union and thought it was a political entity that cannot do real work (interview 18, paragraphs 41, 42). They continued arguing, *"All unions now have a political face. They do not care for the person whom they are*

meant to save. They are loyal to the ruling party, so they make use of these privileges and forget about us. They are not technically skilled and do not serve, while the honest ones who cares for the land are away from the decisions" (interview 18, paragraph 51).

Therefore, there is no connection between farmers and the Pastoral Union in regards to communicating information on grazing issues. However, in other parts, the researcher has suggested creating a relationship between the Pastoral Union and farmers' committees. Creating such a relationship can result in more knowledge shared among the Rahad scheme actors.

Connection of farmers to the Rahad research station
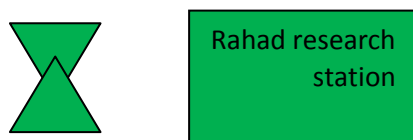
The Rahad research station has expressed good connections with farmers during their technical work. *"We had s good relationship and communication with farmers, and they were our friends. The farmer would be happy if he meets a researcher, and they used to call us at home, but now we are disconnected with them after the arrival of KIAS"* (interview 3 paragraph 10).

However, EL HASSAN (2004) argued that conducting FFS and T & V approaches in the Rahad scheme (1986-1993, 1994-2000) improved or strengthened the linkages of the Rahad research station with the Rahad scheme. Some activities of these approaches included contacts, visits, and meetings of research staff from the Rahad research station with farmers in the Rahad scheme (EL HASSAN 2004). Accordingly, the station expressed its relationship to farmers as a formerly good one. The researcher argues that conducting extension approaches aimed to improve connections of extension to research such as FFS and T & V in the Rahad scheme had fostered the linkages between the Rahad station and extension work in the Rahad scheme at the time. The good connection of research and extension in the Rahad scheme reflected good connections of researchers with farmers. However, once the extension approaches were withdrawn, the connection became weaker. In spite of these positive comments on farmers'/researchers' relationships in the Rahad scheme, the actor is not happy with the level of farmers' interest in farming. The actor thinks, *"Farmers are not interested in being farmers. In their nature they are Arabs moving with animals, researchers and extensionists were forcing them to become farmers, and up until now the farmer would like to plant his entire farm with fodder for his animals and leave a small space for sorghum* (interview 3, paragraphs 15, 16).

At the field level there is no data showing a connection of farmers to the Rahad research station; however, farmers' leaders, specifically within the Farmers' Union, are aware that the station is a source of information for extension activities in the scheme (interview 21, paragraph 25).

The Rahad research station actor criticizes farmers' interests in caring for fodder and animal rising. Moreover, the actor views farmers in Rahad as not the *real farmers*, the real farmers, according to the research station's perspective, are the ones who apply technical packages of cropping or research recommendations on farms.

Researchers are questioning whether research interests in the Rahad research station can be changed, that the station can direct its research to fodder production in the scheme. According to reviewed literature research on agriculture in Sudan since pre-independence times has mainly focused on cash crops, and little research interest has generally been given to ranges or fodder production (BEINTEMA et al. 1995; CFSAM 2011; AHMED et al. 2012). Therefore, there is a need to create connections within agricultural research to research on fodder. The Rahad scheme can help create such a policy shift by creating core/periphery networking between the Rahad research station and the Agricultural Research Corporation (KREBS and HOELLY 2004).

In researchers' thinking, farmers have been disconnected from farming in Rahad because sociological research is not found within the sections of the Rahad research station (ARC 2007; BEINTEMA et al. 1995). Involving rural sociology research in the area would provide a deeper understanding for the social aspects of Rahad communities. Connection to rural sociology research can be a future networking of relations in the Rahad scheme. The Rahad scheme extension department can connect with nearby universities such as Gezira University to conduct sociology research within communities of the Rahad scheme.
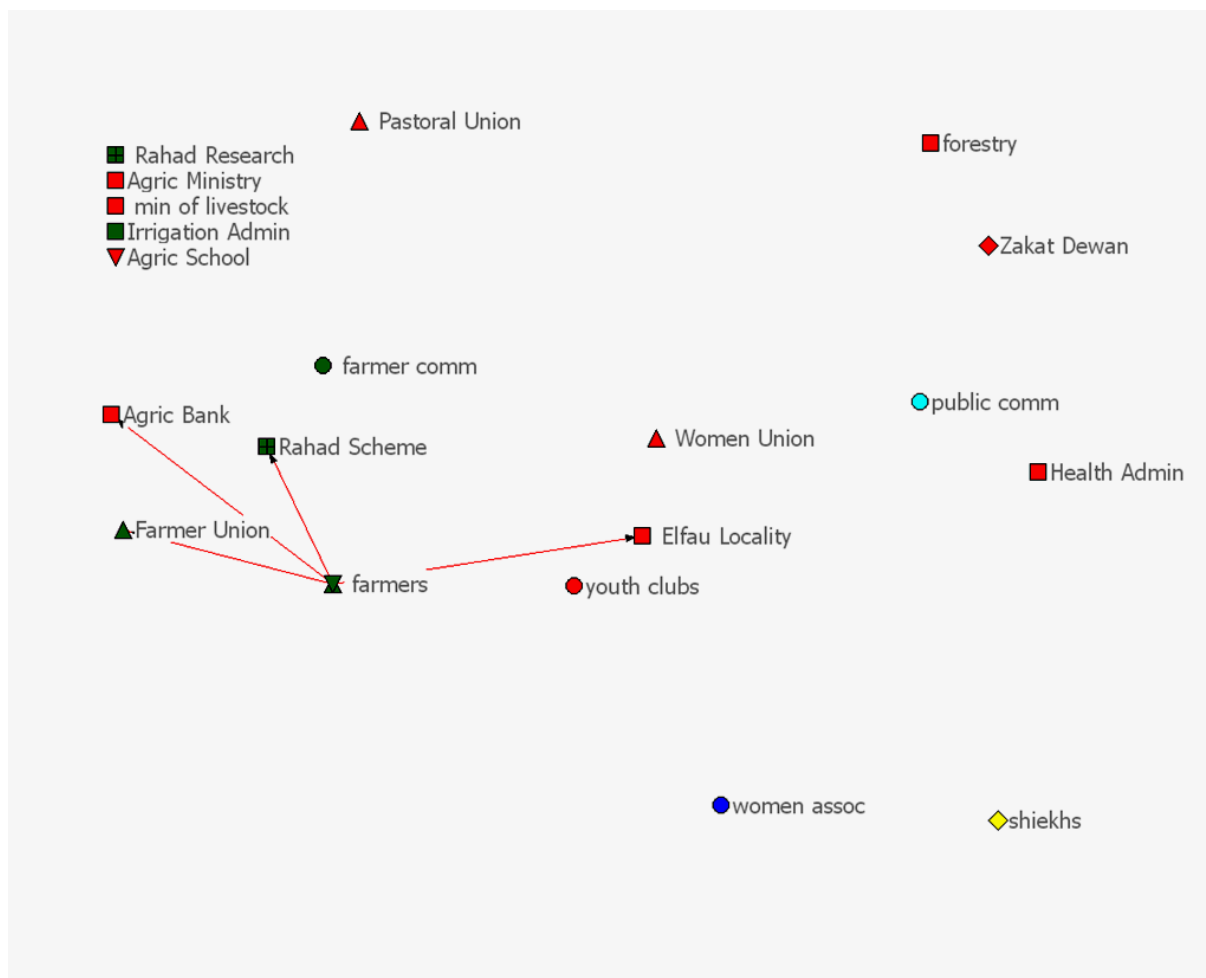
Figure 56: farmers' network
Source field data: 2010
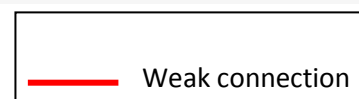
Weak connection

Farmers symboled as green traingle are weakly connected to Rahad scheme administration, Farmers' Union, and El Fau Locality excutive offive

Summary of connections of actors at the Rahad scheme level and actors at the village level

1-Youth club members in the Rahad scheme are looking to improve their bonding relationships with farmers in order to have bridging linkages with them. This could be achieved by strengthening the youth's weak ties to farmers' committees and public committees.

2-Ties between the Women's Union and women's associations in the Rahad scheme cannot be straightforwardly worked out; the researcher suggests that the extension department in the Rahad scheme needs to map the activities of different actors including the women's associations in the scheme area in order to provide direction for better connections and networking of relationships.

3-Public committees in the Rahad scheme area can be local bridges between weakly connected or unconnected actors, for example, the public committee can connect youth clubs to the Rahad scheme as well as the Women's Union to the Rahad scheme.

4-Involvement of previous local sheikhs in decision making within farmers' organizations can foster knowledge sharing within the Rahad scheme.

5-Power issues dominate the relationship or the connection between the farmers' committees and the executive of the Farmers' Union.

6- Farmers' committees have strong connections with some actors in the Rahad scheme. Strong connections can increase access to more information within the network. Creating a relationship between the Pastoral Union and the farmers' committees can lead to access to more information and better possibilities for animal keepers within the Rahad scheme.

7-Extension approaches used in Rahad were financed and supported by international agencies, and there has been no national extension approaches directed towards extension work within irrigated schemes. Therefore, farmers, extension, and research connections worked well according to the objectives of these extension approaches, mainly T & V and FFS.

8-Farmers in the Rahad scheme base their knowledge of farming on their parents or formal experiences within rain-fed farming.

9-In order to improve the relationship between extension work and farmers, the extension department needs to create knowledge sharing between different farming practices, for example exchanging information on extension approaches used in other parts of the country or considering rain-fed farming practices within irrigated farming practices.

10-To strengthen connections between farmers and the Agricultural Bank, the bank can establish branches or offices in the villages. Farmers' committees can help disseminate information to farmers and can facilitate these branches' work on the ground.

11-The Rahad scheme can create a policy shift in the area by creating core/periphery networking between the Rahad research station and the Agricultural Research Corporation in order to consider fodder production within the scheme. The scheme can create networking between universities and local communities in order to access sociological research in the Rahad scheme.
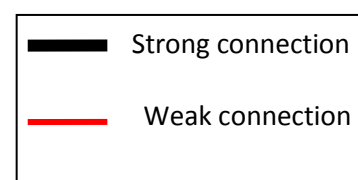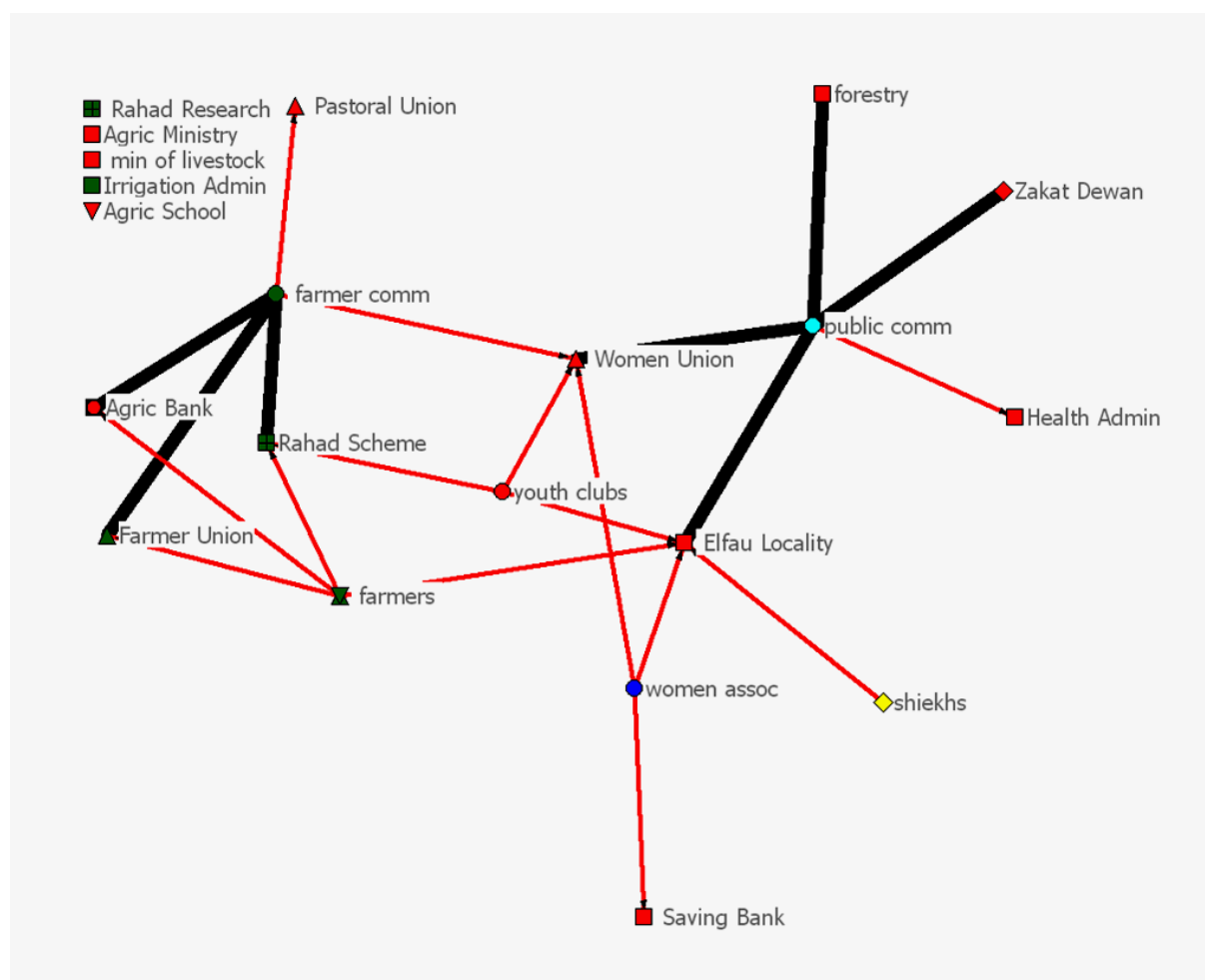
Rahad Scheme level

Rahad research	Agric min	Rahad admin	Farmers' Union	Agric bank	Saving Bank	Elfau locality	Zakat dewan	Health admin	Forestry	Pastoral union	Irrigation admin	Agric school

Village level

Public comm	Farmers commitees	Women's associations	Youth clubs	Public committees	shiekhs	Farmers

Figure 57: Strong and weak connections at scheme and village network
Source: field data 2010

Figure 57 shows weak connections and storng connections between actors in villages and actors at scheme level, the blue lines are strong connections and red lines are weak connections. In the figure it is noticed that public committees andfarmers' committees are the strongly connected with actors at scheme level.

6.5.7 Density of the total network in the Rahad scheme

In diffusion research, network density is associated with faster diffusion; higher network density indicates that there is a lot of communication among individuals within the network (VALENTE 1995). In line with this fact, RAINI et al. (2005) found that the flow of information within the Tomato IPM (Integrated Pest Management) network in Kenya was low due to it being a less densely knit network. However, the sparsely knit network of the Tomato IPM indicated connections through weak ties to other sources of information outside the network (GRANOVETTER 1973). A study by SPIELMAN et al. (2010) measuring how Ethiopian small holders make use of new knowledge and technology in their livelihood decisions, they found that innovators have more ties to a large number of actors than non-innovators. That makes the innovator network larger but less dense than that of non-innovators. The density of actors in the total network of the Rahad scheme is 0.2556, which indicates a low density network (see table 6). However, online with reviewed literature, this low density network is connected through weak ties to outside the scheme area; examples are the connection of the Pastoral Union and Women's Union to their respective unions at federal levels in Khartoum or in Gedarif State. Local sheikhs and farmers are also considered connected to outside sources of knowledge such as their connection to the local experience of livestock keeping and farming within rain-fed farming. Therefore by strengthening of these weak connections, in future, knowledge on farming within Rahad Scheme can be better networked and thus perofmance of Rahad scheme would improve.

Input dataset	Local formal connection(Z:/ ucinet/local formal connection)
Output dataset:	local formal connection-density (Z:\ucinet\local formal connection-density)
Density	0.2256
No. of ties	23.0000
Avg. degree	3.8333

Table 6: Density of scheme and village network
Source: field data 2010

7 Views of Rahad scheme actors on their weakness and strength

In this chapter the results of the analysis are connected to the research recommendations of this study. The main recommendation of this study suggests a methodology to improve knowledge networking on farming and livestock keeping within the Rahad irrigated scheme.

7.1 Roles of actors at the Rahad scheme level

7.1.1 Extension and technology transfer department in the Rahad scheme

This department is responsible for running extensional approaches to farmers; three extension approaches are conducted in the Rahad scheme. Those approaches were the commodity approach, T & V, and FFS. Researcher has discussed implementation of these approaches in chapters five and six of the thesis. Interviewed extensionists believed that a new way of extension needed to be considered. They also mentioned issues such as the fact that renting or sharing farmland with laborers had helped increase farmers absence from farms and lessened the contact of farmers with extensionists. The researcher argues that extension approaches implemented in the Rahad scheme were designed based on individual models of diffusion of innovations, meaning that performance of farming in the Rahad scheme depended on individual farmers adopting the required farming activities (LEEUWIS 2004; ENGEL 1997). In order to improve extension performance in the Rahad scheme, it is important to view adoption of innovations as a complex process that involves communication and networking of different actors who can be sources of different information and knowledge on farming and not focused on individual farmers' performances.

7.1.2 Rahad research station

The Rahad research station was constructed to serve the scheme with research and to serve people in the area since the 1970s. Administratively, the station follows the Research Corporation in Medani, but it technically followed the Rahad scheme. EL HASSAN (2004, 82) commented that, "The mandate of the Rahad research station calls for experimentation on the relationship of crops for the Rahad Agricultural Corporation, both as field crops and vegetable crops."

The station right now conducts research on cotton breeding. Research subjects conducted by the Rahad research station represent agricultural research policies in Sudan the Rahad

research station is a source of scientific knowledge on farming, mainly field crops and vegetables in the area. A technical connection between the Rahad scheme and the Rahad station was established during the implementation of the T & V approach, but this technical connection was not maintained independently. In the researcher's opinion, performance of the Rahad reserch station is highly technically focused on irrigated cropping; however, research on fodder production and management, and sociological research also need to be established within the station.

7.1.3 El Fau locality

The executive unit in the El Fau locality is responsible for managerial work within the locality. Detailed roles of El Fau locality are explained in chapter 5.

 El Fau locality excutive unit is coordinating the work of ministries and offices that follows it. The interviewed actor from the Ministry of Livestockmentioned that the meeting that takes place monthly with the executive office is just a routine meeting where performance reports are handed in, but there are no ideas or suggestions discussed during this meeting. The Health Administration officer agreed that there is no unified vision of the work; there is no one who takes responsibility and directs others. He referred this situation to shortages of funds and facilities, and leaders in the localities are mainly concerned with securing their political positions and power rather than doing real work.

The locality is responsible for forming a technical committee to estimate the problem or the damage to farming land caused by animal owners see chapter 5. Interviewed farmers in the rain-fed area said that they also depend on themselves for solving herding/farming tensions. They use their own knowledge for solving farming/herding issues, as they mentioned. *"Here when we finish harvesting sorghum, we do not allow animals to enter. There are spaces for the animals to stay outside of the farms, and we used to keep the animals in these empty spaces until harvest"* (interview 27, paragraph 32). The researcher thinks farmers in irrigated farms within the Rahad scheme need to make use of such institutional and local arrangements in dealing with issues of crop damage by animals. In this case the Pastoral Union and farmers' committees within the Rahad scheme need to cooperate together.

The locality is also responsible for official appointing of local leaders (sheikhs). Presently the locality supervises locals in villages through local organizations named with public committees who are responsible for estimating and working to provide social services needed in villages. The appointment of local leaders and public committees by the El Fau locality created a sort of confusion about the roles of both actors on villages. Generally local sheikhs

think the public committees have overtaken many of their responsibilities in villages. The researcher thinks to get out of this situation; local sheikhs need to be officially involved in farming and grazing within the Rahad scheme and El Fau locality more than competing with public committees in serving the villages.

7.1.4 Ministry of Agriculture

The Ministry of Agriculture is represented by an office responsible for monitoring and following agricultural activities for rain-fed farming areas within the El Fau locality.

Activities of the office are mainly to conduct extension activities and apply pest controls; the office also has a section for plant protection, which is responsible for controlling national pests or any other horticultural pests.

Herding and farming activities within the locality include some tensions. Especially during rain shortages, herders graze closer to or inside rain-fed farms. In these cases, farmers usually report to the Ministry of Agriculture, and the latter tells farmers to report to law enforcement (interview 2, paragraph 21). The Ministry of Agriculture depends on its own resources to implement extension work. Interviewed farmers in rain fed areas have expressed the need for extension in order to acquire information on controlling some plant diseases. They also mentioned no extension work was planned for women's associations or farmers' associations in the area. Therefore, in spite of human resources allocated by the Ministry of Agriculture for extension work within rain-fed farming areas, there is a need for more rigorous and intensive extension work in communities of rain-fed farming. The Ministry of Agriculture can be a gate to contact rain-fed farming communities, meaning that it can facilitate the exchange information on rain-fed farming and animal grazing in the area.

7.1.5 Ministry of Livestock

According to the manager of the ministry's office, the role of the Ministry of Livestock in El Fau is mainly to monitor animal health for cattle within the El Fau locality (interview 15, paragraph 4), while the animal production officer thinks the ministry is also responsible for applying animal production activities or responsible for making use of the economical viability of animal stock in the area (interview 6, paragraph 17; interview 15, paragraph 21).

The Ministry of Livestock supports and adopts scientific methods for animal production, but the pastorals still retain their cultural way of raising animals (interview 6, paragraph 19). The ministry has reported poor equipment and transportation in perusing its role of educating about animal production. The Rahad scheme has a unit for investment in animal production,

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but there is no linkage between the Ministry of Livestock and the Rahad scheme in this regard. The scope of our research study is not to make a radical change in livestock research, but the researcher is pointing to and stressing the gaps in development of agro-pastoral communities. Reviewed documents of the Rahad scheme proved the importance of integrating animals into farming within the scheme. However, our research results proved that extension work had concentrated on cropping production (cotton, groundnuts, and sunflowers). This would indicate that the relationship of animals to farms have not evolved to the level of policy measurements within the scheme.

7.1.6 Irrigation Administration

The Irrigation Administration works to facilitate the provision of water requirements to farms in the Rahad scheme. Regulations on water use at the farm level will be given to extensionists through regular seminars held by the Irrigation Administration (interview 12, paragraph 18). According to the actor, the Irrigation Administration provides a room for the local people to participate in providing water requirements for the scheme farms (interview 12, paragraph 12). Farmers sometimes quarrel in watering intervals during times of water shortages (interview 19, paragraph 12).

Among the concerns within the Irrigation Administration is watering animals and humans besides plant irrigation. The interviewed Irrigation Administration actor mentioned that there are some problems in using irrigation water in Rahad. Animals that graze outside the scheme area are brought to the scheme in the summer time. Pastorals might use any part of the canals, which can damage these canals of irrigation. The mentioned statements indicate the necessity of more extension work to improve water management in the Rahad scheme, either by farmers within the scheme or pastorals outside the scheme.

7.1.7 Health Administration

The Health Administration is responsible for providing health services, health education, and controlling health problems within the El Fau locality (interview 13, paragraph 3). Providing health services includes services of primary health care such as treatment and vaccinations for children and mothers, services of environmental health including spraying of insects, condemning dead animals, supervising the cleaning of villages, and drying canals (interview 23, paragraphs 3, 10). Control of diseases includes control of waterborn diseases and diseases such as malaria and AIDS (interview 13, paragraph 35). In implementing these services, the office applies health education methods that include training courses and workshops for staff

and volunteers from the local community (interview 13, paragraph 35) (FEDERAL MINISTRY OF HEALTH 2010).

Collected data from villages proves that activities of the Health Administration office are mainly performed at the level of head sections, but not all villages of the scheme are covered with these services. Accordingly, interviewed villagers have complained about deteriorating health situations in villages such as an insufficient number of latrines in villages, outbreaks of malaria and bilharziasis. The actor of health services mainly works alone with no coordination or contact with actors at the Rahad scheme level. However, according to the Health Administration actor, the success of the health system can be measured with how closely the work is connected with related institutions (interview 61, paragraph, 47).

7.1.8 National Forest Corporation -El Fau

The National Forest Corporation in El Fau represents the Ministry of Agriculture and Forests in Gedarif state (interview 9, paragraph 2).

Implementation of corporation roles is accomplished by involving local people and conducting extension work (interview 9, paragraphs 4, 6, 10).

In regards to conducting the extension work on forests, the actor believes that El Fau is a nomadic area and there are difficulties making people understand the corporation's role (interview 9, paragraph 33). Therefore, the actor expresses a need for more effort to increase awareness of people. The actor is criticizing the present level of communication between forest corporations and other actors. He suggests that more meetings and more shared plans should be organized. *"We as institutes of development here that have relevant roles should be meeting regularly or have common plans that we can discuss together in regular gatherings, but now we just meet in public celebrations"* (interview 9, paragraph 34).

7.1.9 El Fau Agricultural Secondary School
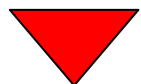
The El Fau Agricultural Higher Secondary School follows the Ministry of Education in the state of Gedarif (interview 10, paragraph 2). See detailed role of Agricluture School in chapter 5.

Unfortunately, the school misses qualifications that make it a proper Agricultural School such as labs, experimental fields for animal production, and workshops for agricultural engineering practices (interview 10, paragraph 15). The Headmaster of the school believes missing these facilities makes the school less enticing for students to come and study at, and yearly new

intakes are low. He further mentioned that if the school got these qualifications it could practice its role in the community better (interview 10, paragraph 15).

An interviewed teacher from one village hoped that in the future the agricultural education in the area could develop to become a college education. In a discussion with one youth group, they mentioned that farmers in the area of the scheme are not connected to their farms. *"Farmers are not yet settled in the domain for farming."* They believed this situation is due to the fact that there was no accompanying education on farming. According to them, the recently established Agricultural School can provide this missing education, and maybe the connection of farmers to farming would improve (interview 41, paragraph 25).

The actor of the Agricultural School believed that students of the school can also be involved in extension work within the scheme; the school can design a simple and understandable syllabus to be taught by students to farmers (interview 10, paragraph 10). However, according to the school syllabus, agricultural extension it is not included in the list, so more work needs to be done to achieve this role. Moreover, the school needs to establish connections with the extension and technology department in the Rahad scheme.

7.1.10 Zakat Dewan
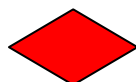
Zakat Dewan in El Fau is the institution responsible for collecting *zakat al mal* from farmers in the locality, either within the rain-fed area or irrigated Rahad scheme (interview 14, paragraph 3).

After collectimg *zakat*, Zakat Dewan either redistributes it to needy people directly or invests the money into micro-projects for the poor. Most aid projects offered by Zakat Dewan cover farmers within rain-fed areas in the El Fau locality (interview 14, paragraph 32) The role of Zakat Dewan in establishing agricultural associations had been recognized by interviewed farmers, assuring us that last year Zakat Dewan constructed associations for poor people and that executive members of the associations got trained in Gedarif state on how to deal with tractors and how to deal with membership (interview 27, paragraph 45). However, Zakat Dewan does not coordinate with the Ministry of Agriculture in establishing or managing these agricultural associations.

Zakat Dewan has representatives in the villages called *zakat* committees to assist in collecting *zakat* and identifying individuals who in need it (interview 14, paragraph 5).

According to the actor of Zakat Dewan, the behavior of the people who work on *zakat* collection can be a problem sometimes. *Zakat* committee members belong to certain tribes; in distributing projects, they show bias for members of their tribes or relatives (interview 14,

paragraph 38). This bias in *zakat* distribution was also complained about by the interviewed women's association (interview 48, paragraph 53). The Zakat Dewan actor also mentioned that sometimes families would misuse the project for other purposes, such as paying school fees for their kids (interview 14, paragraph 40).

On poultry projects, local people do not understand the best or proper conditions of poultry rising and need training (interview 14, paragraph 41). The Ministry of Livestock in El Fau does not have regular connections with Zakat Dewan in monitoring goat rising or poultry projects. Therefore, Zakat Dewan needs to recreate or improve linkages with the Ministries of Agriculture and Livestock in order to coordinate implementation of *zakat* projects.

7.1.11 Sudanese Agricultural Bank

The Sudanese Agricultural Bank is financing irrigated scheme farmers and rain-fed farmers with all types of crops. For example, for cotton crops the bank would finance all farming operations by supporting inputs of seeds, fertilizer, and cost of spraying cotton with chemicals (interview 4, paragraphs 2, 3). In the first years of running the finances, local people would not or could not recognize what the bank was and what it was doing (interview 4, paragraph 13).

Although the bank had been financing farmers in El Fau since the 1990s, fewer people from the villages would come to make use of its services in relation to agents from El Fau city (interview 4, paragraph 13).

More connections from local people towards the bank can be gained through establishing branches or offices of the bank in the villages. These offices will make bank services closer to local's people; they can also be trained on projects the bank is financing and how to deal with financial issues. In this way individuals or families will be well-monitored or followed in finances.

7.1.12 Savings and Social Development Bank
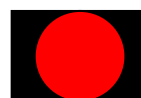
The role of the Saving and Social Development Bank is to finance a limited slice of people or families with limited income whom are also called by the bank small producers (interview 4, paragraph 22). The bank uses micro-finance policies to increase the income of people, which will reflect on the economic growth of the community in the area (interview 4, paragraph 22). The actor thinks the community needs awareness on handling micro-projects, and awareness is acquired from society, but his institution can bring the service (interview 4, paragraph 88). Actors such as the locality can help increase awareness of handling micro-projects by

conducting workshops and seminars, especially for agents or associations following the department (interview 4, paragraph 56). Local leaders can help facilitate the process of the project implementation itself such as selecting the best projects for the agents and reporting payment. This procedure can help individuals avoid failure in a timely manner (interview 4, paragraph 74).

7.1.13 Rahad scheme Farmers' Union

The executives of the Farmers' Union attend meetings with the administrative council of the scheme (interview 11, paragraph 4). In those meetings union representatives are able to supervise input supply to the farmers and money circulation within the scheme (interview 11, paragraph 4).

Members of the executive committee in the union have authority to delegate services to the section committees (interview 11, paragraph 4). The Farmers' Union in the Rahad scheme was among the decisionmakers for the privatization of the scheme (KIAS management from 2010-2012). The secretary of the Farmers' Union is a member of the High Council of Agricultural Development, which is a political body containing politicians at the presidential level (interview 11, paragraph 15). This council suggested private companies as alternatives for managing national schemes, among them is the Rahad scheme (interview 11, paragraph 15).

The political involvement of the Farmers' Union in the area was negatively commented on by interviewed farmers. They described union members as individuals of high status who basically work to secure their own social prestige. Accordingly, farmers have suggested that the Farmers' Union should allocate more time and planning to work on improving social services in scheme villages. Other interviewed actors such as the Women's Union and women's associations stressed that they currently get no support from the Farmers' Union for their work. It is known that the Farmers' Union used to support women's activites in villages through the department of social services and development in the Rahad scheme.

The researcher thinks that the roles of the Farmers' Union in the Rahad scheme reflect a strongly organized union in the scheme.

7.1.14 Pastoral Union

The Pastoral Union in El Fau deals with problems or issues within rain-fed farms and Rahad scheme farms. The Pastoral Union is an organization aiming to improve people, (the pastorals), animals, and pastures. This main goal will be achieved by providing social services

for pastorals (health and education), improving access to pathways, and providing proper veterinary services and water points for pastorals (interview 45, paragraphs 5-8).

The Pastoral Union actor views pastorals as a crucial economic sector in Sudan because livestock export is one of the main components of the national economy in Sudan (AHMED et al. 2012). In spite of this fact, Pastoral Union thinks pastorals continue traditional grazing and retain their traditional way of raising animals (interview 5, paragraph 10) Therefore, the actor has expressed a need for proper services of artificial insemination for cattle, proper milk and meat production factories in the area, and programs of capacity building for pastorals in fodder production and processing (interview 5, paragraphs 10, 11). On the other hand, the Pastoral Union argues for pastoral development as a policy for developing human beings in their area.

In spite of the ideas given by the Pastoral Union, there has been no thought to conduct regular, organized education programs for the Pastoral Union members or for individuals who move with animal "shepherds" (interview 44, paragraph 22).

Another representative of the Pastoral Union reported that the union within the Rahad scheme is not involved in the committee that decides fines for damage caused by animals during grazing on farms.

Although farmers within the scheme have heard about the Pastoral Union, they generally have no exact information on what the Pastoral Union should be doing or what its responsibilities are (interview 24, paragraph 96; interview 26, paragraphs 40, 43; interview 37, paragraph 22; interview53, paragraph 24).

Other farmers had a strong negative opinion about Pastoral Union. They thought the Pastoral Union is a political entity and cannot do real work (interview 18, paragraphs 41, 42). If the Pastoral Union is to get involved in decision making regarding farming in the scheme, it needs to be considered as an equal and parallel farmer organization.

7.1.15 Women's Union

TheWomen's Union implements programs that are designed by the state and then given to localities, meaning that activities of the Women's Union cover villages within the scheme area and outside the scheme see chapter five and (interview 8, paragraph 5)

The Women's Union participates in a large proportion of political work (we participate in the national conference, which is the biggest power of women here) (interview 43, paragraph 8).

The Women's Union participates in social events, helping poor families by donating money (interview 43, paragraph 8).

The Women's Union in villages also expressed shortages of funds to run activities. In order to solve this, sometimes they would collect share money from members to pay for transportation or the running cost of activities (interview 43, paragraph 59). The Women's Union expressed future hopes of having a university in El Fau city (interview 43, paragraph 59). The union also expressed an improvement of health clinics, drinking water, and local roads to El Fau city (interview 43, pargraph 72).

The Women's Union is a sound organization for women in the study area; the organization is considered the official representative of women. However, the union is mainly known for its political engagement at the El Fau locality level rather than for performing its economic role in villages. Accordingly, the Women's Union has been described as a political organization throughout field work.

Since the Women's Union is a popular actor in the Rahad scheme, there is a need for it to play a balanced role in the area. It is important that some actors of the Rahad scheme help the Women's Union pursue its economic role more than political engagement. Finance institutions, the extension department, and farmers' organizations can be examples of actors who assist the Women's Union in getting more engaged in alleviating the economic situation for women within the Rahad scheme.

7.2 Roles of actors at village level

7.2.1 Public committees

Public committees in El Fau locality are responsible for representing the locality by monitoring social services including education, health, and security (interview 7, paragraph 18) Public committees resemble a micro-government, and it is entitled to control any illegal or intruding problems (interview 28, paragraph 4)

Interviewed farmers recognize the role of public committees in solving problems in villages However; farmers did not mention public committees in issues related to exchanging information on farming (interview 84, paragraphs 26-29; interview 37, paragraphs 25-29).

Therefore, the public committees influence actors in the El Fau locality and can influence the decisions made by farmers' committees, especially in the case of donations of farmers from crops to support the social services in the villages. The influence of public committees in villages can challenge network building or weaving among actors in knowledge management within the scheme this challenge is valid because public committees are basically political and empowered actors in the scheme area.

7.2.2 Youth clubs

Youth in the Rahad scheme form social clubs through which they mainly form foot ball teams and some social events (interview 42, paragraph 5; interview 41, paragraph 11; interview 39, paragraph 12; interview 38, paragraph 6) more details on youth clubs roles are in chapter 5. Some local leaders expressed that they do not know what is going on in youth clubs. They do not go there, but they hear youth shouting during football matches (interview 37, paragraphs 27, 29). Accordingly, sheikhs think the youth are more engaged with their clubs rather than working on farms or helping their fathers (interview 37, paragraphs 27, 29). Interviewed farmers appreciate the fact that there are clubs within villages for youth; they also appreciate the activities of the clubs such as forming football teams or watching TV (interview 27, paragraph 118). Other farmers are included within youth meetings on how youth can enlarge their activities in the villages (interview 26, paragraphs 51-54). Farmers agree that youth avoid farming activities or being involved in farming issues because working on farms is not an attractive activity for them these days (interview 18, paragraph 53). Youth indicated the need to get involved in farmers' organizations. This thinking can indicate their desire to change their role within the Rahad scheme. Regular finance resources or good equipping for social clubs can work to improve the general welfare in villages. Therefore, the researcher also argues that connections between youth clubs and farmers' organizations in the Rahad scheme need to be established.

7.2.3 Farmers' committees
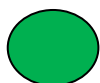
Farmers' committees are responsible for linking farmers with the extensionists; some information is communicated from extensionists to the farmer committee and then to farmers (interview 23, paragraph 8) see also chapter 5. Some interviewed farmers have recognized the role of farmers' committees in directing farmers with information inside farms, mosques, or clubs (interview 24, paragraph 39). However, other farmers think the farmers' committees are distant from farmers (interview 18, paragraph 65). Although there are negative comments given by farmers on the role of farmers' committees, farmers' committees are still important actors in exchanging information on farming within the scheme. However, in order to share information on farming with more actors, farmers' committees need to extend their connections to other actors in the scheme, especially youth and Pastoral Union members. In this way the innovation of the Rahad scheme can perform with better information circulation and thus better ideas and better problem solving.

7.2.4 Local leaders (sheikhs)
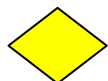
The present roles of local leaders in the Rahad scheme are mainly to keep security and solve problems between members of tribes see chapter 5. During field work local leaders described the present delegation of some authority for them by the government to be not fair enough compared to their past role, especially their roles in farming and grazing issues. They think the public committees are overtaking more authority in the villages. However, some interviewed local sheikhs believe they are more experienced and knowledgeable in planning for the welfare of their villages and solving challenging issues such as taxation over herds and disputes over pasture, land, water, and animals. The researcher thinks the experience of local leaders needs to be recognized by the extension department in the Rahad scheme as well as the El Fau locality.

7.2.5 Women's Associations

 Activities of Women's associations are mainly revolving fund projects and some education events such as Quran learning and illiteracy lessons (interview 48, paragraph 16; interview 49, paragraph 130) see also chapter five.

Generally there is a weak vision among members to develop the work of these associations. However, some associations mentioned trading activities for women to be financed from banks, and registering land for the women of the association to farm (interview 30, paragraph 40). Improvement of drinking water and rehabilitation of main roads to El Fau city have been mentioned by women as ambitions for a better life within the scheme (interview 30, paragraph 46).

Most interviewed associations are yet not officially registered at the El Fau locality, which indicates poorness of communication for these associations with actors. The Women's Union, a formal organization for women in the scheme area, perceives women's associations as dependent organizations to union activities. Some women's associations reject this idea and have expressed independence from the Women's Union.

Women's associations are in need of better organizational skills and better vision for their role and activities. The extension department in the Rahad scheme and the Ministry of Agriculture in El Fau can coordinate to be responsible for this evolution in women's activities in the Rahad scheme and El Fau generally. As a prior step, connections between women's associations and the Rahad scheme need to be created.

7.3 knowledge networking between actors at the Rahad scheme level

The Rahad scheme is strongly connected with the Rahad research station, Irrigation Administration, Forest Corporation, and Farmers' Union. The El Fau locality is strongly connected with the Ministry of Livestock, Ministry of Agriculture, Health Administration, and Zakat Dewan, (figure 58 is a trajectory showing connections among actors at scheme level). Reviewed literature has proved that communication of information can be limited within actors that know each other well. Therefore information can be stagnant within the strong connections. However, strong connections are not always an obstacle in communication; they can also boost information exchange in innovation settings the research station of Rahad is a source of agricultural information because it is connected to the National Research Station of Sudan.Research stations are important stakeholders for developing policies and planning agriculture in the whole country. Moreover, during data collection, we found that the Rahad research station itself has no component of sociological research within its section (socioeconomic and extension research departments are found in the headquarters in Medani) (interview 3, paragraph 12) If they expand, such a department in the Rahad research station could bring new insights to the social sphere of communities benefiting from the scheme.

The El Fau Agricultural School, Ministry of Livestock, and Women's Union are peripheral in the network at the Rahad scheme level; they have fewer connections within the network of the scheme but are connected with other circles outside the Rahad scheme network. If the connections of the mentioned actors are maintained within the scheme, the El Fau Agricultural School, Ministry of Livestock, and Women's Union can bring new knowledge and ideas to the innovation. The El Fau Agricultural School represents a formal education in farming in the area. The El Fau Agricultural School is not getting any support to train students in agricultural practices, but students who study in the school are sons of farmers in the area with well-organized and equipped training in farming. In the long run, students can add further farming knowledge of innovations in the Rahad scheme.

The Ministry of Livestock also has weak connections to the rest of the actors; actually the Rahad scheme had a department of investment in livestock that had its own technical staff. The Ministry of Livestock is not contacted for information or consultation on livestock issues by the scheme (consultation on diseases or animal production activities) (interview 70,

paragraph 3). However, the Ministry of Livestock is connected with the animal research center in Gedarif state (interview 15, paragraph 15); building connections between the Ministry of Livestock and the animal production department in the Rahad scheme can merge and integrate activities and new ideas on animal production within the Rahad scheme.

The Farmers' Union and Pastoral Union are related negatively to each other in regards to livestock keeping and farming activities. Each actor had its own ideas about the better function of farming and animal keeping in the area. Therefore, both actors poorly communicate on these issues. To facilitate communication between both actors, there is a need to create connections between the both actors.

Figure 58 Connections at Rahad scheme level
Source: own preparation
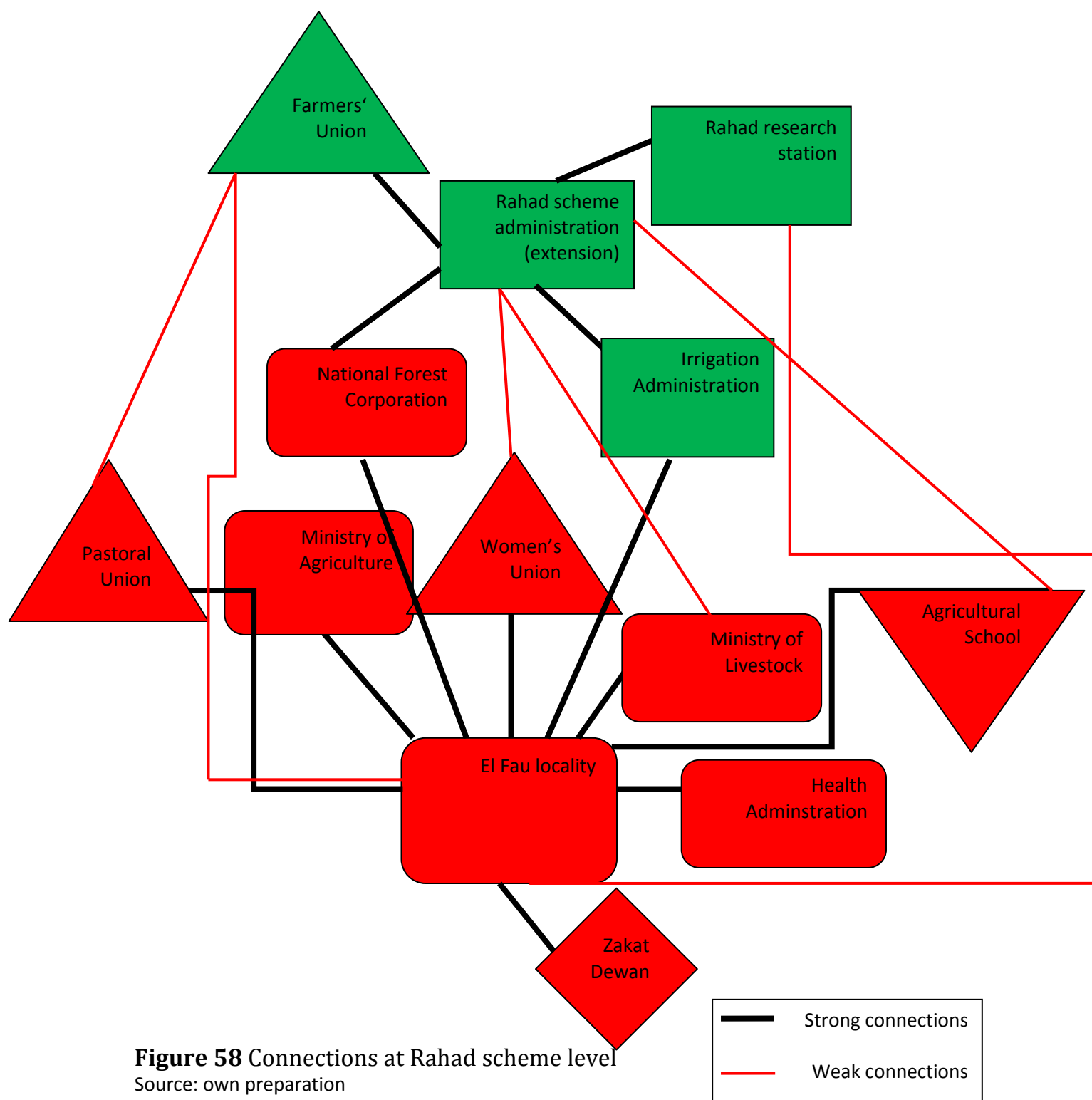
Figure 58 Shows connections at scheme level, black lines indicate strong connections, red lines are weak connections. Rahd scheme admnisitration is strongly connected to Elfau locality through irrigation admnisttration and National Forest Corporation. At elfau locality, Animal wealth Ministry, Women's Union and El FauAgricultural School are weakly connected to Rahad scheme administration

7.4 Knowledge networking between actors at scheme level and actors at village level

Extension approaches used in the Rahad scheme were financed and supported by international agencies, and there have been no national extension approaches directed towards extension work within irrigated schemes. Therefore, farmers, extension, and research connections worked well according to the objectives of these extension approaches, mainly T & V and FFS approaches. In order to improve the relationship between extension work and farmers, the extension department needs to create knowledge sharing between different farming practices, for example, exchanging information on extension approaches used in other parts of the country and considering rain-fed farming practices within irrigated farming practices. Considering rain-fed farming is important because farmers in the Rahad scheme refer their knowledge on farming to their parents or formal experiences within rain-fed farming. (See figure 59 which sumup connections between actors at scheme level and actors at villages' level)

Information on finance comes mainly from finance institutions within the Rahad scheme, specifically the Agrciultural Bank and the Savings and Saving and Social Development Bank. Farmers are indirectly connected to these institutions through farmers' committees or local leaders (sheikhs).

Youth clubs and farmers' organizations are considered weakly connected because they do not communicate or do not share information on farming and livestock keeping see figure 59. Strengthening of youth's weak ties to farmers' committees and the Pastoral Union can work to develop youth's bonding relations with farmers and create linkages with farmers.

Farmers' committees have strong connections with farmers and public committees in the Rahad scheme. Information on farming and livestock keeping is communicated to farmers by farmers' committees in addition to the scheme's extensionists. Public committees and farmers' committees are strongly connected. Strong connections can increase access to more information within the network. Ties between the Women's Union and women's associations in the Rahad scheme cannot be worked out in a straightforward manner; both actors do not implement farming or livestock keeping activities, but they mainly engage in Quran lessons and adult education besides some revolving fund activities. Sometimes both actors can coordinate their activities together, but at other times, they independently conduct their activities

Public committees organize the work or activities of youth in their clubs (interview 28, paragraph 12). Moreover, the activities of the Women's Union in villages are organized or

legalized by the public committees (interview 28, paragraph 16; interview 78, paragraph 24). Public committees are mainly involved in social issues of villages, but they also have strong connections with farmers' committees in deducting farmers share in support of social services in villages, schooling, and health and water services (see figure 59).

According to the role entitled to public committees in villages, public committees can be local bridges that connect weakly connected actors to the rest of the actors. For example, the public committee can connect youth clubs to extension work in the Rahad scheme (. Connecting youth clubs to extension work would improve youth knowledge of farming and livestock keeping. Therefore, if the youth in the future get the chance to get involved in farmers' committees or the Pastoral Union, they can add new ideas and experiences to those organizations.

According to one local leader (sheikh), commenting on their involvement in the Farmers' Union and Pastoral Union, *"No existence for sheikhs' authority here. Unless someone would join individually, we could also be members in banks, but we would say let us leave the chance to the others, the problem is that the Farmers' Union is mainly interested in collecting taxes more than in development"* (interview 36, paragraph 14).

In spite of the accumulated experience of local leaders in the area, especially their knowledge in animal grazing, they reported that they are not consulted by the Pastoral Union in discussions about grazing issues (interview 36, paragraph 14; interview 57, paragraph 12; interview 29, paragraphs 61-62). Of course the distance of local leaders from being officially involved in farming or animal keeping, not only in the research area but also in the whole of Sudan, is a result of political changes in authority, which previously were entitled to local leaders. The researcher is not in a position to suggest official involvement of local sheikhs in the Rahad scheme; however, she only points out the need to consider sheikhs as a source of knowledge in farming or livestock keeping in the area. This necessity was also mentioned by interviewees in this study. The Saving and Social Development Bank actor especially stressed that local sheikhs can mediate contacts and raise people's awareness of micro-projects provided by the bank. Connections are also needed between sheikhs and the Pastoral Union if sheikhs are to be given a chance to become decisive members in the union. Therefore, by mapping the network relationships of actors in the Rahad scheme, a network weaver (extension department in the Rahad scheme) can work to create ties and maintain weak connections in the network (KREBS and HOLLEY. 2004)
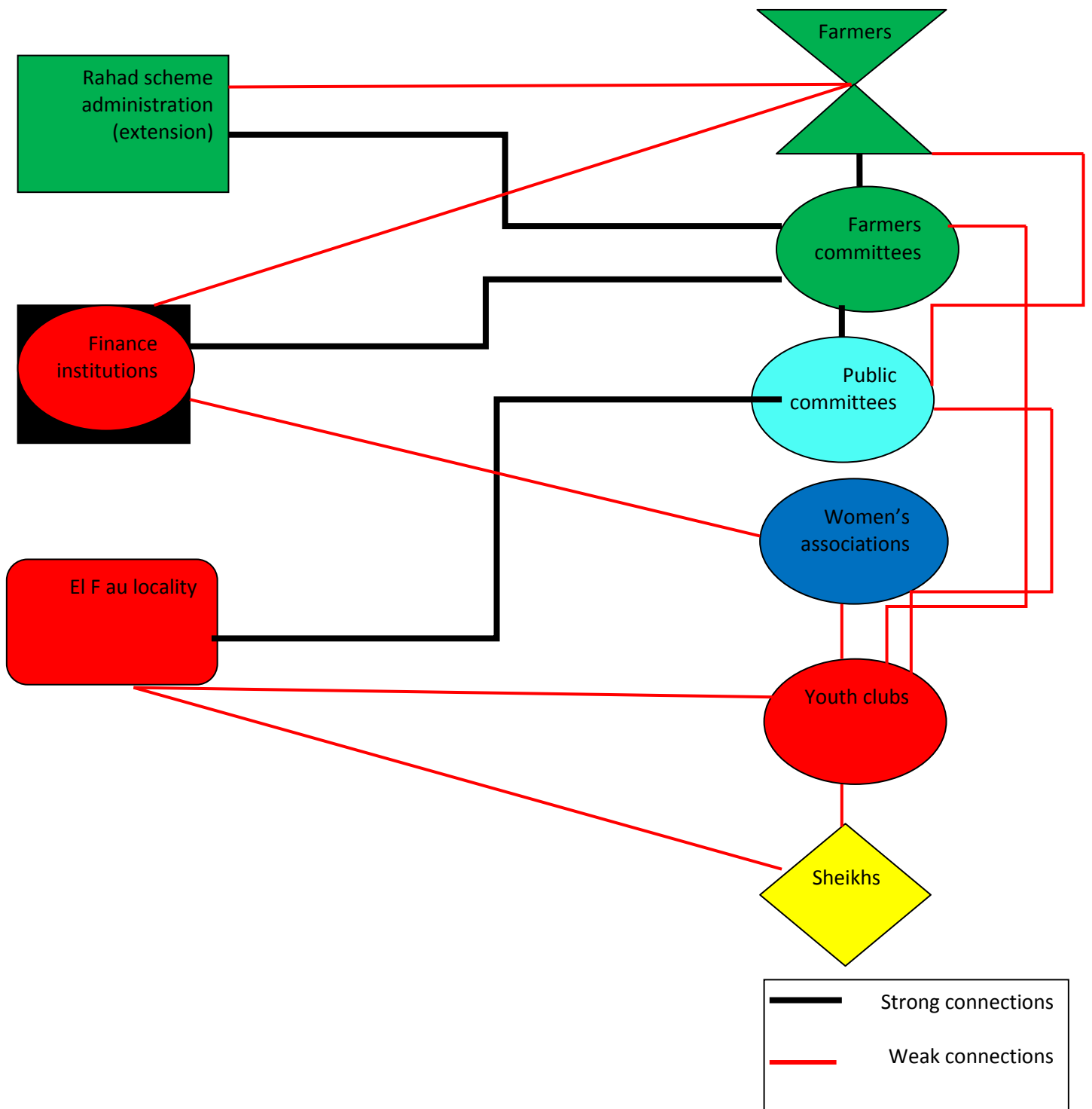
Figure 59: Trajectory of connections at scheme and village network
Source: own preparation

The figure of 59 Shows connections among village actors, between villagers actorsand schemelevel, Red lines indicate weak connections, blue lines indicate strong connections. Connections among village actors are mainly weak. Public committees andfarmers' committees are storng connected to scheme level.

8 Recommendations for improving the Rahad scheme network

8.1 How knowledge networking among actors in the Rahad scheme can be improved

In this chapter the researcher is suggesting implementation of Phase C of RAAKS to improve actors' coordination or communication within the Rahad Scheme (ENGEL1997).

Then the researcher is discussing improvement of knowledge networking in Rahad Scheme through creating and activation of connections between all actors in Rahad Scheme (KREBS and HOLLEY 2004). This activation of connections is thought to be achieved through building of multi hubs of connections between actors in Rahad scheme (KREBS and HOLLEY 2004). The Extension Department in the scheme is suggested the hubs introducer, who would introduce the hubs to its followers and then Extension can further manage the network.

 Firstly Picture of different networks in Rahad Scheme need to be participatory discussed with actors (CLARCK 2006: DOUTHWAITE et al. 2006). The participatory discussion of the network can help actors to build their capacity to strengthen the network which can benefit them all (CLARCK 2006: DOUTHWAITE et al. 2006). Discussion of network can let actors identify their strategic contacts within the net or even from outsider (CLARCK 2006: DOUTHWAITE et al. 2006). This discussion is also important because actors may visualize a relation or relations that are different than what the researchers have come up with. Conducting such a workshop can also let actors at level of Rahad Scheme recoginse their weak connections and put practicalities to improve it. Then there is a need to manage the networking or the connections between actors at different levels. Extension personnel in Rahad Scheme can be the volunteers who do the job of managing this network (CLARCK 2006: DOUTHWAITE et al. 2006).

8.2 Present Rahad Scheme network

In Rahad Scheme the researcher could define actors who are connected together with common interests, but connections between theses are weak. Actors at village level figure 50 are women's associations, Youth Clubs, Farmers' Committees, public committees, individual's farmers, and local sheikhs. Youth clubs are weakly connected to framers committees, women's associations, and public committees but strongly connected to farmers.farmers' committees and public committees are strongly connected together butfarmers' committees

are weakly connected youth clubs and women's associations. Farmers are strongly connected youth clubs but sheikhs are weakly connected with all the actors in the network.

Connections between actors at village level and actors at level of the Scheme in figure 57 can be explained as follows, Youth Clubs are connected with El Fau locality through its connection with Public committees. Women's associations are either weak connected or have no connections with the rest of actors at level of the Scheme.farmers' committees are strong connected to Extension Department and Farmers'Union within Rahad scheme, however, they admitted weak connections to the rest of actors at level of the scheme. Public Committees are strong connected to El Fau locality, National Forest Corporation, and Zakat Dewan, but showed weak connections to Health Administration. Sheikhs are weakly connected to El Fau locality and to the rest of the actors at Rahad Scheme.Farmers expressed weak connection to activities of Women's Union, Pastoral Union, and Farmers' Union.

Actors at level of Rahad scheme (see figure 48) are mainly strong connected in communication of information on irrigating farming. However, the network at Rahad scheme also contains weak connected actors or isolated ones, Ministry of Livestock, Agriculture School, and Women's Union are the examples.

Figure 60: Scheme and village network in Rahad scheme
Source: field data 2010

8.3 Building of Multi hubs model

The connections in the study area need to be organized or rearranged in order to have strong and producing networks. There is a need for network weaver, who can knit or build the relations (KREBS and HOLLEY 2004) the weaver will be responsible for creating new interactions and relations in the network. The weaver needs to have the energy, the social skills to connect to the actors in Rahad Scheme at different levels (KREBS and HOLLEY 2004) The weaver is some identity that have connections outside the community so new

resources, and information can be brought to the innovation (KREBS and HOLLEY 2004). The researcher of the study is also suggesting extension in Rahad Scheme as the weaver of the network. Weaving of relation in Rahad scheme can be achieved by building of multi hubs model, (see figure 65).

Having multi hubs in the network can decrease the failure of the network and increase its impact and reach (KREBS and HOLLEY 2004). In this process also appears the strength of weak ties in the network (KREBS and HOLLEY 2004). In the Rahad Scheme actors who are connected with few ties, or less tensely connected in the exchange of information, their connection will be activated or strengthen through weaving of relations by a third actor the hub .Also actors can go outside the domain of their groups since exchange of information and new ideas can come out of one's group (KREBS and HOLLEY 2002; EASLY and KLEINBERG 2010; ROGERS 2003).So it could be successful for the innovation within Rahad Scheme to connect similar but at the same time different actors. For example, building relation between youth clubs and farmers' committees, (see figure 63) can bring new ideas for both actors; the same can be said about connection of farmer committees to pastoral Union. By connecting farmers' committees to Pastoral Union, the weak connections between Farmers' Union and Pastoral Union can improve. Connecting similarity of actors can build trust between the actors, while diversity can bring new ideas and vision of work. One challenge in this stage could be existence of interests to control over the community for example, the stereotyping about Farmers' Union, Pastoral Union and Women's Union as identities that serve personal and political interests can obstruct building successful network.

The hubs in Rahad network can be farmers' committees, public committees, and Saving and Social Development Bank Public committees can be hubs and its followers are Pastoral Union, Farmers' Union, and youth clubs (see figure 62). The aim of this hub is to get youth clubs, Farmers' Union, Pastoral Union to be more involved on health awareness programs and National Forest Corporation conversation programs at the level of El Fau locality.

Farmers'committees can be a hub and its followers can be Agricultural School, youth clubs, sheikhs, Pastoral Union, Ministry of Agriculture, Farmers' Union, and farmers. Rahad research station (see figure 63).The researcher is expecting building this hub will get youth clubs, Agricultural School, Pastoral Union and sheikhs more involved in farming activities at level of the Rahad scheme. Through this hub also it is expected that knowledge on rain fed farming and fodder production can be better integrated within irrigated farming in Rahad scheme

Saving and Social Development Bank is another hub its followers are Women's Union, Women's associations, Pastoral Union, and Ministry of Livestock, (see figure 64). This hub can lead to create better connections between women association and Women's Union by coordinating running of micro economic projects. The same can be said about connections between Pastoral Union and Ministry of Livestock. Pastoral Union is interested on running micro projects of animal rising, Saving and Social Development Bank can link Ministry of Livestockin to this projects to act as technical expertise for running such projects. Sheikhs can also be followers in this hub too because they can mediate contact between pastorals and the Saving and Social Development Bank.

As hubs are built and followers of each hubs communicate with each other's it is supposed that alls hubs would be connected to Extension in Rahad scheme. Extension in Rahad scheme is suggested to introduce hubs to its followers; after connections being established the Extension can also coordinate training needed for every actor and may be suggesting further connections within the actors. The figure 65 below shows hubs and followers, it also shows connections of hubs to Extension in Rahad

The final stage of managing Rahad Scheme Network could be by producing what is called the core- periphery model (KREBS and HOLLEY 2004). This network can merge after many years of weaving relations within the network. In this stage the network became connected to outsider network of relations or the network can also get connected to outsider source of knowledge (KREBS and HOLLEY 2004). In the case of Rahad Scheme the periphery can be knowledge on animal grazing, animal production, rain fed farming, forage management etc. This knowledge can be imbedded in closer communities or closer setting to the Rahad Scheme, example is Universities, Research centers in Gedarif State or Medani, and other irrigated Scheme within the area of Rahad Scheme. This knowledge can also found on experiences of rain farming communities surrounding Rahad Scheme. Rahad research station, Ministry of Agriculture, Ministry of Livestock, Pastoral Union, and Farmers' Union can be the core actors that can connect to outside knowledge sources (KREBS and HOLLEY 2004).

In the core - periphery network, the task of Extension in Rahad Scheme can form inter-regional alliances to create new products, services and markets within Rahad Scheme. The Scheme can also work to shape and influence policy that will strengthen the region. This happens by connecting the core to the peripheries, Ministry of Agriculture to Research on rain fed farming. Rahad research station can be connected to research on fodder management. Ministry of Livestock can cooperate with research on animal production. Farmers'

organizations and women organizations within the scheme can be linked to sociological and socio economic researches in the near universities.

The core- periphery network is only a prediction at this level of the research; the researcher is not going to go in further deep for discussing this idea.

In figure 61, the researcher is suggesting the hubs that can connect to other actors in the network; those hubs are farmers committees, public committees and Saving and Social Development Bank. These hubs or actors are suggested to be the initials connectors in builling of Multi hubs model in Rahad scheme, see the following section for more details.

Saving and Social Development Bank as a hub

Public committee as a hub

Farmers committee as a hub
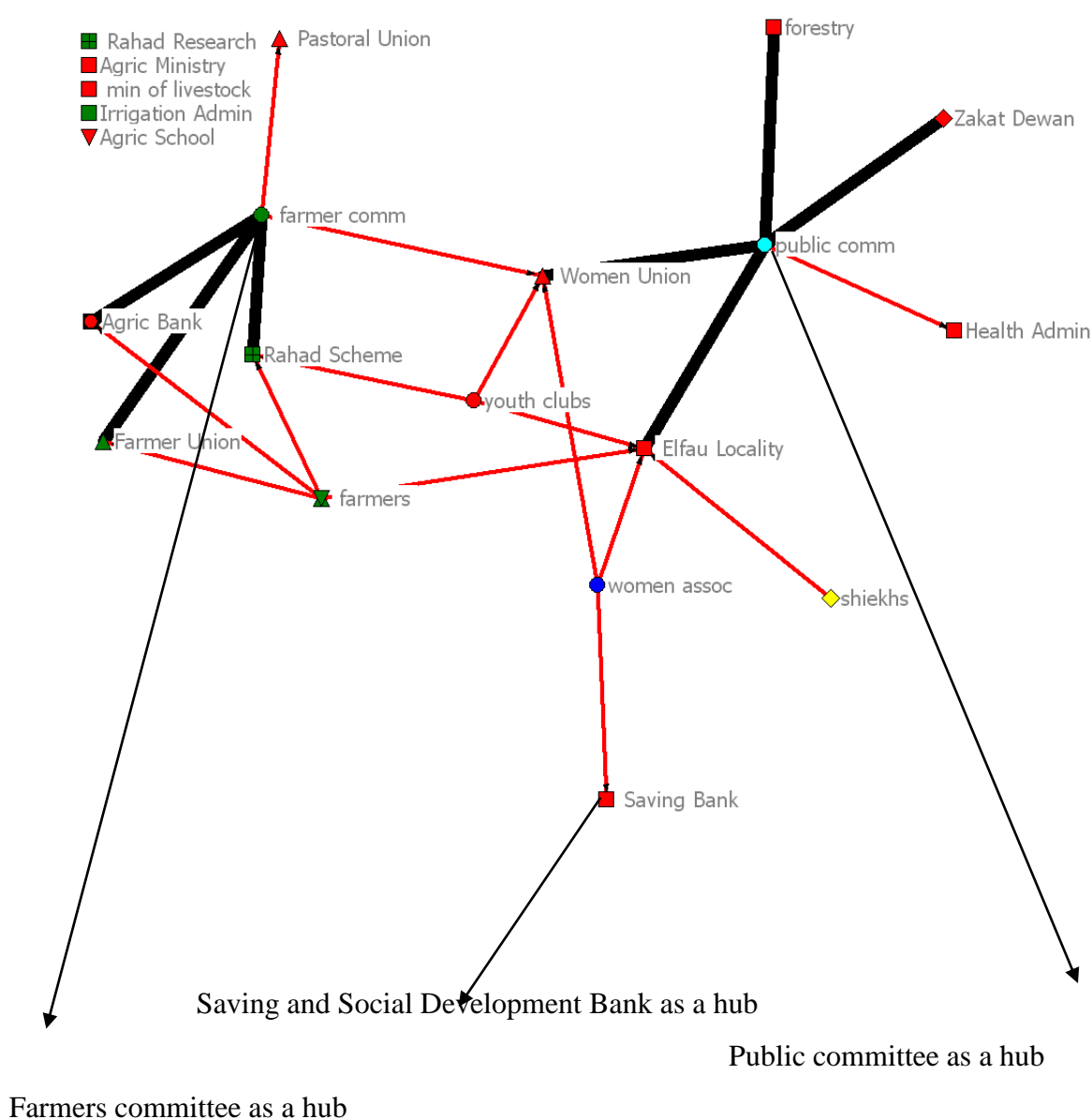
Figure 61: Suggested hubs in Rahad Scheme network
Source: field data 2010

Public committees as a hub

Public committees have strong connection to Zakat Dewan andNational Forest Corporation but have weak connection to Health Administration (see figure 57) youth clubs are the new actor joining these connections. Youth clubs can become connected to the actors of National Forest Corporation, Health Administration and Zakat Dewan as they connect to public committees. In this hub also Ministry of Agriculture and Ministry of livestock can join. The idea behind this hub is to establish continous connections of those ministries to activities of Zakat Dewan especially micro finance projects on farming and poultry. To connect Farmers' Union, pastoral union and youth clubs to educational programs of Health Administration and National Forest Corporation

Figure 62: Public committee as a hub
Source: own preparation
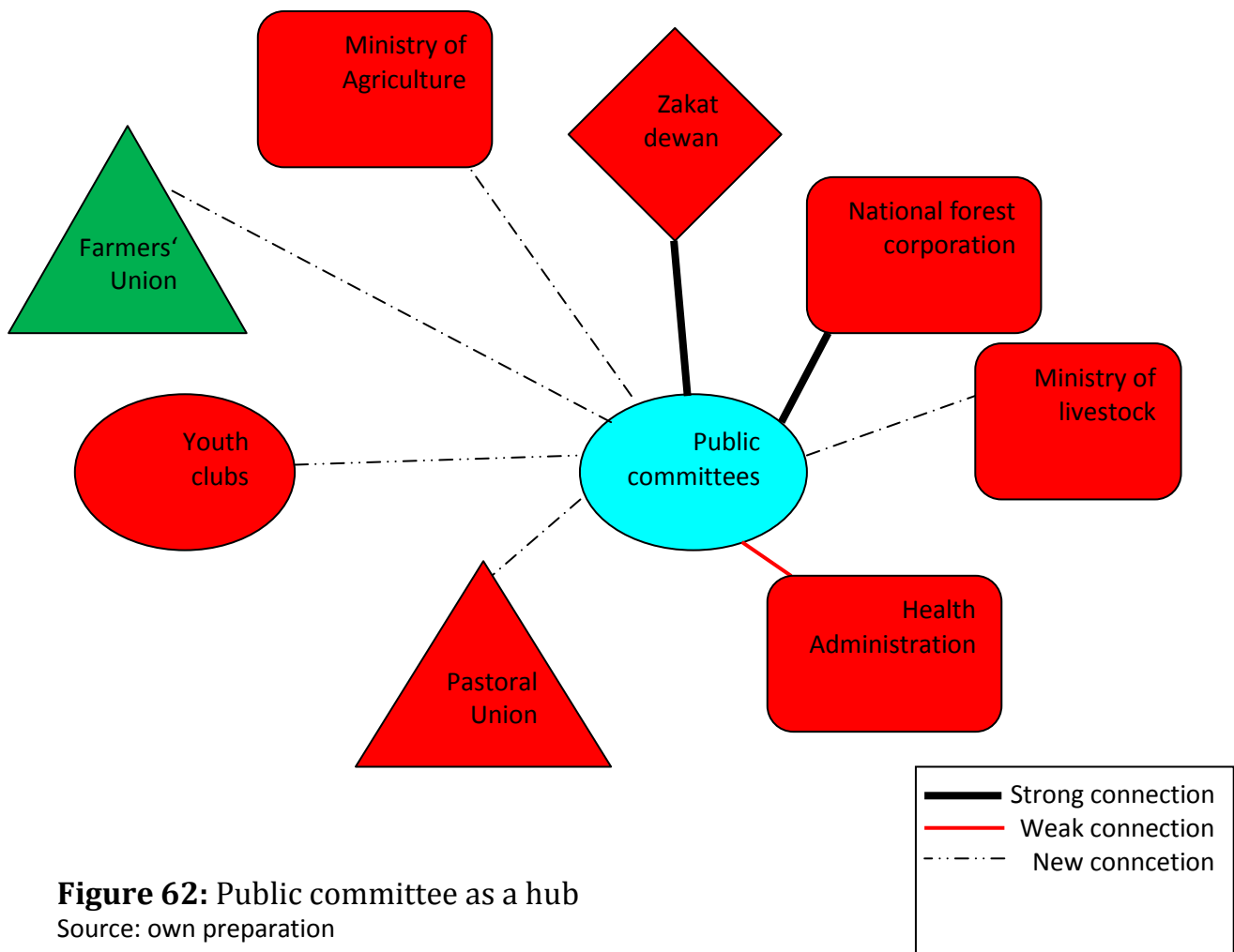
Farmers' committees as a hub

On other level of network (see figure57) farmers'committees are connected with Farmers' Union, Pastoral Union, Rahad administration and Sudanese Agricultural Bank. The new comers to these connections can be youth clubs and sheikhs it is expected in this hub connection of youth clubs and sheikhs to famring activities in this scheme improves through their connection tofarmers' committees. Also in this hub, connection between Pastoral Union and Farmers' Union will improve.farmers' committees can also connect to Ministry of Agriculture and Agriculture school. By this way students of the school can be more connected to activities on rain fed farming and irrigated farming within the scheme. In this hub alsofarmers' committees are creating connections to Rahad research station through these connections it is expected that Rahad research station can get closer viewing of farmers' own preferences and challenges in farming.

Figure 63 Farmers committee as a hub
Source: own preparation

▬▬▬	Strong connection
▬▬▬	Weak connection
─·─·─	New connection
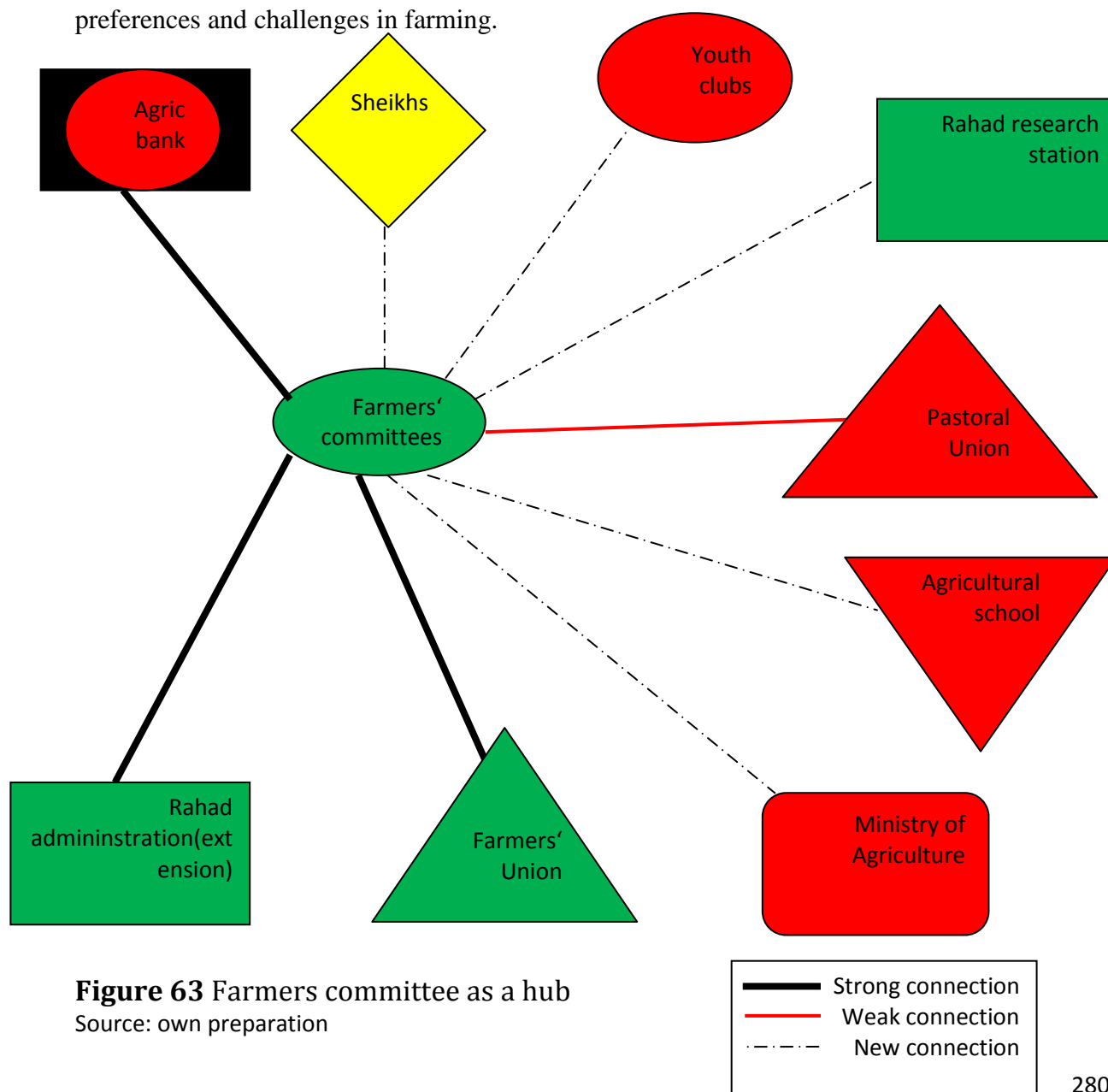
Saving and Social Developement Bank as a hub

At scheme level of connections (see figure 43) it is found that Saving and Social Development Bankis strongly connected to El Fau locality, Pastoral union, and Women's Union. At level of scheme and village connections the bank is weakly connected to women's associations' (see figure 57)

In hub of Sving and Social Development Bank (see figure65), Sheikhs, Ministry of livestock andfarmers' committees are the new comers joinng this hub. Sheikhs and Ministry of livestock can get involved on running of micro finance project offered by the bank to farmers. El Fau locality can also get connected to the projects directed to women's associations and Women's Union forexample coordinate training courses. Since connections between women's associations and Women's Union were not easy to define it is expected in this hub better connections can be worked between the tow actors.
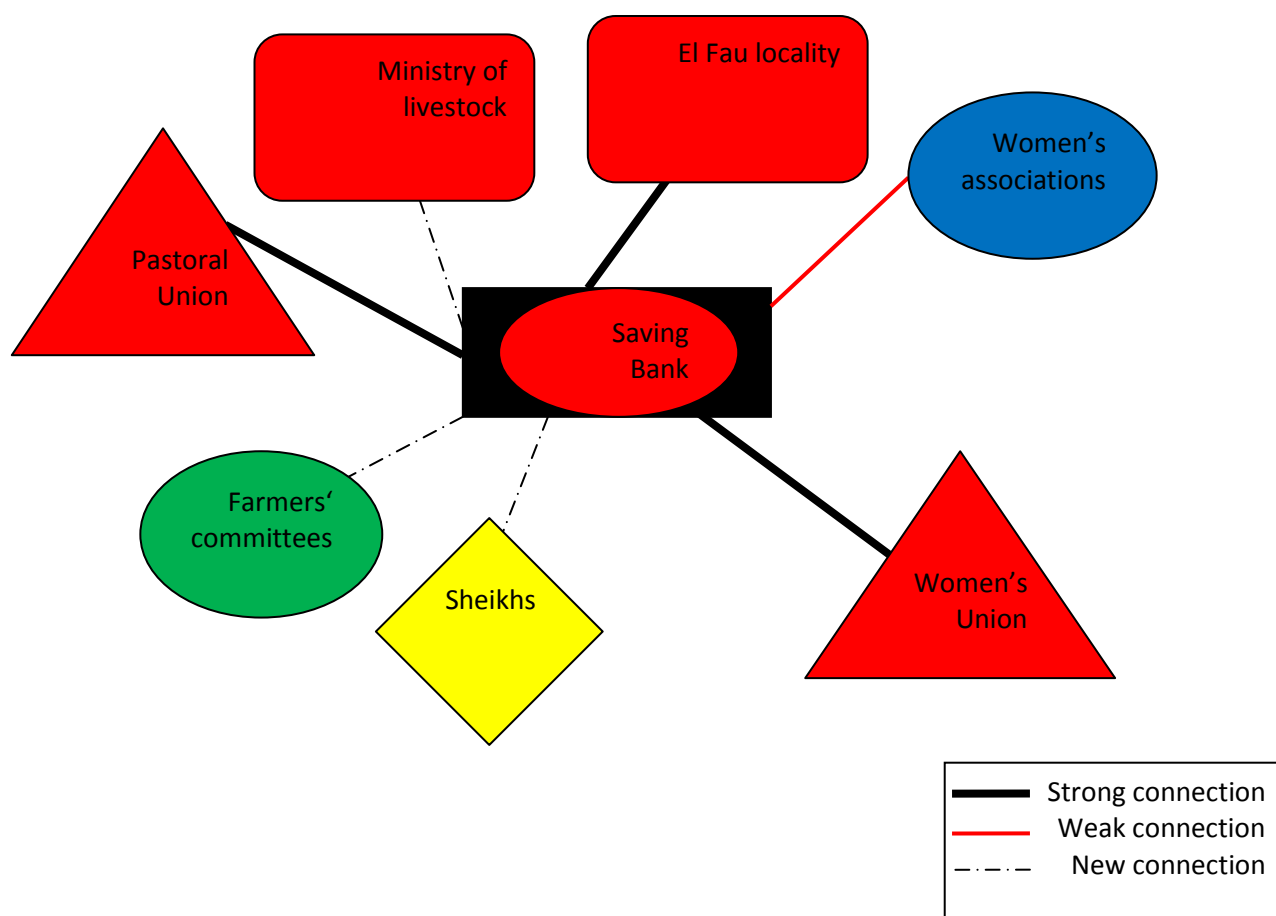
Figure 64: Saving and Social Development Bank as a hub
Source: own preparation

Multi hubs Model in Rahad scheme

Figure 65 shows hubs and their followers connected to Rahad scheme administration where Extension can coordinate or manage and improve the suggested connections. Fore example extenstion can put ideas to organize and florish connections created between Pastoral Union and Farmers' Union within the scheme.Extension can put vision for work of women's associations and their connections to Women's Union. If youth are able to join farmers' committees and Pastoral Union, extension can work to train youth on projects managements. Extension can also support or encourage communication between Farmers' Union, Pastoral Union and local sheikhs. Extension department can also enrich connections of Rahad research station with farmers and their organizations, in this regards, new perspectives of research such as fodder production and sociology might need to be recalled in the area. Since farmers' committees are expected to connect to Agricultural School it is expected that better connection to knowledge on irrigated farming can also be gained by students of the school.

It is possible that not all suggested connections would florish especially issues such as power and gender differences can domain negotiations or relations between actors. However, the researcher is stressing on weaving of connections as the approach to improve network of relations among actors in the study area.

Figure 65: Hubs and their followers connected to Extension
 Source: own preparation

8.4 possible trainings and materials to be realized within Rahad Scheme

Researcher is suggesting implementation of Phase C of RAAKS to improve actors'
coordination or communication within the Rahad Scheme. ENGEL1997). First the present
picture of Rahad Scheme networks need to be participatory discussed among actors of Rahad
Scheme. This discussion can take place by conducting of a workshop. The RAAKS team
members can be invited to be facilitators in this workshop. The next step of Phase C is
weaving of relations within actors in Rahad Scheme.

In this step connections between actors are mapped, created, or improved: Extension within Rahad Scheme had been suggested the weaver of these connections.

The extension department in Rahad can introduce actors' hubs to their followers within the network so as the followers can create connections with their relevant contacts or strategic contacts in the network (building of multi hubs connections). Finally, Extension in Rahad Scheme in course of the years can build core-periphery network where Rahad Scheme can create connections with sources of knowledge that are not available within Rahad Scheme at the time being. Connections to outsider knowledge can foster innovation performance within Rahad Scheme.

DOUTHWAITE et al. (2006) conducted a study in building Colombian farmers' capacities for networking and used simple trainings on network analysis. They believed learning network mapping is of greater benefit when the service provider is in ongoing relationships with its groups or beneficiaries.

Extension department in Rahad Scheme which is also known as Department of Technology Transfer and Extension is staffed with 45 extension workers (B. Sc holders) who are formally trained for their position (IBRAHIM 2006; EL HASSAN 2004). Each section in Rahad Scheme has 5 extension workers and the ratio of farmers to extension worker approximately is 300:1 (IBRAHIM 2006; EL HASSAN 2004). In spite of the irregularity of extension work in Rahad caused by the existence of KIAS Company, 2010-2012. Extensionists in Rahad Scheme can provide promising human resources who can be trained to build important relations with actors in the scheme. Maybe at first step, simple introductory workshop on concept of social networks can be implemented to the extension staff. RAAKS team can consider using of social network analysis tools for illustrative purposes RAAKS team can use different colored wool strings (DOITHWAITE et al. 2006). This exercise is important to be conducted for extension staff so they can visualize the communication channels that connect actors of the scheme in a network of relations. Therefore, learning social network analysis for extension staff in Rahad Scheme can help to realize the recommendations of this research.

9. Summary

9.1 English Summary

The Establishment of the Rahad Agriculture Scheme in Eastern Sudan in the 1970s established an agricultural innovation system where different actors including research, extension, investment, and agro-pastoral farmers network in order to provide better

livelihoods within the irrigated scheme area. The investigation of this research focused on the question of how knowledge of farming has been networked among the actors in the scheme so as to facilitate the innovation process within Rahad Scheme area which is the settlement of agro pastoralist farmers to practice irrigated farming.

This broad research question has been broken down to specific research questions of what the roles of actors of Rahad scheme, and what their structure and communication pattern are in seeking information on farming and livestock keeping within the Scheme. The research tried to answer these questions using arguments of knowledge system thinking and social network theory.

In order to understand the roles of Rahad Scheme actors, researchers have implemented Rapid Appraisal of Agricultural Knowledge Systems (RAAKS) which is a tested participatory action research methodology used to investigate knowledge systems including agricultural innovations. Phase A, of RAAKS was implemented in form of semi structured interviews and one group discussion with actors who are representing Rahad Scheme management(extension department), government institutions, research and finance institutions. Those actors are concerned with the achievement of agricultural innovation at level of Rahad scheme administration. Implementation of Phase A was used to give general ideas of the performance of Rahad Agriculture Scheme. Phase B of RAAKS was conducted using semi structure interviews with individuals and associations of the agro pastorals who were resettled in villages within the scheme area to practice irrigated farming. This category included; farmers' and pastorals' associations, women's associations, youth clubs, and local leaders (sheikhs) Investigation of phase B allowed researchers to understand information network among actors at villages' level, between actors at level of Rahad scheme and actors at villages. In a second step, researchers collected social network data from actors at Rahad Scheme by asking; who communicate with whom, how strongly or weakly actors are connected. It was important to understand the structure of actors at Rahad Scheme level so as suggestion to improve communication network between these actors can be worked out. Research study in Rahad Scheme concluded that the structure of the network at level of Rahad Scheme showed the prominence of actors central to the network that influence information flow within the actors; the Rahad Agricultural Scheme Administration, Ministry of Agriculture, Sudanese Agricultural Bank Farmers' Union and Pastoral Union are the main actors that circulate communication on irrigated farming, rain fed farming and credits for farming.

However, some central actors at Rahad Scheme level such as the Pastoral Union and Farmers' Union can exploit the Rahad Scheme network with personal and political interests that may

shift the innovation process in the scheme (information flow). Farming and pastoral activities are not well coordinated within the scheme area; this situation had resulted on a negative relating between Pastorals' Union and Farmers' Union. The network at level of Rahad Scheme also contains actors that have fewer connections within the network but are connected to outside sources of knowledge. The Women's Union, El Fau Agricultural School and Health Administration are examples. Strengthening such connections can bring better performance for agricultural innovation in the Rahad Scheme.

Connections of actors at level of villages are showing that there are actors who are weakly connected on communicating information on farming and livestock keeping. Examples are connections of women's associations with youth clubs, farmers' committees, and sheikhs. Connections of youth clubs with farmers' committees, public committees and sheikhs Connections between actors at village level and actors at scheme level is revealing prominence of local bridges or actors who are well connected at at level of Rahad scheme but connected with weak ties with actors in villages. Examples are, farmers' committees, and public committees. Public committees are involved in social activities and representing authority of El Fau locality in villages. Farmers' committees in villages are the actor that is mainly concerned with farming and animal keeping activities in villages. From social network perspective farmers' committees can connect actors such as youth clubs in villages to farming activities at Rahad Scheme. On the same manner connecting shiekhs to farmers' committees can add local experience on farming and livestock keeping within Rahad scheme. Farmers' committees are also suggested to connect Pastoral Union to Farmers' Union. Creating linkages between Pastoral Union members and farmers' committees in villages can help to get Pastorals Union more involved on decision making in Rahad scheme. Women association is weak connected actor who misses proper training and planning of its socio economic activites. Connecting those associations to traninig instituions and finance institutions at level of Rahad scheme administration can help to develop the performance of this actor

Researcher is suggesting implementation of Phase C of RAAKS through managing of network of relations between actors at different level of Rahad Scheme.

A work shop to dsicuss the finding of this stuy among actors of Rahad scheme is being suggested. Participatory discussion of the Rahad scheme network is important because actors may visualize a relation or relations that are different than what the researchers have come up with. Conducting such a workshop can also let actors at level of Rahad Scheme recognise their weak connections and put practicalities to improve it. Building multi hubs network in Rahad scheme is suggested by the researcher to manage network of relations in Rahad

scheme. Hubs in Rahad scheme are famrers committees, public committees, and finance institutions within the scheme such as Saving and Social Development Bank .Extension in Rahad Scheme is the actor who should introduce hubs to their followers.

Multi hub model is hoped to produce well connected actors at different levels of the scheme which can foster information exchange between actors of the scheme. In future it is expected that total network of Rahad Scheme become connected to outsider sources of knowledge by developing a pheriphery - core network. Managing relations networks in Rahad scheme according to the mentioned manner is expected to improve the performance of agriculture innovations in Rahad scheme.

9.2 Deutsche Zusammenfassung

In den 1970er Jahren wurde in der Region Rahad im Ostsudan ein Bewässerungssystems eingeführt. Es wurde ein landwirtschaftliches Innovationssystem errichtet, das unterschiedliche Akteure aus den Bereichen Forschung, Beratung, Investitionen zusammenführte sowie ein Netzwerk agro-pastoraler Bauern entwickelte. Die Zielsetzung bestand darin, die Lebensbedingungen innerhalb des bewässerten Untersuchungsgebietes zu verbessern.

Die Untersuchungen dieser Forschungsarbeit fokussieren sich auf die Frage, wie landwirtschaftliches Wissen zwischen den Akteuren mit dem Ziel der Erleichterung des Innovationsprozesses im Untersuchungsgebiet ausgetauscht wird.

Diese breite Fragestellung wurde auf spezifische Fragestellungen heruntergebrochen: Welche Rolle spielen die Akteure innerhalb des Projektgebietes und welche Strukturen und Kommunikationsmuster nutzen sie bei der Suche nach Informationen über Landwirtschaft und Viehhaltung. Die Untersuchung versucht diese Fragen vor dem Hintergrund von Systemdenken und sozialer Netzwerk-Theorie zu beantworten.

Um die Rolle der Akteure des Rahad-Programms zu verstehen, wurden Verfahrenselemente des Rapid Appraisal of Agricultural Knowledge Systems (RAAKS) genutzt. RAAKS ist eine weit erprobte partizipative Forschungsmethode zur Untersuchung von Wissenssystemen, einschließlich landwirtschaftlicher Innovationen. Phase A der RAAKS wurde in Form von halb strukturierten Befragungen und einer Gruppendiskussion mit Akteuren des Rahad-Programm Managements, der Regierung, Beratungsstellen, Forschern, Investoren und dem privaten Sektor durchgeführt. Diese Akteure sind für die Ausführung landwirtschaftlicher

Innovationen zuständig, zusammen mit der Rahad-Programm Verwaltung. Die Datenerhebung der Phase A diente dazu, eine allgemeine Vorstellung über die Leistungsfähigkeit der Landwirtschaft zu bekommen. Phase B von RAAKS wurde durchgeführt mit Hilfe von Befragungen von Personen und Organisationen, die in Dörfern innerhalb des Untersuchungsgebiets wieder angesiedelt wurden, um Bewässerungslandwirtschaft zu betreiben.Dazu gehören: Bauern-, Hirten- und Frauenvereinigungen, Jugendvereine und lokale Führungskräfte sowie Scheichs. Durch die Untersuchungen innerhalb der Phase B konnten die Informationsnetzwerke zwischen den Akteuren auf Dorfebene sowie auf Ebene des Rahad Programms identifiziert werden. In einem zweiten Schritt wurden quantitative Daten zu den sozialen Netzwerken des Rahad-Programms durch Befragungen gesammelt; wer kommuniziert mit wem, wie stark oder schwach ist die Akteure miteinander vernetzt. Dabei war es wichtig die Rollen der Akteure des Rahad-Programms zu verstehen, um Verbesserungsvorschläge zum Kommunikationsnetzwerk zwischen den Akteuren heraus zu arbeiten. Aus der Struktur des Netzwerks auf Programmebene geht hervor, dass der Bekanntheitsgrad der Akteure eine zentrale Rolle beim Informationsfluss zwischen den Akteuren spielt. Die Landwirtschaftsverwaltung des Rahad-Programms, das Landwirtschaftsministerium und die Landwirtschaftsbank sind die Hauptakteure, welche Informationen über Bewässerungslandwirtschaft, nicht bewässerte Landwirtschaft und Kredite für Landwirtschaft zur Verfügung stellen.

Die Analyse der Akteure auf Dorfebene zeigt, dass der Informationsfluss hinsichtlich Landwirtschaft und Viehhaltung oft unzureichend ist bzw. gar nicht existiert. Dies gilt beispielsweise für die Verbindungen zwischen Frauenverbänden und Jugendvereinen, Landwirtschaftsausschüssen und lokalen Entscheidungsträgern. Der Vergleich von Akteuren auf Dorfebene und von Akteuren innerhalb des Programms zeigt, wie gut die Kontakte innerhalb des Programms sind und wie schwach die Akteure auf Dorfebene eingebunden sind.

Beispiele hierfür sind Landwirtschaftsvereinigungen und öffentliche Ausschüsse. Die öffentlichen Ausschüsse sind an sozialen Aktivitäten beteiligt und repräsentieren die lokale Autorität in den Dörfern. Die Landwirtschaftsvereinigungen sind diejenigen Akteure, die die größte Rolle hinsichtlich Landwirtschaft und Viehhaltung der Dörfer spielen. Aus Sicht der sozialen Netzwerke können die Landwirtschaftsausschüsse dazu beitragen Akteursgruppen zusammenzuführen, z. B. Jugendverbände mit den Landwirten des Bewässerungsgebiets. Auf diese Weise kann durch das Zusammenbringen von lokalen Entscheidungsträgern und

Landwirtschaftsverbänden der Erfahrungsschatz von Landwirten bereichert werden. Für die Verbände empfiehlt es sich ebenfalls sich darum zu bemühen, dass die unterschiedlichen Selbstorganisationen der Bauern (Pastoral Union und die Farmers' Union) zusammenzuführen. Die Frauenvereinigung ist ein sehr schwach vernetzter Akteur, dem oft eine weitsichtige Planung ihrer sozioökonomischen Aktivität fehlt. Diese Vereinigungen und Verbände in besseren Kontakt miteinander oder etwa mit Finanzinstitutionen zu bringen, kann dazu beitragen sie leistungsfähiger zu machen Und das Gesamtsystem zu stärken.

Es wird empfohlen, die Phase C von RAAKS durch eine Zusammenarbeit der dörflichen Akteure mit dem Management der entsprechenden Netzwerke einzuleiten. Vorgeschlagen wird hierzu ein Workshop, um über die Ergebnisse dieser Studie unter den Akteuren des Rahad-Programms zu diskutieren. Eine partizipatives Vorgehen ist dabei empfohlen, da die Akteure oft andere Vorstellungen von den Beziehungen innerhalb des Netzwerks haben als sie durch die Studie identifiziert wurden. Die Durchführung eines solchen Workshops kann auch dazu führen, dass die Akteure innerhalb des Rahad-Programms die Schwachstellen ihres Netzwerks erkennen und diese gemeinsam verbessern.

Die Erstellung von einem Multi-Hubs-Netzwerk innerhalb des Rahad-Programms kann langfristig dazu führen, die die Netzwerkbeziehungen zu organisieren. Mögliche Hubs im Rahad-Programm sind die Landwirtschaftsvereinigungen, öffentliche Ausschüsse und Finanzinstitutionen. Der Berater innerhalb des Programms ist derjenige Akteur,derdieHubseinführt.

Vom Multi-Hub-Modell wird erwartet, dass es dazu beiträgt die Netzwerke zwischen den Akteuren auf unterschiedlichen Ebenen zu verbessern, was wiederum zu einem verbesserten Informationsfluss beitragen kann. Für die Zukunft wird außerdem davon ausgegangen, dass die Beteiligten des Bewässerungsprogramms durch entsprechende Netzwerke einen verbesserten Zugang auch zu externem Wissen erlangen. Das Management der Beziehungsnetzwerke im Untersuchungsgebiet wird als Schlüssel angesehen für eine bessere Performance der landwirtschaftlichen Innovationen.

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11 Appendices

Annex 1

A:RAAKS Phase A: interviews with actors at level of Rahad Scheme
Interview adapted from A1

- What general problems do you have in Relation to exchange of information between formal institutes in Rahad Scheme?
- If your institute has a direct contact with local people in the area what do you think about exchange of local and scientific knowledge
- Do you think there is a problem in communicating the information, understanding the message of your institute among local people?
- If so what is the reason and who is affected by this problem

B:Interview adapted from A2A3 (Stage1)
- What is your role within Rahad Scheme area?
- What is your real achievement according to your resources?
- Which actors play significant role in issuing technical innovations- research and deliver it to the recipients?
- Who else is considered and how it happens?
- What changes are needed to improve integration of local institution with the knowledge they have in development activities in the area?.
- What opportunities and problems of agricultural innovations in the area? (Rahad Scheme and rain fed farming)

C: Group discussions adapted from A4 (Stage2)
- Environmental limits in the area of Rahad Scheme.

D: Group .discussion adapted from A5 (Stage 2)

Prime movers in Rahad scheme

E: Group discussion Selected tools from window B

- Info-use- source sheet (Stage 2)
- Type of knowledge actors get in dealing with agricultural innovation
- Strategic- source
- Practical – source
- Marketing – source
- How information is applied.

F: Selected tools from window B

Communication network sheet

- Who of actors in the area present information on regulations, organizations, finance of agricultural innovations?
- How close the information to you
- Type of communication (formal- informal)
- How do you value the information been offered.

G:Linkage Matrix

Cancelled

H: Adapted from Communication Analysis exercise

- Can actors who come from different social and economical background understand each other?
- If there are problems in communication among actors is it social, technical, etc.

I: RAAKS road map

Steps	Method	Actors at administration of Rahad scheme
Definition of the problem (	Individual interviews	15 actors

communication of knowledge on farming and livestock keeping	Adapted from A1	
Identify actors and their roles	Individual interviews Adapted from A2,A3	15 actors
Environmental diagnosis (environmental check list)	Group discussion Adapted from A4	8 actors
Clarify the problem situation (prime mover spectrum	Group discussion Adapted from A5	8 actors
Knowledge network analysis (info- source- use)	Group discussion Selected window from phase B	8 actors
Communication network sheet	Group discussion Selected window from phase B	8 actors
Integration analysis Linkage matrix	cancelled	-
Communication analysis(communication analysis exercise	Group discussion Selected window from phase B	8 actors

J: Repeated knowledge networking questionnaire with 15 actors at administration of Rahad scheme

Do you know x actor	How often do you meet each other	What content of your discussions with x actor

Annex 2

RAAKS Phase B: interviews with actors at level of villages

1-Interview with pastoral union representative

- What is your role in this union?
- Why did you establish this union?

- What are sources of information available to you?

- How you communicate with these sources?

- What do you think of; the locality, public committees, farmers union, youth groups, women groups, the irrigated scheme?

- How do you think of local leaders (native administrations) as an authority to organize peoples live in villages?

- What feelings do you have for irrigated farming?

- What feelings do you have towards moving from semi nomadism to settled?

- What fears the settlement brought to you and what hopes you have for it?

- Are there organizations for marketing of cattle?

- How do you know about it?

- How do you think pastorals can be better integrated in development of the area?

2- **Group discussion guide with youth groups**

- What activities do you make in your village

- What sources of information do you have

- What do you think of; the locality, public committees, farmers union, pastoral union, women groups, and the irrigated scheme?

- Did you hear of native administration?

- How do you think of local leaders (native administrations) as an authority to organize peoples live in villages?

- What problems of communication with these groups and what problems of communications among you.

- What feelings do you have for irrigated farming?

- What feelings do you have towards moving from semi nomadism to settled?

- What fears the settlement brought to you and what hopes you have for it?

- How do you think pastorals can be better integrated in development of the area?

3- **Interview guide with local leaders, teachers, traditional medicine men, old women**

- What is your role inside your village?

- Can you remember days of Native administration?

- Can you talk to us about it, how it was used to organize grazing of animal and farming

- What do you think of; the locality, public committees, farmers union, women groups, the irrigated scheme?

- Do you trust these organizations?

- What is your relation with youth in exchange of information?

- What feelings do you have for irrigated farming?

- What feelings do you have towards moving from semi nomadism to settled?

- What fears the settlement brought to you and what hopes you have for it?

- How do you think native administration can be better integrated in the development of the area?

4- **Group discussion guide with farmers committees**

- What are your roles in the villages

- How do you perceive the changes in learning farming with existing of extensionists

- What sources of information do you have

- How do you communicate with these sources

- What problem of communications exists among you and other organizations?

- What do you think of; the locality, public committees, youth gruops, pastoral union, women groups, and the irrigated scheme?

- How do you think of local leaders (native administrations) as an authority to organize peoples live in villages?

- What feelings do you have for irrigated farming?

- What feelings do you have towards moving from semi nomadism to settled?

- What fears the settlement brought to you and what hopes you have for it?

- What could be the alternative for irrigated farming from your point of you?

- How do you think you can be better integrated in the development of the area?

5-**Group discussion guide with women groups**

- What activities do you have in the villages?

- What problems do you face in accomplishing these activities?

- Has the irrigated scheme ever helped you in your activities?

- What sources of information do you have?

- What do you think of; the locality, public committees, farmers union, pastoral union, youth groups, and the irrigated scheme?

- Did you hear of native administration?

- How do you think of local leaders (native administrations) as an authority to organize peoples live in villages?

- What feelings do you have for irrigated farming?

- What feelings do you have towards moving from semi nomadism to settled?
- What fears the settlement brought to you and what hopes you have for it?
- How do you think your group can be better integrated in development of the area?

6- Interviews road map

Area of the scheme	Number of villages	Methods	Who interviewed
South of the scheme	2 villages	6 group discussions 20 individual interviews	Women groups Youth clubs Farmers'committees farmers Sheikhs / teachers extensionists
North of the scheme	2 villages	4 group discussions 6 individual interviews	Women groups Youth clubs Farmers' committees farmers Sheikhs/ teachers extensionists
Middle of the scheme		1 group discussions 6 interviews	Farmers' committees Farmers Sheikhs/ local healers (one man+ one woman)

7- Adjacency matrix for actors at the Rahad scheme level

	Rahad scheme	Research Station	Ministry of Agric.	Ministry of Livestock	Fau Locality	Irrigation Admin.	Farmer Union	Pastoral Union	Women Union	Development Bank	Agric. Bank	Health Admin.	Zakat Dewan	Forestry	Agric. School
Rahad scheme	0	1	1	1	1	1	1	1	0	0	1	1	1	1	1
Research Station	1	0	1	0	0	1	1	0	0	0	1	0	0	1	0
Ministry of Agric.	1	1	0	1	1	1	1	1	1	0	1	1	0	1	0

Ministry of Livestock	1	1	1	0	1	0	0	1	0	1	0	1	0	0	0
Fau Locality	1	0	1	1	0	0	1	1	1	1	1	1	0	0	1
Irrigation Admin.	1	1	1	0	0	0	1	1	0	0	0	0	0	1	1
Farmer Union	1	1	1	0	1	1	0	0	0	1	1	0	1	1	1
Pastoral Union	1	1	1	1	1	1	0	0	1	1	1	0	1	1	0
Women Union	0	1	1	0	1	0	0	1	0	1	0	0	1	1	0
Saving and Social Development Bank	0	0	0	1	1	1	1	1	1	0	1	0	1	0	0
Agric. Bank	1	1	1	0	1	0	1	1	0	1	0	0	1	0	1
Health Admin.	1	0	1	1	1	0	0	0	0	0	0	0	0	0	1
Zakat Dewan	1	0	0	0	0	0	1	1	1	1	1	0	0	0	1
Forestry	1	1	1	0	0	1	1	1	0	0	1	0	0	0	1
Agric. School	1	0	0	0	1	1	1	0	0	0	1	1	1	1	0

Source: field data 2010

8- Geodesic distances of actors at the Rahad scheme level

Average distance = 1.400

Distance-based cohesion ("Compactness") = 0.800

(Range 0 to 1; larger values indicate greater cohesiveness)

Distance-weighted fragmentation ("Breadth") = 0.200

Frequencies of Geodesic Distances

1 2

Frequent Proportion

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1 1 126.000 0.600

2 2 84.000 0.400

Source: field data 2010