THE EFFECT OF INFORMAL INFORMATION NETWORKS ON THE FLOW AND PROVISION OF AGRICULTURAL INFORMATION: THE CASE OF AHAFO ANO SOUTH DISTRICT, GHANA.

BY

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DECLARATION

I, Danley Colecraft Aidoo do hereby declare that except for the references, which have been duly cited, the contents of this thesis for the award of the MPhil. Agricultural Extension degree is the result of my own work. No previous submission of this study has been presented elsewhere for the award of a degree.

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ABSTRACT

To improve agricultural development and to empower farmers to make sound, practical decisions, access to reliable agricultural information and knowledge is required. Farmers who are unable to access agricultural information from formal sources frequently turn to information transmitted through their informal information networks. The study examined existing informal agricultural information networks by using network characteristics, i.e., Network density, Centralization Measures (Degree Centralization and Betweenness Centralization) and explored the implication of such characteristics on the flow and provision of information. Specifically the study sought to meet the following objectives: find out the existing local information networks for the transmission of agricultural information, their characteristics, and the major providers of information in the various networks; determine the strength of network ties among members of the information networks and how these affect availability of agricultural information; and to examine the differences between actors in the various information networks and its influence on the availability of information.

The study was conducted in three communities and the snowball method of sampling for network analysis was used in selecting respondents. Key communicators were identified by means of the sociometric technique. The networks were presented in the form of sociograms in order to reveal the ties between actors in the networks. A high density of information ties was observed among a comparatively small group of core farmers, demonstrating the existence of a core-periphery structure in all three communities. Key communicators were identified on the basis of membership of local groups, status in the community, output access to training programs and experience acquired over many years of farming; thus serving as conduits between actors in the informal networks, spreading available information throughout the farming

community. The findings revealed a level of disparity in actor influence in the networks, signifying the presence of individuals who had some influence over the flow and provision of information. In addition, the networks were heterophilous with respect to the ties formed between actors.

It is recommended that extension service providers should target key communicators of informal information networks as they can serve as essential sources of information in disseminating information to farmers in a community. The study also suggests the use of farmers who can serve as intermediaries by virtue of their links with various actors.

DEDICATION

To my loving parents, David and Georgina Colecraft Aidoo, and my brother, Samuel Colecraft Aidoo.

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CHAPTER ONE

INTRODUCTION

1.0 Background

Information is fundamental to our way of life and agriculture is no exception. To be successful in agriculture would require gaining, processing, using and evaluating a huge quantity of information (policies, markets, new techniques). Agricultural information is invaluable to improved agricultural development. In order to make sound, practical decisions, farmers need access to reliable agricultural information and knowledge. Such information and knowledge when readily available can play a major role in improving agricultural productivity and in the long run, enhance the agricultural development of farmers and other users of agricultural information.

Information has an impact on individuals' farming practices within a specific place and time, and it arrives from many sources. Consequently, the various sources of information combine to create the varied reality of what can be depicted as a person's information environment. This information environment is bounded by the normal limitations and restrictions within which people create their farming practices and life habits (Sligo, Massey, and Lewis, 2005). A number of authors identify a variety of information sources available to farmers. Examples of these sources of agricultural information are libraries, internet, extension agents, research organizations, radio, television, community based organizations, neighbours, family, fellow farmers (farmer to farmer communication), cooperative groups and societies, traders (Ngathou, Bukenya, and Chembezi, 2006; Daudu, Chado, and Igbashal,2009; and Mwalukasa, 2013).

In view of the rapid growth and expansion of communication technologies, there has been a lot of research in the area of communication and agricultural development. However, the focal point of researchers have been geared towards modern communication media, and how these can contribute to improving agriculture. On the other hand, interpersonal communication is invaluable to communication among the rural folk who incidentally are at the core of agriculture.

Several studies highlight the potential of interpersonal communication. For instance, Ogbama (2010); Okwu and Daudu (2011); and Lwoga, Stilwell, and Ngulube (2011) realized that friends, relatives and neighbours are regularly available and accessible to the farmers to gain the agriculture information they need. This is in agreement with Ansu-Kyeremeh (1997), that indigenous group structures exist whose credibility, effectiveness, organizational and mobilization capacity have been tested over time and enjoy the co-operation of rural farmers. Adjaveh and Aborampah (2004) also echoed the same point. They found out that cultural and societal networks were important in any given society. For example, among the Akans in Ghana, they discovered that solidarity among members of the extended family bonded individuals, with elders being the major conduits of cultural dissemination. Elders wielded a very important status, being responsible for the education of all, younger adults inclusive.

Mundy and Crompton (1995), explain that local information networks are diverse, flexible in time, location specific, suited to local socio-cultural conditions, are already in place and so involve less cost, and are accessible to the majority of a community. Proper choice of information sources can contribute to development by bringing about beneficial changes in the behavior of individuals, groups, and organizations. According to Feder and Slade (1985), the dynamics of diffusion methods rely

generally on horizontal communication among farmers. Adoption is strongly influenced by constituents of the same societal group. New ideas are more easily adopted when they come from others who are similar in several respects. Outsiders are not entirely trusted, especially in conservative localities. Farmers scrutinize and have their perception of other farmers' skills, practices and performance, and they discover more by discussing their own experiences with friends and neighbors. The argument that rural farmers prefer farmer-to-farmer communication is supported by several studies that indicate that even in communities where social organisation and infrastructure exist, farmers favor their colleague farmers as their prime information source (Grandstaff and Grandstaff, 1986). Feder and Slade (1985) reveal that while farmers in India without contact with formal extension service used farmer-to-farmer communication, farmers who had contact with formal extension services also favored fellow farmers as their key source of information.

In line with this, Goswami and Sarkar (2009) identified three different types of social relations namely: neighborhood pattern, friendship pattern, and the discussion group pattern. Similarly, Soyka and Streiffeler (2003) also established strong linkages between farmers in the same neighborhoods and nearby neighborhoods. There were also strong network ties between family members. Consequently, farmers often resort to more vertical communications to gain access to innovations. Opinion leaders, who are also local farmers, are sufficiently heterophilous to be good sources of new information and advice. They usually enjoy considerable authority on the way other locals think and behave (Rogers, 2003). BenYishay and Mobarak (2012), explain that even beyond agriculture, studies indicate that social interactions are important driving forces for the spread of information in a variety of circumstances, including job information (e.g., Magruder, 2009; Beaman, 2011), deworming (Miguel and Kremer,

2007), HIV testing (Godlonton and Thornton, 2009), and menstruation cup use (Oster and Thornton, 2009).

Chapke and Bhagrat (2011) highlight the significance of local information networks in nudging rural masses towards accepting social changes that are being introduced through various development agencies. They highlight the following strengths:

1. The sources of information are familiar to rural audiences since they provide opportunity for instant feedback.
2. The techniques used are simple because they reflect the cultural philosophy of the people.
3. They already play a meaningful role in rural areas, in educating rural folk about the consequences of social evils. Consequently, the use of such media makes nation building and socio – economic development easier and acceptable to rural masses.

Traditional information networks come from the people and their appeal has by and large been both capable and creative. They have always served to amuse, educate to buttress existing ideas or ideologies or to transform existing ideals and attitudes. Being close to people at the local level, these interpersonal networks are potentially useful in the service of social concerns, as determined by local or national authorities themselves. They are, moreover, abundantly present in areas where mass media technology has not been fully or effectively developed to capture sustained interest at local and national levels. Interpersonal information networks are personal forms of entertainment and communication. This is important because behavioural changes are most easily brought about by personal interaction. These forms of transmitting information are a part of the way of life of a community and provide acceptable

means of bringing development issues into the community in its own-terms. They are capable of reaching intimate social groups, thus making use of already established information networks in the audience.

1.1 Research Problem

Developing agriculture by disseminating the right information to the right groups has proven to be an effective strategy (Shaffril, Hassan, and Samah, 2009). In Ghana, the Ministry of Food and Agriculture (MOFA) which is the major source of information to farmers, is faced with several constraints. One of such constraints relevant to this study is the low extension – farmer ratio. For example, in the Ahafo Ano South district, the extension officer – farmer ratio is 1:2,171 (www.ghanadistricts.com). Even though this ratio is better than the national figure which stands at 1:3000, this situation negatively affects the availability of agricultural information to farmers in the district (www.ghana.gov.gh). The result has been that there is lack of an effective farmers' information support system for the farming activities in the country. As a result, farmers rely on their own informal sources for the information they need to improve upon their activities. Apart from the low extension agent to farmer ratio, another problem is that in instances where there has been some level of agricultural information dissemination through the mass communication media, there still exists the problem of farmers not having any choice with respect to the kind of information made available to them (FAO/DFID/ODI, 2002). This is a serious issue since rural farmers certainly have a pivotal need for agricultural information.

The constraints associated with the use of ICTs for the provision of agricultural information also make it necessary to consider the potential of informal information networks. Elijah and Ogunlade's (2006) study in Nigeria identified several constraints

in the implementation of ICTs. The constraints are: lack of access to electricity or unstable supply of electricity and lack of adequate technical support. In the same vein, Ngwenyama,Andoh-Baidoo, Bollou, and Morawecynski (2006) made the following affirmation: "in Africa, three quarters of the population is illiterate and lives in rural areas that lack basic facilities such as electricity and to expect effective utilisation of communication technologies like the Internet in all areas, by all people, would be unreasonable" (p.4). This view is also supported by Ghatak (2007) who mentions constraints such as differing literacy, poor technical skills and lack of practical digital content. Hassan, Shaffril, Azril, and D'Silva (2009) also indicate that people in the rural areas are still hesitant to use the advanced technology that are available to them. Consequently these disparities in use of ICTs by farmers, as well as the limited access to agricultural extension officers by farmers make it logical to examine the potential of local information networks in improving the provision and flow of agricultural information.

Moreover, Sligo et al., (2005) indicate that there is inadequate research into the varying interpersonal sources of information that make up the individual's environment. The ways in which these connections help to enhance the individual's "information bank" (from which they can produce insights into their occupation and lifestyle) is generally unfamiliar.

1.2 Research Questions

1. How do the existing local information networks affect the exchange and sharing of agricultural information among members of the community?
2. How do ties among members of information networks influence the provision of agricultural information?

1.3 Research Objectives

1. To find out the existing local information networks for the transmission of agricultural information, their characteristics, and the major providers of information in the various networks.
2. To determine how the structural properties of the existing networks affect the flow of agricultural information.
3. To examine how differences between actors in the various information networks influence the provision of agricultural information

1.4 Relevance of Study

Rural farmers in general are not adequately-served by the agricultural extension services agents as a result of the poor extension – farmer ratio (Entsua-Mensah, 2005). The inability of these extension service providers to equitably satisfy all rural farmers indicates the presence of a gap with regards to fulfilling farmers' information needs. In contrast, information networks are present in rural communities and reach comparatively higher number of farmers. Such networks possess potential features that can be harnessed for transfer of agricultural information. The contribution made by rural farmers in agriculture is invaluable, thus justifying the need to examine how their existing information networks satisfy their need for information. This provides the foundation and relevance for this research work.

1.5 Study Area

The study area was the Ahafo Ano South district in the Ashanti Region. The district is in the north-western part of the Ashanti Region, bounded to the north by Brong Ahafo

Region, to the south by Atwima District, to the west by Ahafo Ano District and to the east by the Offinso District. The district lies 32 kilometres northwest of Kumasi on the Kumasi - Sunyani road. The capital of the district is Mankranso. The Ahafo Ano District covers a total surface area of about 1241km, representing 5.8% of the region's total surface area (www.ghanadistricts.com).

The district has a population of 133,632. Males constitute 55.2 percent and females represent about 44.8 percent. Of this population there are only about 20 Agricultural Extension Agents in the district. The District is predominantly rural with over 160 organised settlements. Agriculture is the stronghold of the district's economy. Economic activities are therefore very low with farming as the most important productive activity with respect to output, income and employment. Cash crops, such as cocoa, citrus, oil palm and food crops like rice, plantain, cassava, cocoyam, maize and vegetables (tomatoes and okro) are the main agricultural produce in the district.According to the latest population and housing report, just a few households have access to electricity (6%). A major part of the population depends on other sources of power.

1.6 Organisation of Thesis

The thesis is organized into six chapters. Chapter one has provided a background to the study, outlining the research questions and objectives that form the basis of the study. In chapter two relevant literature is reviewed, and theories that explain various aspects of the study are discussed. The third chapter explains the various techniques and methods that were used by the researcher in order to achieve the objectives of the study. In Chapter four, the results obtained are presented while these results are discusssed in Chapter five. Finally, chapter six presents the conclusions and the recommendations that arise from this study.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

In this chapter, concepts of communication that underpin the study are reviewed. It discusses the elements of the communication process, the forms of communication, and the contexts in which communication takes place. Social and communication network analysis are explained with practical examples of their use. Finally, theories relevant to network analysis are discussed with the focus on their relevance to information networks.

2.1 Definitions and Meanings of Communication

Rogers (1995), defines communication as “a process by which participants create and share information with one another in order to reach mutual understanding”. The word communication is derived from the Latin verb *communicare*, which means "to *share*" or "to *make common*" (Coates, 2009). Considering the function of communication, it could basically be viewed as reaching a common ground of understanding. According to Chandan (2010), communication can be defined as “the process by which a person, group or organization (the sender) transmits some type of information (the message) to another person, group or organization (the receiver)”. From these definitions, communication can be explained as a process of passing information from one person to another. The various definitions also highlight the need for recipients of information to properly understand what is transmitted. If the message is not understood, then the rationale of communication is defeated. Thus, it can be concluded that communication is not just a mere transmission of information but it also involves the interpretation and understanding of information.

Communication is also shown to be a significant interaction between people such that it makes certain that the thoughts conveyed from one person to another is passed on in a way that the implication and worth of the message is the same for both sender and recipient. This aspect of communication emphasizes how necessary it is for the message being communicated to be passed on and fully understood.

2.2 Elements of the Communication Process

A process is a continuous, non-stationary action. DeVito (1986) says that "communication is referredto as a process to emphasize that it is always changing, always in motion" (p. 239). Thus the description *"process"* in relation to communication shows that it is an ongoing occurrence. Communication then means a procedure of sending out opinions, facts, desires, and sentiments to others in the form of a message. This implies that for communication to occur, at least two individuals, a sender and recipient, are required. Several researchers identify the elements or components of the communication process as being made up of a source or sender, the message, the channel of communication, the recipient, and feedback as shown in figure 1 (Chandan, 2010; Lunenburg, 2010). The *sender* commences the communication. The sender is the individual who wants to convey a thought or concept. The *recipient* is the individual to whom the message is sent. The sender codes the idea by choosing words, symbols, or gestures which would make meaning. The *message* is in the form of oral, nonverbal, or written words. The message is sent via a *channel*. The recipient interprets the received message into significant information. Finally, *feedback* occurs when the receiver reacts to the sender's message. Feedback allows the sender to establish whether the message has been received and understood. The elements in the communication process determine the

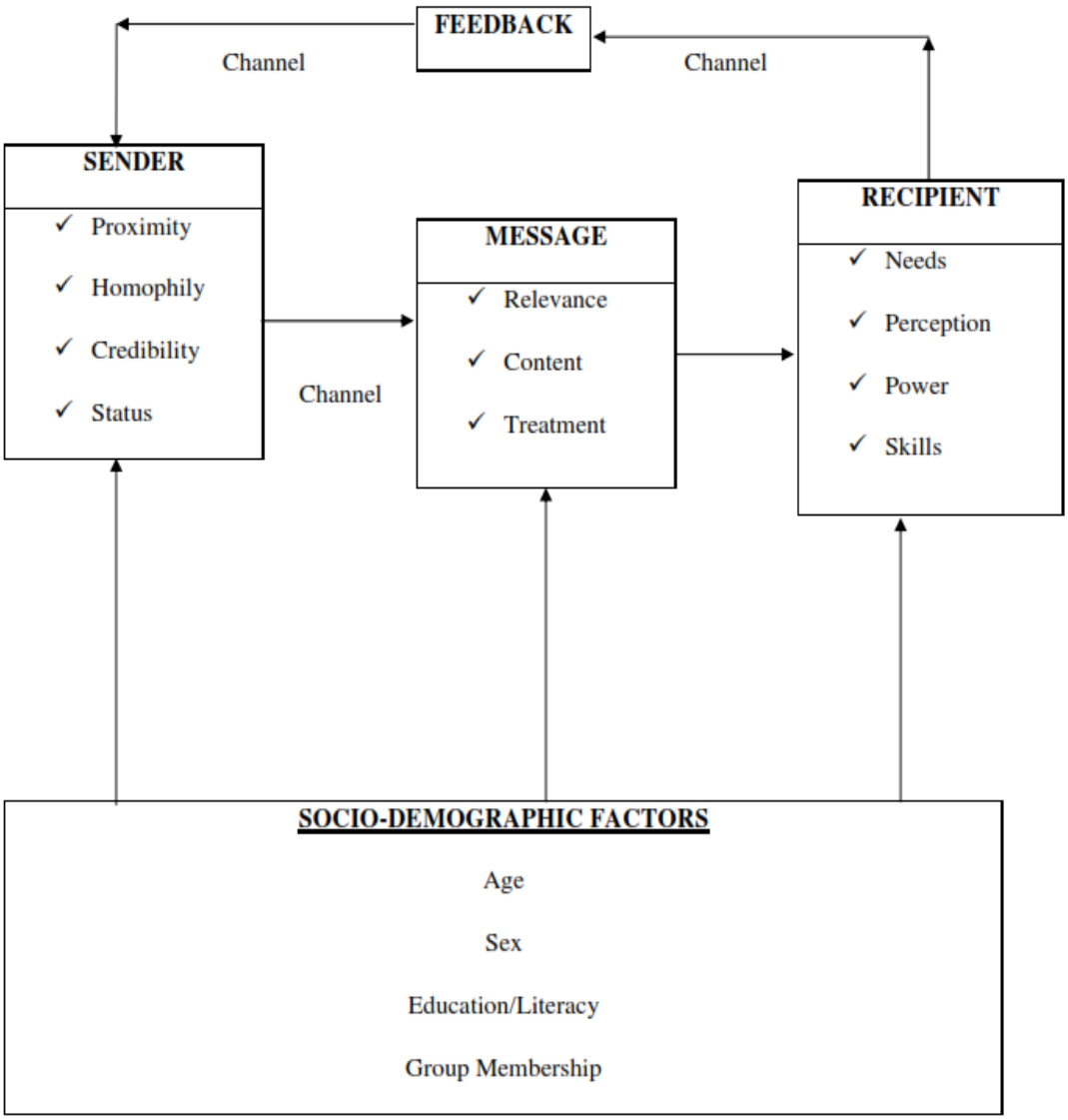
quality of communication. A problem in any one of these elements can reduce communication effectiveness (Keyton, 2011).

2.2.1 Sender

The sender is the source of the message or information that is communicated. He conveys ideas or concepts to others. The sender can be an individual, group, or organization who initiates the communication. As the source of the message, the sender is initially responsible for the success of the message. Consequently, he must be aware of the purpose of the communication and the recipient's capacity to comprehend it's meaning in terms of language, importance, etc. Thus, the sender's experiences, thoughts, familiarity, abilities, observations, and culture influence the message. Burnett and Dollar (1989) state that "the written words, spoken words, and nonverbal language selected by the sender are paramount in ensuring the receiver interprets the message as intended by the sender".

Persons in any social organization who are sought out for information and guidance on broad or precise subject matters are identified as key communicators. These individuals are also described as influencers, information leaders, opinion leaders, style-setters, gate keepers etc. Rogers and Kincaid (1981) define opinion leadership as the degree to which an individual is able to informally influence another's knowledge, attitudes, or obvious behaviour in a desired way with relative regularity. It is believed that such individuals are highly esteemed in each social structure to which some people turn for suggestions and information and who by means of such discussions, influence their behaviour and actions.

Figure 1. Elements in the Communication Process and how they are related



(Adapted from Barnlund, 2008)

Rees et al (2000) classifies sources of agricultural information into four general areas. They are as follows:

- Local sources and Community Based Organizations (CBO) e.g. friends, relatives, neighbors, farmer cooperatives, water point discussions, etc.
- Agribusiness (formal and informal) e.g. traders, banks, transporters, etc
- Government sources e.g. Ministry of Agriculture, Farmer training centers, agricultural colleges, etc

- NGOs/Church sources e.g. OXFAM, World Vision, Plan Intl. etc

In Ghana, several sources of information have been identified by various researchers. Codjoe, Asuming-Brempong, and Mabe (2013) identified information sources generally used by farmers and classified them into four in accordance with their similarities, that is: personal information sources, public information sources, private information sources and mass media. They explain that in rural communities, farmers seek information and knowledge mostly from their fellow farmers, relatives (personal sources) as well as from their small radios and television (mass media) more often than from extension agents, research institutes and university staff (public); and independent sources such as input dealers and Licensed Buying Companies (private). In his study conducted in the Atwima Mponua and Amansie West districts in the Ashanti region of Ghana, Baah's (2008) findings agree with the conclusion above. He discovered that of the 278 farmers interviewed, 83.8% of farmers had not met an extension agent in the year preceding the study. The farmers relied heavily on their network of family members and friends for information on cocoa and only 13% regarded the extension system as a reliable information source.

Sumbo (2001) explains that irrespective of whether the sender is an institution or a person, there are certain general factors that have a bearing on the reliability of the information source. He identifies these factors as communication skills, attitudes, level of knowledge, and the position that is occupied by the source within the socio-cultural system. Boahene (1995) states a number of factors that influence the source of information in interpersonal communication among farmers in rural communities. Some of these factors are the level of authority and influence of the farmer, level of

participation in community activities, and the proximity of the farmer to other farmers who can access the type of information required.

2.2.2 Message

The message is simply the information the sender wants to communicate to the receiver. The message is usually verbal, but it can also be non-verbal. According to Burtis and Turman (2010), a message includes verbal content (i.e., written or spoken words, sign language, e-mail, text messages, phone calls etc) and may contain nonverbal content (significant actions beyond words: e.g., body movement and gestures, eye contact, touch, timing, etc.). Intentionally or not, both verbal and nonverbal content form part of the information that is transferred in a message. Bovée et al (2004) explain that the message is an invaluable element of the communication process because communication is successful only when the message is understood and when it stirs up action or encourages the receiver to think in new ways.

Zins (2007) describes information as a message used by a sender to represent one or more concepts within a communication process, intended to increase knowledge in recipients. There are two foremost facets of the message communicated: content and treatment. The content of the message refers to the statements, opinions, requests, topics and ideas which the sender conveys to his recipients. On the other hand, the treatment highlights the arrangement or organization of the content by the sender.

Selassie (2001) defined agricultural information as the data for decision-making and as a resource that must be acquired and used in order to make an informed decision. Demiryurek, Erdem, Ceyhan, Atasever and Uysal (2008) indicate that agricultural information relates with and affects agricultural efficiency in diverse ways. Agricultural information is invaluable in decisions concerning land, labour, capital

and management. Umali and Schwartz, (1994) categorize agricultural information into two broad groups: pure agricultural information and agricultural information naturally tied to new physical inventions. Pure agricultural information refers to any category of information which can be utilized without acquiring a particular material expertise. Agricultural inventions or technologies occur in the form of agricultural inputs, management technologies facilitating farm management, and marketing and processing equipment. On the basis of this classification, agricultural information can be deemed as consisting of both agricultural messages transmitted through extension and reflected in the form of agricultural technologies that are shared between the actors in the agricultural extension system.

2.2.3 Recipient

Also known as the receiver, the recipient puts meaning into and reacts to the transmitted message. Tait, Wibe, and Yarbrough (1980) state that once the recipient accepts the message conveyed by the sender the goal of communication has been reached. They indicate that the recipient accepts the message by means of attention and comprehension. Attention takes place when the recipient listens to, watches or tunes in to the message being transmitted. Comprehension transpires when the message is understood by the recipient. Yarbrough (1968) proposes that after paying attention to and comprehending the message the recipient accepts the message. He describes the acceptance of the message as occurring on three levels, namely, cognitive (accepting that the message is true), affective (accepts the message as being both true and good), and overt action (the recipient believes the message as true and good and also takes appropriate action). However, the information seeking decisions of the recipient are determined by several factors. Some of these factors that affect the

choices made by the recipients with respect to the source of information are discussed below.

Needs: Case (2007) describes a need as "an inner motivational state" that brings about thought and action. He goes on to explain an individual's need for information as a recognition that the knowledge he possesses is inadequate to satisfy his goal. One characteristic of needs is the expectation of fulfilling a desired goal. Thus when the individual becomes aware of a gap in their state of knowledge regarding a specific situation or topic he seeks to address it by requesting or seeking information. Bachav (2012) shows that farmers need information for various reasons related to agricultural activities, and they use diverse sources for access to such information. Consequently, farmers would choose sources of information that they believe would help satisfy their needs and achieve their goals.

Perception: Perception is the way an individual thinks about or understands someone or something. Individuals are inclined to concentrate on information that they believe would meet their desires and interests. Such discriminatory consideration is usually instrumental in fulfilling individual requirements and getting things done.

Other factors such as the recipient's power to make use of the information received and possession of the skills required to utilize the information received are important when deciding which information source to patronize.

2.2.4 Feedback

Sending back awareness about the message to the communicator is known as feedback. The importance of feedback cannot be overstated. Feedback is a benchmark which measures the efficacy of communication and is useful for appraisal of the communication process and to amend the message accordingly. A communication

process is deemed to have feedback when the recipient responds to the sender's message. On the other hand the communicator must be aware of how well the message has been received by the receiver, and whether it has been understood and put to use. To improve communication feedback is desirable. Often, people are unaware of the way they communicate. Sending and getting feedback can help to gain insight about the communication process. It means that people who communicate notify each other about the outcome of the other person's role in the entire process. Georgievska (2011) explains that "we understand whether communication was successful from the feedback that we will obtain, and if communication was not successful the first time, the second time we might consider a different approach." He goes on to explain that the person with the most supple behaviour has the greatest influence on others. Consequently, if an information source repeats the same thing that does not work, there likelihood of failure is great. The feedback is thus an important reaction, that helps to indicate if communication has been understood or not. Guo and Anderson (2005) agree, establishing that feedback should be used to improve communication efficacy. It is a successful approach in boosting targets, responsiveness, and learning.

2.2.5 Channel

Basically, the channel is the medium of communication used to convey the intended message. The channel can be thought of as a bridge, connecting the source of the message and the recipient. Guo and Anderson (2005), identify two main types of channels, verbal channels and non-verbal channels.

The effectiveness of a communication channel is determined by several dimensions, some of which are;

- Channel Credibility: the reliability of the channel as perceived by the recipient

- Channel Feedback: the opportunity a channel provides a recipient to respond to a message
- Complementary nature: the ability to balance the work of other channels

Generally, the choice of which communication channel to use depends on the type of communication. In the light of this study, emphasis would be placed on interpersonal communication since it is the main channel of transmitting information among informal information networks.

2.3 Socio-Demographic Factors and the Transmission of Agricultural Information

Socio-demographic factors are those features that are related to individual uniqueness. Very often, they correspond to the socio-economic characteristics of a population and are rendered in statistical form. Some of these factors are sex, age, level of education, marital status and household patterns among many others. According to DeNegri, Brown, Hernandez, Rosenbaum, and Roter (2012), the communication context is affected by the socio-demographic characteristics of the provider of information and the recipient, as well as by the environment in which the communication occurs. The age, sex, ethnicity, and educational background of both information providers and recipients influence how they communicate with each other.

Banjade (1994) explains that although the mass media assists in creating awareness and providing basic information, implementation of the information is most often encouraged or discouraged by opinion leaders, close to members of the community, who share many of the same characteristics as the target group.

Consequently, effective interpersonal communication in a community network is as a result of the information source and recepient being aware of the various characteristics, cultural values, and societal institutions that characterize the community. This study is concerned with factors such as homophily and proximity between the information source and recepient, credibility of the information source as perceived by the receiver, status of the information source in the community, and the needs of the recepient. These factors are briefly highlighted below:

2.3.1 Homophily

It is the tendency of individuals to associate and bond with similar others (McPherson, Smith-Lovin, and Cook, 2001). Several studies that have examined homophily in some form or another establish that corresponding characteristics breed connection. These similarities could be age, gender,class, or organizational role. Those in homophilic interactions possess familiar characteristics (beliefs, ethics, level of education) that make communication easier.

2.3.2 Proximity

Proximity refers to the substantial space between people. People in face-to-face interactions command one another's concentration and are actively occupied with the subject of communication. The attention paid to those present makes interactions with them more outstanding than exchanges with those far-off (Latane, Liu, Nowak, and Bonevento, 1995). Proximity facilitates informal communication since it increases attention, social impact, and familiarity (Kiesler and Cummings, 2002).

2.3.3 Source Credibility

The Source Credibility theory states that people are more likely to be persuaded when the source presents itself as credible. Gilbert, Fiske, and Lindzey (1998) explain that even though the theory of source credibility has several elements, the two general elements are the proficiency and trustworthiness of the source. Beebe and Beebe (2005) describe trustworthiness as the ability for people to believe that a person is reliable and honest.

2.3.4 Status of the Sender

This refers to the relative position that an individual holds in a social chain of command based upon honour ("Status," 2013). In the context of this study, the status of the sender is in relation to his/her perceived leadership in the community with respect to education, occupation, marital status, and other special qualities gained through competition and individual effort (achieved status) or factors such as sex, age, race, family relationships, or birth (ascribed status).

2.4 Levels of Communication

According to Sridhar (1988), the settings in which communication takes place can serve as a basis for classification. He mentions that communication can be classified into formal and informal, interpersonal and intrapersonal, etc. Some authors (Patidar, 2013; Dunn and Goodnight, 2010) have identified various levels of communication. Some of these levels are highlighted below.

- Interpersonal Communication: This refers to communication between two or more people, usually occurring by face to face interaction. It usually occurs in two stages: dyads (groups of two) or small groups. *Dyadic communication*is the interaction between two people. It normally is informal, and entails little or

no preplanning. *Small-group communication*refers to exchange of information involving three to eight people. In most cases, small-group communication is less intimate than dyadic communication and less official than public speaking.

- Intrapersonal Communication: This iscommunication with the individual's self. It involves the person's consciously sending information to himself/herself and includes such activities as self evaluation, analysis of a situation, decision making, problem solving, and so on.
- Mass Communication: This is a description of an individual or organization sharing information with a large, diverse audience. Usually the information is transmitted via mass media such as journals, television, newspapers, and the internet. Verbal communication through mass media usually involves the use of microphones or amplifiers while written messages require electric or print media.
- Machine-assisted interpersonal communication: It involves one or more people communicating using a mechanical appliance or devices with one or more recipients. It combines features of interpersonal and mass communication conditions. A typical example of this is the use of the Internet. The devices used in this level of communication give the information transmitted permanence and/or broaden its range. The source and receiver can be separated by time and space.

2.5 The Relevance of Networks to Agricultural Information Delivery

This section discusses the theoretical framework on which this study is based, highlighting how significant it is to the effective provision of agricultural information.

2.5.1 Social Networks and Analysis

According to Wasserman and Faust (1994), a social network is a social construction made up of a set of social actors (such as individuals or organizations) and a set of the dyadic (a group of two people) ties between these actors. Serrat (2010) also describes social networks as nodes of individuals, groups, organizations, and related systems that tie in one or more types of interdependencies such as shared values, visions, and ideas; social contacts, kinship, conflict, financial exchanges, trade, joint membership in organizations, and group participation in events, among numerous other aspects of human relationships. A social networkcan thus be expressed as a social structure consisting of persons or organizations called "nodes" (or actors), which are connected or linked (tied) by one or more definite types of ties, such as friendship, kinship, general interest, or status. This theoretical construct is valuable in studying the interactions that exist between individuals, groups, or even whole societies.

The social network theory seeks to explain how the social structure of interactions around an individual, group, or organization affects values or behaviour. The theory views social relations basically in terms of nodes and ties. The nodes correspond to individual actors while the ties stand for the relationships or linkages between the actors. Social networks are usually represented as maps of relevant ties between nodes that are being examined. These maps are also called sociograms. In sociograms, the nodes are represented by points or dots, while the ties are depicted as lines. Social networks helps to examine interactions between individuals or groups.

According to Krebs (2002), "social network analysis is the mapping and measuring of relationships and flows between people, groups, organisations, computers or other

information/knowledge processing entities." Social Network Analysis (SNA) is a technique that facilitates the mapping of interactions between people in order to identify the flows of information. It identifies who people in a community seek information and facts from and who they share their information and knowledge with.

This method focuses on informal relationships, indicating how existing informal interactions ease or hinder the transfer of information and knowledge. Social network analysis has been applied in a wide range of academic disciplines such as anthropology, business studies, communication studies, information science, organizational studies, development studies and literature studies (De Nooy, 2003). The method has also been practically applied in countering money laundering and terrorism (Krebs 2002). This study however dwells on the flow of communication and how it is aided or hindered by the informal interactions between members of the networks.

2.5.2 Communication Networks

A Communication network refers to a description of the direction and flow of information between two or more linked individuals in a community, organization, or group. Corman and Scott (1994) explain that the network is a conceptual arrangement of perceived communication relationships that function as a set of rules and resources actors draw upon in accomplishing communication behavior. Wrench and Punyanunt-Carter (2012) identify two types of communication networks, namely, Formal and Informal communication networks.

Formal communication networks are networks in which transfer of information occurs via official organizational or institutional channels on the basis of established

positions of authority. The channels used in formal communication networks are established according to the hierarchical configuration of the organization. Wrench and Punyanunt-Carter (2012) identify three directions of information flow in formal communication networks. They categorize these as horizontal/lateral flow of information (information conveyed to other individuals on the same level of the organizational chain of command), downward flow of communication (messages that start at the top of the hierarchy and are transmitted down the ladder to the lowest pecking order), and upward communication which refers to information that emanates from the bottom of the hierarchy and are transmitted up the ladder to the highest rungs of the hierarchy.

In contrast, informal communication networks lack a stable structure, are unplanned and situationally derived. Information flow in informal networks is based on unofficial associations (such as friendship, membership of a group, the same occupation, etc.) and, therefore, is free from all the organisational formalities that characterise formal communication networks. Exchange of information at this level usually occurs in casual settings. Since it is founded on the basis of social relations and interactions, information transmitted through informal communication networks can reach a targeted audience quickly and effectively.

2.5.3 Communication Network Analysis

A communication network consists of interconnected individuals who are linked by patterned flows of information, and analysis of communication networks identifies the communication structure within a social system (Rogers and Kincaid, 1981). Generally, the focal point of network analysis is to identify the relationships between people, instead of their individual characteristics. These relationships include the

feelings people have for each other, the transfer of information, or more concrete items such as commodities and currency. By expressing these interactions in the form of sociograms (a graph that depicts the social relations in a group), network analysis helps to reveal the unofficial communication patterns that exist in a community, group or organization. As shown in several studies, the patterns that emerge from network analysis enables an understanding of some group or societal trends. For instance, the relations between employees in an information network (as described by their connections or interactions), affects their access to and control over information (Burt, 1992; Haythornthwaite, 1996).

Communication network analysis gives meaning to the communication structure of the group or organization being studied. It differentiates between the various structural characteristics, such as the types of information transmitted through the respective communication networks, the roles played by various actors in the network, the channels used for different types of information transmitted, and the effectiveness of information flow in the network. The measures of network analysis could be in terms of the network, the actors in a network, or the ties that link actors in a network.

Hanneman and Riddle (2005), state that network descriptors that deal with connections among actors in a network can be extremely consequential for understanding the attributes and behavior of these actors. They further explain that actors with more connections is an indication of their exposure to more diverse information. Highly connected individuals may be more influential, and may be more influenced by others, depending on the direction of information flow. Another method of analysing information networks is the use of network descriptors that deal with

how far (in terms of social distance) an actor is from others (Izquierdo and Hanneman, 2006). According to Katz et al (2004), these descriptors can be generally categorised as measures of actor degree centrality (the extent to which actors send or receive direct ties), betweenness centrality (the extent to which actors have ties with others who are not directly connected), closeness centrality (the extent to which actors are directly or indirectly connected to the rest of the actors in the network), reciprocity (the extent to which there are mutual ties between actors), or transitivity (the extent to which actors who are connected to one another are also connected to the same other actors).By means of these descriptors, key actors (referred to as key communicators in this study) are identified on the basis of the positions they occupy.

The actor with most ties to other actors (degree centrality) directs communication and resources across the network. These key actors are generally perceived as highly knowledgeable than the others or possess a higher status or level of influence than others in the community (Valente and Pumpuang, 2007)and are consulted the most for any required information. The positions these key actors occupy make the networks vulnerable in the event of their absence.

The other descriptors (betweenness, closeness, reciprocity, etc) determine key actors on the basis of their lying between other actors such that if they were removed the network could be fragmented, endangering the flow of information between the other actors (Burt, 2005). Actors in these positions are indispensable in sealing gaps or boundaries imposed by a key actor's perceived power or status (Gray, 2008). It must however be noted that these positions are not mutually exclusive, thus, an actor may be a key communicator by virtue of the number of ties initiated with others and still be influential in terms of his/her position in the network

2.6 Homophily Theory and Information networks

Monge and Contractor (2003) state that there are 'families of theories' that seek to explain why people form, sustain, break, or reinforce network ties with others. One of such theories fundamental to this study is the theory of homophily. The homophily theory is defined as a "principle that contact between similar people occurs at a higher rate than among dissimilar people" (McPherson et al, 2001). Hamm (2000) explains that likeness in terms of traits and skills possibly eases the process of evaluating, communicating with, and even predicting the behavior of others. This phenomenon explains why friends, spouses, romantic partners, co-workers, colleagues, and other professional and recreational associates all tend to be more similar to each other than randomly chosen members of the same population with respect to a variety of dimensions, including race, age, gender, socioeconomic status, and education (Kossinets and Watts, 2009). Homophily is typical of network systems and homogeneity is an attribute of personal networks. Sex, age, religion, and education have a strong effect on the structural relationships between individuals, while occupation, network position, conduct, and intrapersonal ideals also show substantial homophily, but they are more specific to certain forms of networks (McPherson et al, 2001).

McPherson and Smith-Lovin (1987) identify two categories of homophily, namely, *choice homophily*and *induced homophily.* Choice homophily refers to homophilous ties that are formed on the basis of personal preferences. Homophilous ties that exist or are formed as a result of the presence of structural opportunities for interaction, such as an individual's vicinity, place of employment, school, etc, are designated as induced homophily. According to Handcock, Hoff, and Raftery (2002), these two

categories of homophilous ties are not mutually exclusive, instead, they buttress each other. Thus, while it is possible to state that an individual selects into an environment with the specific aim of meeting the class of people that also exist in those locations, it is equally reasonable to establish that the predisposed categorization of individuals to structurally nearby locations is itself an outcome of structural limitations.

Homophily has extensive implications for the delivery of agricultural information in informal networks. The fact that homophily facilitates the spread of resources among similar people implies that information that flows via informal networks could possibly be confined or restricted to a group of similar individuals. As Granovetter (1973) indicates, communication among a homophilous group is repeated, unchallenging, and speeds up the rate of diffusion in an information network. Consequently, homophily in information networks aids the transfer of information, not just with the aim of introducing information, but additionally, it supports social relations, reinforces existing networks, and enhances social closeness among farmers.

2.7 Summary

Thus far, the review of literature has discussed how important the communication process is to the operation of informal information networks. The elements in the communication process play various roles to ensure that agricultural information is transferred in the network. Consequently, it has been revealed that by means of network analysis, key aspects of a network such as identification of influential actors (key communicators), and the flow of information among actors can be determined. The theories on which this study is grounded have been discussed. This chapter has also helped to explain the rationale behind the type of methodology used in the study.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter highlights the study design, sampling and data collection methods. It also gives a background to the study area and explains other relevant factors related to analysis of the data collected.

3.1 Research Design

According to Burkingham and Saunders (2004), a research design is an outline that directs data collection and analysis, allowing the investigator to examine and explain the problem being studied. In addition, Burns and Grove (2011) add that a research design is the plan for the study, which gives the researcher authority over aspects that could meddle with the force of the results. It helps the researcher to plan and carry out the research in order to accomplish the projected goals.

For the purpose of this study, both qualitative and quantitative methods were employed.Data was collected primarily by means of questionnaires administered by the researcher. The initial respondents were selected by means of the sociometric technique. Additional questionnaires were also administered to actors identified as key communicators. Data collected was analyzed by means of UCINet 6 (Borgatti, Everett, and Freeman, 2002), Pajek (Batagelj and Mrvar, 2007), and the SPSS package.

3.2 Population

The population for this study encompasses all natives and resident farmers in the Ahafo Ano South District. The respondents were drawn from the population. The District is predominantly rural with over 160 organised settlements. The district has a population of 133,632 (2000 population and housing census) of which 48.2% live in the 20 larger settlements. The major crops grown by farmers in the area are cash crops, such as cocoa, citrus, oil palm and food crops like rice, plantain, cassava, cocoyam, maize and vegetables (tomatoes and okro). Farmers in the district belong to various groups, agricultural and non-agricultural. Some of the agricultural groups are locally formed (eg. Nnoboa groups) while the others are formed by external agencies, non governmental organizations (NGOs), and produce buying companies. Traditional methods of farming (use of cutlasses, hoes, slash and burn are very common. In view of the high cost of hired labour, a large number of farmers form nnoboa groups (groups formed on the basis of communal labour) to work on each farm.

3.3 Sampling Method

The study adopts the snowball method of sampling for network analysis as proposed by Hanneman and Riddle (2005). The snowball method begins with a central actor or set of actors. Each of these actors is asked to name some or all of their ties to other actors. Then, all the actors identified (who were not part of the initial listing) are tracked down and asked to name their ties. The process continues until no new actors are identified, or until the researcher decides to stop (usually for reasons of time and resources, or because the new actors being named are very marginal to the group being studied).

The study area was purposively selected due to practical limitations (i.e., distance, finance and transportation). Specifically, respondents were drawn from Dunyankwanta, Afreseni, and Kunso camp. These three communities were purposively selected on the basis of their being predominantly rural farming communities. The communities also have various formal and informal groups.

3.4 Data Collection Procedures

The Sociometric technique was used to identify the key communicators. This technique, developed by Moreno (1951) studies human connectedness. The respondents were asked to indicate their choices from whom they receive information regarding agricultural activities (Moreno, 1960; Goswami and Sarkar, 2009). Respondents were required to make unlimited choices without any specified categories. The choices were directed in nature, i.e. they distinguished between seeking information and providing information. The number of received choices by the respondents were ranked. Key communicators identified from the analysis of responses collected with the aid of the initial questionnaires were consulted for a second round of interviews to determine their sources of information, information sharing habits, and their positions or status in the community. Pretesting of questionnaire was done to ensure the validity and reliability of the instruments used in the data collection process.

3.5 Data Collection Instruments

Data was collected primarily by means of questionnaires that were administered to respondents. The questionnaires sought information on individual characteristics of the respondents, their choice of information sources, and their membership of local farmer groups. Another set of questionnaires were administered to key

communicators, seeking information on their output, level of experience, training programs attended, and status in their respective communities.

3.6 Data Analysis

Social network analysis usually involves the use of questionnaires and/or interviews to obtain data about the interactions within a distinct cluster or network of people. The data collected is then charted with the aid of a software instrument designed for that specific purpose. Social network analysis expresses social interactions using network theory terms, comprising nodes (which symbolize individual actors within the network) and ties (which also stand for relationships between the individuals in the network) such as friendship, kinship, organizational position, sexual relationships, etc (D'andrea, 2009; Pinheiro, 2011).

Farmer responses were coded in terms of dual variables (distinguishing between the presence or absence of ties), to allow entry into a name-based adjacency matrix (Hanneman and Riddle, 2005). The coded responses were entered into Pajek (Batagelj and Mrvar, 2007) to create socio-grams and analysed with the aid of the software Ucinet 6 for Windows (Borgatti et al., 2002). The sociograms were created according to the core-periphery model (Cattani and Ferriani, 2008). The Core-periphery model generally arranges actors in a network into two categories, one category for highly sought farmers and the other for farmers who are less consulted. Basically, network members who occupy core positions possess relatively many interconnected ties, whereas occupants of the peripheral positions in a network have relatively few connections to the core and to each other (Borgatti and Everett 1999). The networks were also analysed in terms of network descriptors such as degree, density, in/out-degree links, network size, and network centrality. Personal characteristics of key

communicators were presented with the aid of charts, graphs, and tables generated from SPSS.

3.6.1 Sociograms

Sociograms, are graphic pictures, or descriptions, of a type of social connection. Sociograms show aspects of a relationship at a given point in time (Durland, 2003). A sociogram is composed of nodes (or actors or points) connected by lines (or relations or ties) and usually represents types of relations among the actors (Hanneman and Riddle, 2005). The sociogram shows whether there are numerous or a small number of ties between members in a network, the general pattern of the existing ties, and where every individual member is located in the network (Katz et al, 2004). In this study, the ties that made up the sociograms were directed with the aid of arrows to reveal the flow of information (i.e from information source to target). The ties were reciprocal (X chose Y and Y chose X) in which case such ties were represented with a double-headed arrow, or non-reciprocal (only one member chose the other). In this study, information about ties were entered into Pajek (Batagelj and Mrvar, 2003) in order to obtain sociograms.

3.6.2 Measurement of Network Descriptors for Network analysis

This section discusses the various measures of network analysis that are relevant to this study. These variables were measured with the aid of UCINET 6 (Borgatti et al., 2002).

i. Degree of Nodes: According to Brass (1995) degree as used in network analysis deals with the number of direct links with other actors. This measure of analysis helps to identify key communicators or major information sources. The key communicators possess the highest number of “out-going” links,

indicating the flow of information from them to other actors in the network (Wrench and Punyanunt-Carter, 2012).

ii. Network Size: This refers to the number of interconnected individuals in a network. This was determined by literally counting the members of the network.

iii. Network Connectedness: This measure of social network analysis refers to the percentage of the theoretical number of connections that have been achieved (Zhang et al, 2013). Network connectedness primarily focuses on evaluating networks (groups of actors) in terms of the number of ties that link different networks. This study explored network connectedness in terms of network density.

- Network Density: Density of a network is the ratio of the actual number of relationships that exist in a network to the total number of potential relationships in the network (Thaden and Rotolo, 2009). The density of a network gives meaning to trends such as the rate at which information diffuses among the nodes. According to Wasserman and Faust (1994), if a network of size x contains y relationships, the density of the network is defined as: $\Delta = \frac{y}{x\,(x-1)}$

iv. Network Centrality Measures: These refer to the overall centrality present in a network and calculate the extent to which ties in a network are situated in the region of one or a few middle network members. High network centrality values are an indication of information flow in the network being reliant on few individual actors (Izquierdo and Hanneman, 2006). For the purpose of this study the networks were evaluated on the basis of degree centrality and betweenness centrality measures.

- Degree Centrality: The underlying principle for this centrality measure is that actors with more ties are the most important (Izquierdo and Hanneman, 2006). Actors who possess extraordinarily high out-degree ties are deemed capable of transmitting information to many others in the network. Actors who display high out-degree centrality are often said to be *influential* actors (Hanneman and Riddle, 2005). Freeman's *graph centralization measures* as found in UCINet 6 (Borgatti et al., 2002), also determine the total centralization measures for the entire network. According to Hanneman and Riddle (2005), these network measures reveal the degree of disparity or variance in the network as compared to an equivalent perfect network where all possible ties are present. On the basis of those network measures conclusions can be drawn regarding the level of centralization in the entire network.
- Betweenness Centrality**:** This centrality measure identifies information sources and gatekeepers that exist in a network. According to Müller-Prothmann (2007), it determines whether an actor plays a comparatively central role as a mediator or gatekeeper of information flows with a high potential of indirectly controlling the relations of other actors in the network. The study adopts the Flow approach to betweenness centrality as found in UCINet 6 (Borgatti et al., 2002). The flow approach to centrality assumes that actors will use all pathways that connect them, proportionally to the length of the connecting paths. Accordingly, the flow approach calculates the contribution of an actor to all possible maximum flows. (Hanneman and Riddle, 2005). Additionally, it calculates a network flow centralization measure for the entire network, indicating the degree of

inequality, or concentration in the distribution of flow betweenness centralities among the actors relative to that of a perfect network of same size.

v. Homophily scores: This determines measures of homophily in the entire network on the basis of a specific partition. The homophily measures are expressed in terms of three values: the **E-I** (external – internal) **Index,** the **PBSC** (point biserial coefficient), and the **Yule's Q**.

- The E-I index is the number of ties outside the groups minus the number of ties that are within the group divided by the total number of ties. The possible values range from 1 to -1 with -1 being the highest degree of homophily and +1 the highest heterophily possible.
- PBSC is used to determine correlation based homophily measures by correlating the dichotomous variable "is in the same group as" with the corresponding entry in the attribute matrix (UCINet 6, Borgatti et al., 2002). It ranges from 0 to 1 indicating a positive relationship (i.e, in the same direction), and 0 to -1 indicating a negative relationship (i.e, opposite directions). The higher the value, the stronger the relationship.
- Yule's Q is a nominal level measure that determines the strength and direction of association between two possibly related dichotomous variables (Baddie and Fred, 1995). The values range from -1 to 1. When Q = -1, it indicates a perfect negative correlation, meaning that when one variable occurs it invariably leads to the non-occurrence of the other and vice-versa. There is no relationship between the two variables when Q = 0. However values that are close to zero are indications of weak associations.

Table 3.1 summarizes the relevant information required for achieving each objective as well as the sources of information, how data was collected, and the type of analysis undertaken.

Table 3.1 Summary of data required and method of data collection

OBJECTIVE OF RESEARCH	INFORMATION REQUIRED	SOURCE OF INFORMATION	METHOD OF DATA COLLECTION	METHOD OF ANALYSIS
To find out the existing local information networks for the transmission of agricultural information, their characteristics, and the major providers of information in the various networks.	Sources of agricultural information in the communities, mode of transmission of agricultural information, mode of contacting sources of information and mode of seeking further clarification or sending feedback	Farmers in the study area	Researcher-administered questionnaires	Descriptive Statistics, Sociograms (identification of local information networks), degree of nodes, determination of network size and network density of core/periphery class members
To determine how the structural properties of the existing networks affect the flow of agricultural information.	The primary sources of information contacted by the respondents, the type of information received, and the level of clarity and trustworthiness of the information received from their sources	Farmers in the study area	Researcher-administered questionnaires	Network density, Centralization measures (Degree Centralization and Betweenness Centralization)

To determine how differences between actors in the various information networks influence the provision of agricultural information	Personal characteristics of primary sources, types of agricultural information transmitted, types of training programs received, interactions with AEAs, types of crops grown, output per season	Farmers in the study area	Researcher-administered questionnaires	Homophily scores: E-I Index (External ties – Internal ties index), PBSC (Point Biserial Coefficient), and Yule's Q

CHAPTER FOUR

RESULTS

4.0 Introduction

In this chapter, the results are presented according to the communities and the types of agricultural information networks that exist in them.First, a brief description of the structural properties of the various information networks is given. References are made to the sociograms in order to help explain these structural properties. The network characteristics that are discussed are the network size, the core-periphery structure, network density, network degree centralization, network betweenness and homophily. Personal characteristics of members who belong to the core (key communicators) are summarized to highlight possible similarities.

4.1 Characteristics of Agricultural Information Networks and Primary Sources of Information

In this section, the results are presented across the various communities. The mode of information seeking and sending feedback was by oral communication that took place during home visits, farm visits, informal conversations, group meetings, etc.The sociograms portray the social relations existing in each community, revealing the unofficial communication patterns that exist in the community. In addition, results from analysis of other network properties such as core-periphery structures, network size, and network density are shown. Key communicator characteristics as well as results of t-tests conducted on these characteristicsare also presented..

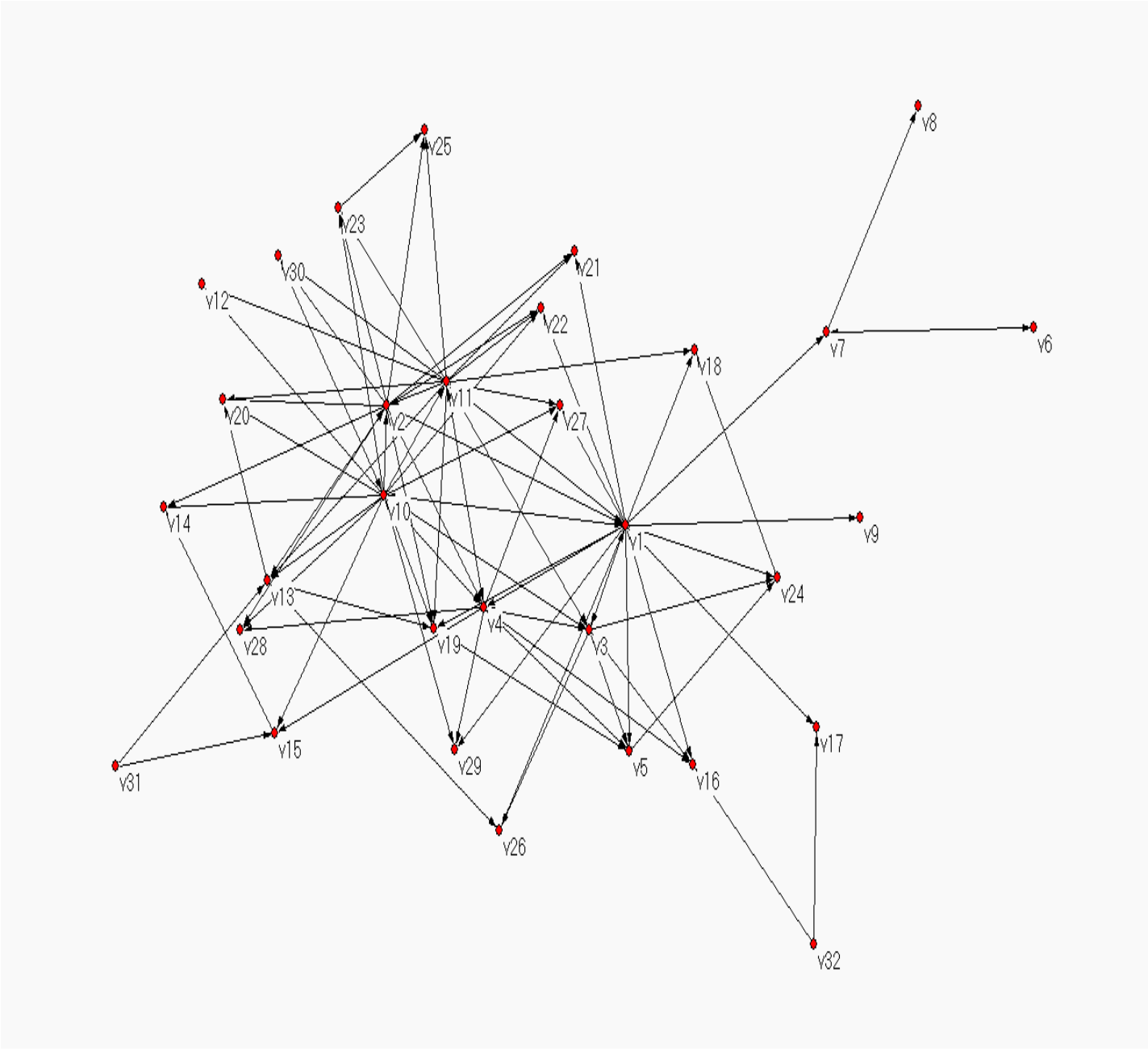
4.1.1 Agricultural Information Network in Kunsu Camp

The agricultural information network found in Kunsu Camp is presented in the form of a sociogram (Figure 2). The information network in Kunsu has a network size of thirty-two. The network transmits information regarding fertilizer application, weed, pest, and disease control, harvesting, and marketing. Six key communicators were identified in the network.

Core/Periphery Class Memberships

The core-periphery model identifies actors who have high number of ties within the network by sharing information with most members of the network (the core), and another set of actors who have very low number of ties with members of the networks (the periphery). Consequently, actors in the core are at a structural advantage in terms of exchanging relations with actors in the periphery. The core-periphery structure of the network indicates that respondents 1, 2, 3, 4, 10, and 11 form the core and are the key communicators in Kunsu camp community. Table 4.1 indicates the role each node plays as a source of information. The sum is the total number of ties that consult an actor for information. Taking into account the statistics, the core members are influential (key communicators), considering the number of ties (information transmitted to other actors) they have with other farmers. From the table, actor 1 is most influential (18 out-ties) with actors 10 (17 out-ties), 11 (15 out-ties), 2 (12 out-ties), 4 (9 out-ties) and 3 (7 out-ties) following respectively.

Figure 4.1 Agricultural Information Network in Kunsu Camp, Ahafo Ano South, Ghana



NB: Direction of arrows denotes direction of information flow. Double-ended arrows symbolize reciprocal ties.

Table 4. 1: Out-degree statistics for Core and Periphery members (Kunsu)

Connections from Core to others			Connections from Periphery to Others		
Actor	**Mean**	**Sum**	**Actor**	**Mean**	**Sum**
V1	0.581	18	V 8, 9, 12, 14, 16	0.00	0
V2	0.387	12	V 17, 18, 20, 21, 22	0.00	0
V3	0.226	7	V 25, 26, 27, 28, 29	0.00	0
V4	0.290	9	V 5, 6, 15, 19, 23, 24, 30	0.032	1
V10	0.548	17	V7, V31, V32	0.065	2
V11	0.484	15	V13	0.129	4

Network Density: The density values indicate the quantity of potential ties in the network that are really existent. The values range from 0 to 1, where the lower limit corresponds to networks with few relationships carried out and the upper limit stands for dense portions of the network with interconnected nodes.

Table 4.2 shows that farmers in the core group sought advice from other core acquaintances more often than from farmers in the periphery, resulting in a high level of communication within the smaller core group (0.733). Generally, the comparatively small, dense cluster of farmers (core) was consulted by the larger population for agricultural information. Farmers in the core group sought advice from other core acquaintances more often than from farmers in the periphery, resulting in a high level of communication within the smaller core group (0.733). Generally, the comparatively small, dense cluster of farmers (core) was consulted by the larger population for agricultural information.

Table 4. 2: Density of farmer ties between the Core and Periphery groups in the Kunsu Agricultural Information Network

	CORE	PERIPHERY
CORE	0.733	0.359
PERIPHERY	0.013	0.023

Kunsu Camp – Key Communicators

The network in Kunsu Camp had 6 key communicators (Table 4.3). They are all married, with children. All six key communicators are members of local farmer groups and occupy various leadership positions in the community. Ibrahim Zakaria is the Unit Committee Chairman of Kunsu Camp and the Chairman of the "Koroye Nkabom" farmers group. Adam Mohammed Zakaria, Abukari Yakubu, and Stephen Boadi are prominent members of the "Koroye Nkabom" farmers group. Yaw Manu and Kojo Manu are also members of a local farmers group sponsored by Armajaro Ghana. Yaw Manu is the head of farmers, while Kojo Manu is the Financial Secretary. All six key communicators have been previously sponsored by Armajaro Ghana to receive training geared towards use of good planting materials, improved planting methods, good cultural practices related to cocoa production and disease control. Ibrahim Zakaria is also a beneficiary of a JICA training program aimed at improving proper weeds, pests, and disease control in rice and proper fertilizer application. These key communicators have been farming for at least twenty years. The key communicators in Kunsu cited older family members (father and grandfather), interactions with other skilled farmers, interactions with the Agricultural Extension Officer (AEA), and training from other organizations. The key communicators stand out with regards to the acreage per crop grown and their output per acre each season (Table 4.3).

Table 4. 3: Selected Background Characteristics of Key Communicators (Kunsu Camp)

Name	Age (Years)	Years Of Farming(Years)	Acreage For Cocoa (Acres)	Output Per Season (Bags Per Acre)
Ibrahim Zakaria	37	20	6	7
Stephen Boadi	50	25	7	7
Adam Mohammed Zakaria	39	20	6	6.5
Kojo Manu	52	31	5	6.5
Yaw Manu	50	30	6	8
Abubakari Yakubu	58	30	5	8

A one-sample *t*-test was run to test the mean value of the average age of the key communicators against the community.From the one-sample *t*-test in Table 4.4, the key communicators were significantly older (47.67) than the population norm of 38.8 years. Also, the difference in mean output between the key communicators and the population norm was statistically significant (Table 4.5).

Table 4. 4: One-sample statistics of age and output of key communicators in Kunsu

	N	Mean	Std. Deviation	Std. Error Mean
Average Age	6	47.67	8.066	3.293
Average Output	6	7.1667	.68313	.27889

Table 4. 5: One-sample t-test of average age and output of key communicators in Kunsu

	Test Value = 38.8					
	T	Df	Sig. (2-Tailed)	Mean Difference	95% Confidence Interval Of The Difference	
					Lower	Upper
Average Age	2.693*	5	.043	8.867	.40	17.33
Average Output	Test Value = 4.52					
	9.490*	5	.000	2.647	1.9298	3.3636

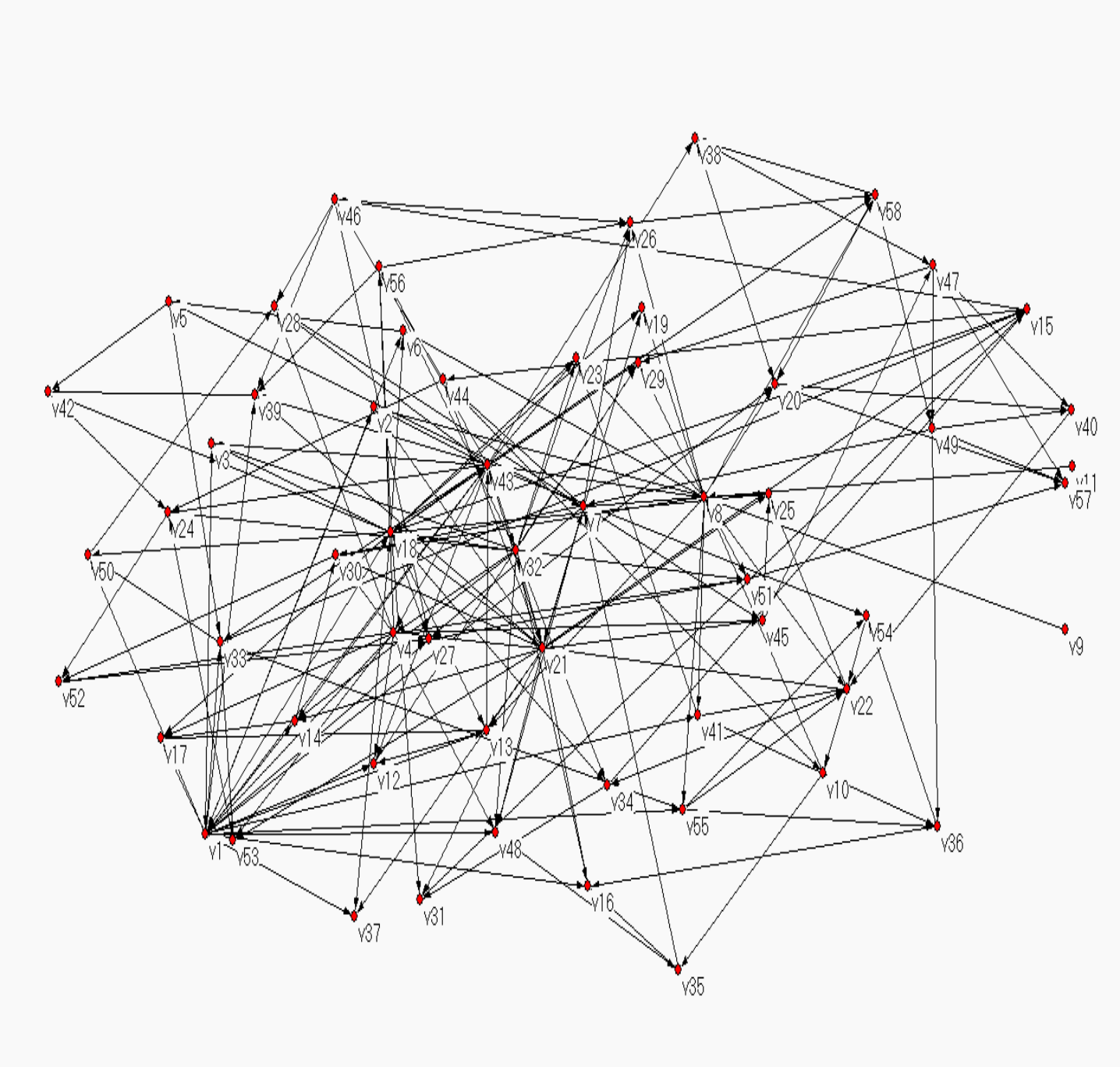
* p < .05

4.1.2 Agricultural Network in Afreseni

The Afreseni information network presented in Figure 3 indicates that there are fifty-eight members in the network. The information network in Afreseni transmits information concerning fertilizer application, weed, pest, and disease control, harvesting, and marketing. From the network eight key communicators were identified.

Core/Periphery Class Memberships: By means of the core/periphery structure, influential actors in terms of agricultural information ties sent out are identified. From the core/periphery structure in the Afreseni network, eight key communicators stand out. The key communicators identified are: 1, 4, 8, 13, 18, 21, 32, and 43. Table 4.6 indicates how influential each node is as a source of information. The sum is the total number of ties that consult an actor for information. Considering the statistics, the core members are influential on the basis of the number of ties (information transmitted to other actors) they have with other farmers. From Table 4.6, actors 1 and 43 are the most influential (19 out-ties each) with actors 18 and 21 (18 out-ties each), 8 (15 out-ties), 32 (14 out-ties), 4 (11 out-ties) and 13 (8 out-ties) following in that order respectively.

Figure 4.2 Agricultural Information Network in Afreseni, Ahafo Ano South, Ghana



NB: Direction of arrows denotes direction of information flow. Double-ended arrows symbolize reciprocal ties.

Table 4.6: Out-degree statistics for Core and Periphery members (Afreseni)

Connections from Core to others			Connections from Periphery to Others		
Actor	**Mean**	**Sum**	**Actor**	**Mean**	**Sum**
V1	0.333	19	V16, 17, 19, 23, 25, 27 - 29	0.00	0
V4	0.193	11	V3, 6, 9, 11, 12, 24, 26, 30, 31	0.018	1
V8	0.263	15	V37, 39, 40, 42, 50, 52, 53, 54, 57	0.018	1
V13	0.140	8	V2, 14, 15, 20, 34, 35	0.035	2
V18	0.316	18	V36, 38, 45, 48, 51, 56	0.035	2
V21	0.316	18	V5,10, 41, 44, 55, 58	0.053	3
V32	0.246	14	V7, 22, 33, 46, 47, 49	0.070	4
V43	0.333	19			

The density of ties between the groups in a network is an indication of the rate at which information spreads among members of the groups. Thus, denser portions of a network ensure that information flows readily among the nodes in that part of the network. From Table 4.6, farmers in the core group sought advice from other core acquaintances more often than from farmers in the periphery, resulting in a high level of communication within the smaller core group (0.411). Generally, the core transmitted agricultural information to the larger population.

Table 4. 7: Density of Farmer Ties between the Core and Periphery groups in the Afreseni Agricultural Information Network

	CORE	**PERIPHERY**
CORE	0.411	0.237
PERIPHERY	0.023	0.032

Afreseni – Key Communicators

Analysis of the Afreseni information network indicated that there were 8 key communicators. They are all married, with children. Only four key communicators are members of local farmer groups while all of them occupy various leadership positions in the community. Paul Opoku Anane is the Unit Committee Chairman of Afreseni. Paul Wisdom Femeyibor is the Assemblyman in the area and a prominent member of "Odo Kuo", the local farmers group. Joseph Kusi is the treasurer of the local farmers group, "Odo Kuo". Samuel Obiri Addo and Osei Yaw are also members of the local farmers group, "Odo Kuo". Samuel Obiri Addo is a "gang supervisor" (cocoa spraying exercise), while Osei Yaw is the Chief's linguist. Kojo Nsiah is the chief cocoa farmer, Elizabeth Aniko is the queen mother of Afreseni and Nana Akwasi Owusu is the chief of Afreseni. Some of the key communicators have received agricultural related training from various organizations. Osei Yaw, Kojo Nsiah, and Joseph Kusi are beneficiaries of a training program sponsored by the Ministry of Food and Agriculture to help improve cocoa spraying practices. Paul Femeyibor and Nana Akwasi Owusu are beneficiaries of training programs by Care International – Ghana, which sought to improve cocoa production through use of healthy planting material, fertilizer application, and weed control. They were also sponsored by Armajaro Ghana for similar training programs.

All the key communicators in Afreseni cited older family members (father, uncle and grandfather), interactions with other skilled farmers, contact with the Agricultural Extension Officer (AEA), and training from other organizations. The key communicators stand out with regards to the acreage per crop grown and their output per acre each season. Their figures are shown in Table 4.8.

Table 4. 8: Selected Background Characteristics of Key Communicators (Afreseni)

Name	Age	Years Of Farming (Years)	Acreage For Cocoa (Acres)	Output Per Season (Bags Per Acre)
Osei Yaw	52	10	10	7.5
Joseph Kusi	39	15	15	7
Paul Wisdom Femeyibor	49	7	6	7
Nana Akwasi Owusu	62	30	16	7.5
Elizabeth Aniko	52	30	10	6.5
Kojo Nsiah	36	16	12	8
Paul Opoku Anane	48	12	8	7
Samuel Obiri Addo	61	12	7.5	7

A one-sample *t*-test was run to test the mean value of the average age and the average output of the key communicators against the community.The t test showed that the difference in ages between the key communicators and the population (36.6) was statistically significant (Table 4.10). Similarly, the difference in mean output between the key communicators and the population norm was statistically significant.

Table 4. 9: One-sample statistics of average age and output of key communicators in Afreseni

	N	Mean	Std. Deviation	Std. Error Mean
Average Age	8	49.88	9.219	3.259
Average Output	8	7.1875	.45806	.16195

Table 4. 10: One-sample t-test of average age and output of key communicators in Afreseni

	Test Value = 36.6					
	T	Df	Sig. (2-Tailed)	Mean Difference	95% Confidence Interval Of The Difference	
					Lower	Upper
Average Age	4.073*	7	.005	13.275	5.57	20.98
	Test Value = 4.71					
Average Output	15.298*	7	.000	2.47750	2.0946	2.8604

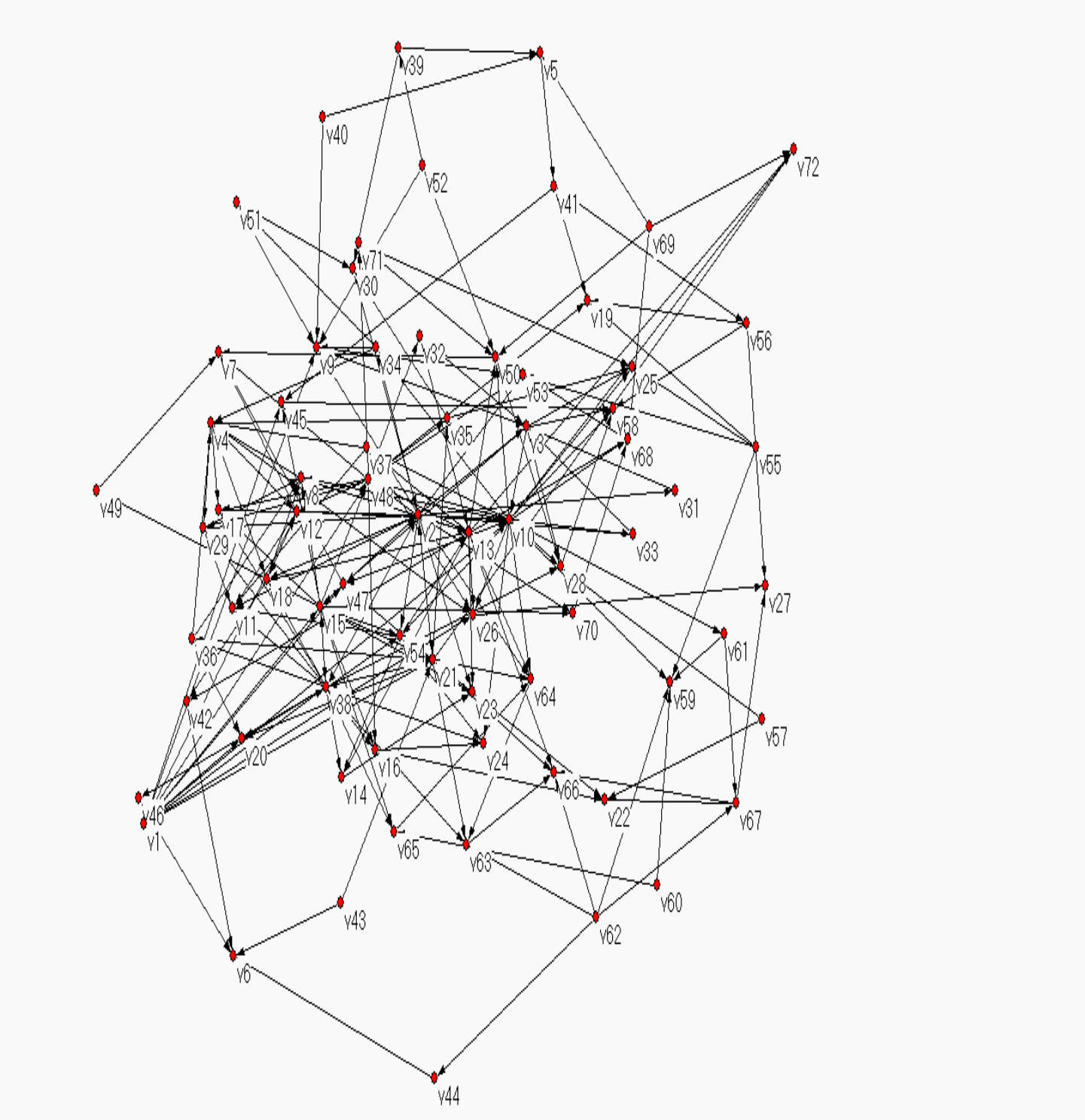
* p < .05.

4.1.3 Agricultural Network in Dunyankwanta

The information network as presented in the sociogram(Figure 4) indicates that there are seventy-two members in the network. The information network in Dunyankwanta transmits information concerning fertilizer application, weed, pest, and disease control, harvesting, and marketing.From the network nine key communicators were identified.

Core/Periphery Class Memberships: The core/periphery structure of the network identified influential actors in terms of those consulted for agricultural information. From the core/periphery structure, nine key communicators stand out. The key communicators identified as core farmers and key communicators are: 1, 2, 10, 13, 15, 21, 38, 48 and 54.

Figure 2.3 Agricultural Information Network in Dunyankwanta, Ahafo Ano South, Ghana



NB: Direction of arrows denotes direction of information flow. Double-ended arrows symbolize reciprocal ties.

Table 4.11 indicates the prominence of each node as a source of information. The sum displays the total number of actors that consult an actor for information. The statistics show how influential core members are on the basis of the number of out-degree ties (information transmitted to other actors) they have with other farmers. From the table, actor 2 is the most influential (21 out-ties) with actors 10 (19 out-ties), 38 (17 out-ties), 15 and 21 (13 out-ties each), 13 and 48 (12 out-ties each), 1 (11 out-ties) and 13 (6 out-ties) following in that order respectively.

Table 4.11: Out-degree statistics for Core and Periphery members in Dunyankwanta

Connections from Core to others			**Connections from Periphery to Others**		
Actor	**Mean**	**Sum**	**Actor**	**Mean**	**Sum**
V2	0.296	21	V3, 4, 62	0.070	5
V10	0.268	19	V55, 69	0.056	4
V38	0.239	17	V12, 34, 35, 36, 37, 41, 50, 52, 56, 67	0.042	3
V15	0.183	13	V8, 16, 18, 29, 32, 39, 40	0.028	2
V21	0.183	13	V43, 51, 57, 60, 61, 71	0.028	2
V13	0.169	12	V5, 9, 14, 26, 28, 30, 31, 33, 42, 44	0.014	1
V48	0.169	12	V45, 46, 47, 49, 53, 63, 64, 65, 70	0.014	1
V1	0.155	11	V6, 7, 11, 15, 17, 19, 20, 22	0.000	0
V54	0.085	6	V23, 24, 27, 58, 59, 66, 68, 72	0.000	0

Network Density: The density of a section of a network is an indication of the speed at which information is disseminated among the nodes that exist in that segment of the network. Consequently, denser portions of a network would ensure that information

flows readily among the nodes in that network. Table 4.12 presents the network density values for the Dunyankwanta network. Actors who form the core group sought advice from fellow core actors regularly than from farmers in the periphery, resulting in a high level of communication within the smaller core group (0.444). On the whole, the core group was prominent in the transmission of agricultural information to the larger population.

Table 4.12: Density of ties between core and periphery groups in the Dunyankwanta Agricultural Information Network

	CORE	PERIPHERY
CORE	0.444	0.162
PERIPHERY	0.009	0.024

Dunyankwanta – Key Communicators

The information network in Dunyankwanta has 9 key communicators. They are all married, except one, who is a widower. Seven out of the nine key communicators are members of local farmer groups while several of them occupy various leadership positions in the community. Opanin Kwaku Duruyeh is the Chief Cocoa Farmer in Dunyankwanta and a member of the local farmer group sponsored by Care International - Ghana. Eric Kofi Asenso is the Chief Rice farmer in Dunyankwanta and the current winner of the Best Rice Farmer award in the district. He is also the secretary of the Abrabopa Rice Growers Association, a local rice farmer group in Dunyankwanta. Agnes Achiaa and Francis Brenyah are members of the local farmer group sponsored by Care International – Ghana. J.K. Sarfo is a member of the Care International – Ghana sponsored group and a treasurer of the Abrabopa group, Andrews Donkor is a Community Emulator in the Care – International group and the Chairman of the Cocoa Abrabopa group while Kwame Sekyereh is the chairman of

the Abrabopa Rice Growers group. Some of the key communicators have received agricultural related training from various organizations. Eric Kofi Asenso, Kwame Sekyereh, and Andrews Donkor are beneficiaries of training programs sponsored by the Ministry of Food and Agriculture to help improve cocoa production. Agnes Achiaa and Andrews Donkor are also beneficiaries of training programs by Kuapa Cocoa, which sought to improve cocoa production through use of healthy planting material, proper spacing of crops, timing of fertilizer application, and effective weed control. In addition, the key communicators in Dunyankwanta cited older family members (parents and guardians), interactions with other skilled farmers, contact with the Agricultural Extension Officer (AEA), and training from other organizations. . The key communicators are prominent with regards to the acreage per crop grown and their output per acre each season (Table 4.13).

Table 4.13: Selected Background Characteristics of Key Communicators (Dunyankwanta)

Name	Age	Years Of Farming (Years)	Acreage For Cocoa (Acres)	Output Per Season (Bags Per Acre)
Opanin Kwaku Duruyeh	78	40	8	7
Agnes Achiaa	47	7	5	6
Eric Kofi Asenso	59	6	5	8
Andrews Donkor	34	15	6	7
Francis Brenyah	53	11	4	6.5
J. K. Sarfo	55	30	6	6
Yaw Attah	48	15	8	6.5
Mallam Adamu	53	14	5	6
Kwame Sekyere	49	10	4	6

A one-sample t-test was run to compare the means of the ages and output of the key communicators against the population. The results are presented in Tables 4.14 and 4.15. From the t-test, the difference in ages between the key communicators and the population was statistically significant (Table 4.15). Correspondingly, the difference in mean output between the key communicators and the population norm was statistically significant.

Table 4.14: One-sample statistics for Average Age and Output of Key Communicators in Dunyankwanta

	N	Mean	Std. Deviation	Std. Error Mean
Average Age	9	52.89	11.741	3.914
Average Output	9	6.5556	.68211	.22737

Table 4.15 One-sample t-test for Average Age and Output of Key Communicators in Dunyankwanta

	Test Value = 40.2					
	T	Df	Sig. (2-Tailed)	Mean Difference	95% Confidence Interval Of The Difference	
					Lower	Upper
Average Age	3.242*	8	.012	12.689	3.66	21.71
	Test Value = 5.10					
Average Output	6.402*	8	.000	1.45556	.9312	1.9799

* p < .05.

4.2 Structural Properties of Networks and their Role in the flow of Agricultural Information

This section presents results about the structural properties of the networks in the various communities. These properties are, network density, degree centralization, and betweenness centralization. The means of these network values are compared across communities for similarities. A network centralization measure is an indication

of how compactly the network is structured around its most central point. The centrality measures are Degree Centralization and Betweenness Centralization.

Degree Centralization measures express the level of variability in the degrees of actors in a network. This is done by expressing the extent of inequality or variance in the network as a percentage of thatof a perfect network of the same size. The whole network values of degree centralization in terms of outdegree (number of ties sent out) and indegree (number of ties received) are presented.

Betweeeness Centralization measures determine influential actors in terms of their control over the flow of information by virtue of their position as intermediaries connecting many pairs of other actors in the network. The betweenness centrality of the individual actors are presented alongside the network centralization measure.

4.2.1 Structural Properties of the Agricultural Information Network in Kunsu Camp

Table 4.16 indicates that the out-degree network centralization is 50.05% and the in-degree network centralization is 6.764%, indicating that a significant quantity of centralization exists in the entire network. However, it also confirms that the influence of individual actors differs considerably, and influential actors are quite randomly dispersed in the network.

Table 4.16: Degree Centralization Measures of Kunsu Camp Network

Out-Degree (%)	In-Degree (%)
50.052	6.764

Results in table 4.17 show that the actors 10, 1, 2, 11, 4, 13, 3, 7, 5 respectively are obviously the most significant mediators in the Kunsu network. These actors are most involved in the flow of information between the other pairs of actors. On the other

hand, the concentration in the placement of betweenness centralities among the actors is low as indicated by the Network Centralization Index (5.866%). The descriptive statistics in table 4.17 also indicate that there is a high disparity in individual actor betweenness (from zero to 113.00).

Table 4.17 Betweenness Centralization for Kunsu Camp Agricultural Information network

Vertex Number	Flow Betweenness
v1	113.000
v2	99.000
v3	40.000
v4	57.000
v5	10.000
v7 .	19.000
v10	117.000
v11	63.000
v13	46.000
v15	7.000
v19	9.000
v23	6.000
v24	9.000
v30	13.000
v6, 8, 9, 12, 14, 16, 17, 18, 20	0.00
v21, 22, 25, 26, 27, 28, 29, 31, 32	0.00

Network Centralization Index = 5.866%

4.2.2 Structural Properties of the Agricultural Information Network in Afreseni

From Table 4.18, the out-degree graph centralization is 27.578% and the in-degree graph centralization is 4.371%. This demonstrates a significant disparity in the level of power wielded by actors in the network on the basis of direct ties with other actors.

Table 4.18 Degree Centralization Measures of Afreseni Network

Out-Degree (%)	In-Degree (%)
27.578	4.371

Table 4.19 shows actors 22, 58, 21, 7, 8, 26, 15, 20, 47, 54, 10, 49, 1, 18, and 40 respectively as the most significant mediators in the Afreseni network. These actors

are most involved in the flow of information between the other pairs of actors. However on a whole, the concentration in the placement of betweenness centralities among actors in the network is low (13.237%), suggesting that some actors in the network are more central than others. A very high disparity in individual actor betweenness (from zero to 478.267) is observed, indicating the presence of actors who are influential as intermediaries in the dissemination of information in the network.

Table 4.19 Betweenness Centralization measures for actors in the Afreseni network

Vertex No	Flow Betweenness	Vertex No	Flow Betweenness
V22	478.267	V46	85.733
V58	240.633	V44	77.750
V21	238.300	V43	75.683
V7	218.017	V5	65.000
V8	206.750	V36	62.667
V26	178.600	V57	58.000
V15	163.083	V38	55.517
V20	159.017	V55, v35, v33, v13	30.000 – 49.999
V47	145.033	V34, v32, v4, v41, v6	10.000 – 29.999
V54	136.100	V 56, v53, v52, v51,v50, v48	0.900 – 9.999
V10	132.400	V45, v42, v39, v30, v14, v12	0.900 – 9.999
V49	125.700	V3, v2	0.900 – 9.999
V1	122.517	V37	0.800
V18	119.550	V9, v11, v16, v17, v19, v25	0.000
V40	113.400	V27, v28, v29	0.000

Network Centralization Index = 13.237%

4.2.3 Structural Properties of the Agricultural Information Network in Dunyankwanta

From Table 4.20 the network centralization measures of 25.956% (out-degree) and 5.674% (in-degree) observed are an indication of a substantial variance across actors

in the network in terms of out-degree and in-degree ties. The low percentages indicate that there is an unequal distribution of power among actors in the network.

Table 4.20 Degree Centralization Measures of Dunyankwanta Network

Out-Degree (%)	In-Degree (%)
25.956	5.674

From Table 4.21 actors 10, 3, 2, 9, 30, 13, 8, 15, 48, 21 and 4 respectively are thekey intermediaries in the Dunyankwanta network. These actors are most involved in the flow of information between the other pairs of actors thus, indicating their status as central figures in the information network. On a whole, the low concentration in the placement of betweenness centralities among actors in the network (10.451%) is indicative of an unequal distribution of central positions in the network. This is reinforced by the high disparity in individual actor betweenness (from zero to 551.550) observed, indicating that some actors are more prominent in the dissemination of information in the network.

Table 4. 21 Betweenness Centralization measures for Dunyankwanta network

Actor	**Flow Betweenness**	**Actor**	**Flow Betweenness**
V10	551.550	V4	72.383
V3	447.983	V38	57.650
V2	283.683	V53	57.200
V9	231.383	V18, 34, 50, 54, 61	30.000 – 49.000
V30	183.633	V5, 26, 28, 35, 39, 41, 42, 51, 64, 67	10.000 – 29.000
V13	140.383	V12, 14, 16, 29, 31, 32, 33, 36, 37, 44	1.000 – 9.000
V8	114.767	V45, 46, 47, 49, 56, 63, 65, 70, 71	1.000 – 9.000
V15	99.300	V1, 6, 7, 11, 17, 18, 20, 22, 23, 24, 25	0.000
V48	90.800	V27, 40, 43, 52, 55, 57, 58, 59, 60, 62	0.000

V21	84.250	V66, 68, 69, 72	0.000

Network Centralization Index = 10.451%

4.2.4 Comparison of Structures in the Three Agricultural Information Networks

Table 4.22 shows considerable variability among the networks in terms of density, degree centralization, and betweenness centralization. The density across the networks decreases as the size of the network increases. This can be seen in the differences in density between Kunsu which is the smallest network and Dunyankwanta which is the largest. The degree centrality means explain the distribution of the degree centrality scores of the network actors. It is observed that there is more variability across the actors in terms of outdegree than indegree (standard deviations). The variability of actor degree aids in describing the heterogenous features of a network in terms of structural positions occupied by individual actors. The central tendency values (mean and standard deviation) for betweenness centrality also display a relatively high variation in actor betweenness (comparing the standard deviations to the means). This is logical, since not all actors are influential in the provision of information. Consequently, the level of influence of actors with respect to positions in the network vary greatly.

Table 4.22 Mean and (SD) of density, degree, and betweenness parameters averaged over the networks

Community	**Density**	**Degree**		**Betweenness**
		InDegree	**OutDegree**	
Kunsu	0.096	2.969 (5.199)	2.969 (1.262)	9.482 (18.008)
Afreseni	0.062	3.552 (5.018)	3.552 (1.262)	63.021 (87.732)
Dunyankwanta	0.043	3.083 (4.499)	3.083 (1.898)	39.325 (94.349)

4.3 Similarities and Differences between Actors and the Provision of Agricultural Information

Similarities and differences between actors in information networks are determined using homophily scores and the level of ties formed between and within various categorizations of farmers in the networks. For each community, the distribution of ties across the various groupings on the basis of attributes such as age, gender, level of education, and membership of local group.are presented along with the homophily scores.

4.3.1 Distribution of Ties on the basis of Age

The results presented in this section show the distribution of information ties between actors in the various agricultural information network across age categories. In addition, the homophily scores (E-I Index, PBSC, and Yule's Q values) are also indicated.

Actors in the various networks were grouped on the basis of age into three categories; 30 – 40 years, 41 – 50 years, and 51 years and above (Table 4.23). In the Kunsu network, a total of 95 ties are distributed within and between the three different age groups. Actors who fall in the age range of 41 – 50 years are prominent in terms of sending out information within and between the groups. The Afreseni network has 206 ties distributed within and between the three different age groups. Actors in the 30 – 40 year group and those 51 years and older are major sources of information. The Dunyankwanta network has 222 ties dispersed within and between the three age groups. Actors aged 51 and above are prominent sources of information in the network.

Table 4.23 Distribution of ties within and between groups (age attributes) of Agricultural Information Networks

NETWORK		30 – 40 yrs	41 – 50 yrs	51 yrs and above
Kunsu	**30 – 40 yrs**	7	15	13
	41 – 50 yrs	12	14	11
	51 yrs and above	8	8	7
Afreseni	**30 – 40 yrs**	25	30	17
	41 – 50 yrs	22	30	10
	51 yrs and above	25	33	14
Dunyankwanta	**30 – 40 yrs**	5	19	12
	41 – 50 yrs	14	28	24
	51 yrs and above	21	63	30

The E-I index values in table 4.24 show that on the basis of the proportion of ties within and between the groups, there is a prevalence of external than internal ties for the three networks. This suggests that actors in the various age groups are more likely to have out-group ties instead of ties within their age groups. The point biserial coefficient values also indicate a negative relationship between age and homophily in the networks. The Yule's Q values presented exhibit a negative association between age and homophily in all three networks.

Table 4.24 Network Homophily Measures (Age)

NETWORK	E-I INDEX	PBSC	YULE'S Q
Kunsu	0.42	-0.02	-0.06
Afreseni	0.33	-0.01	-0.05
Dunyankwanta	0.38	-0.03	-0.15

4.3.2 Distribution of ties on the basis of Gender

Actors in the three networks were grouped on the basis of gender into two categories; male or female. The results show the distribution of ties across the gender groupings and the homophily scores for the distribution observed in the various networks. In all

three networks, males were dominant over females in terms of ties sent out (Table 4.25).

Table 4.25 Distribution of ties within and between groups (Gender attribute) of Agricultural Information Networks

Network		**Male**	**Female**
Kunsu	**Male**	67	23
	Female	1	4
Afreseni	**Male**	145	46
	Female	7	8
Dunyankwanta	**Male**	127	49
	Female	20	26

The E-I index values in table 4.26 suggest a high occurrence of internal than external ties for the networks. This implies that actors of both sexes are more likely to have ties among themselves instead of with the opposite sex. However, the point biserial coefficients demonstrate a positive relationship between gender and homophily in the networks. There is a weak positive association between gender and network homophily as indicated by the Yule's Q values.

Table 4.26 Network Homophily Measures (Gender)

NETWORK	E-I INDEX	PBSC	YULE'S Q
Kunsu	-0.50	0.11	0.39
Afreseni	-0.49	0.04	0.19
Dunyankwanta	-0.38	0.04	0.21

4.3.3 Distribution of ties on the basis of Level of Education Attained

Network actors were grouped on the basis of level of educationattained into three categories; no formal education, basic education, and secondary education. The results in Table 4.27 show the distribution of ties across the different levels of education attained and the homophily scores for the distribution of ties observed.

Farmers educated to the secondary level are dominant over the other categories in terms of sending out information in the network

Table 4.27 Distribution of ties within and between groups (Educational level) of Agricultural Information Networks

NETWORK		No Formal Education	Basic Education	Secondary Education
Kunsu	**No Formal Education**	6	4	7
	Basic Education	5	8	9
	Secondary Education	12	24	20
Afreseni	**No Formal Education**	10	10	3
	Basic Education	13	26	41
	Secondary Education	17	43	43
Dunyankwanta	**No Formal Education**	23	22	20
	Basic Education	15	19	17
	Secondary Education	22	37	47

The E-I index results in table 4.28 show that considering the number of ties within and between the three groups of different educational levels across the three networks, there is a high incidence of internal than external ties for the entire network. This signifies that actors were more likely to have ties within their group instead of outside their respective groups. However, the point biserial coefficient valuesshow a positive relationship between educational level and homophily in the network. This is

supported by the Yule's Q value which also points to a positive association between actors' level of education and homophily, albeit weak.

Table 4.28 Network Homophily Measures (Educational Level)

NETWORK	E-I INDEX	PBSC	YULE'S Q
Kunsu	-0.50	0.11	0.39
Afreseni	-0.49	0.04	0.19
Dunyankwanta	-0.38	0.04	0.21

4.3.4 Distribution of ties on the basis of Membership of local groups

Actors in the network were grouped according to their membership of local groups or otherwise. Farmers belonging to local groups are dominant over non-members of groups in terms of sending out information in the Kunsu and Dunyankwanta networks.The Afreseni network shows an even distribution of ties sent out by both members and non-members of local farmer groups (Table 4.29).

Table 4.29 Distribution of ties within and between groups (Local Group Membership) of Agricultural Information Networks

Network		Local Group Members	Non-Members
Kunsu	**Local Group Members**	41	40
	Non-Members	5	9
Afreseni	**Local Group Members**	41	61
	Non-Members	65	39
Dunyankwanta	**Local Group Members**	96	53
	Non-Members	40	33

The Kunsu and Dunyankwanta networks exhibit a low occurrence of internal ties than external ties as evidenced by the E-I Index results (Table 4.30). The point biserial coefficients for the two networks also demonstrate a positive relationship between local group membership and homophily. In addition, the Yule's Q values suggest a

moderately weak but positive relationship between membership of a local farmer group and homophily. In contrast, the Afreseni network shows a low occurrence of external ties as compared to internal ties. There is a negative relationship between local group membership and homophily in the network as indicated by the point biserial coefficients and the Yule's Q values.

Table 4.30 Homophily Network Measures (Local Group Membership)

NETWORK	E-I INDEX	PBSC	YULE'S Q
Kunsu	-0.05	0.01	0.02
Afreseni	0.22	-0.06	-0.25
Dunyankwanta	-0.16	0.04	0.18

CHAPTER FIVE

DISCUSSION OF RESULTS

5.0 Introduction

In this chapter the findings presented in the previous chapter are discussed. The discussions are guided by the research objectives set out in this study and are presented as folllows: First, the existing agricultural information networks and their characteristics are discussed. Then the structural properties of the networks as well as the network descriptors (network density, network centralization, etc.) are also considered. The factors that influence homophily are then discussed together with the implications of the structural properties of the various networks on agricultural information flow.

5.1 Existing Local Agricultural Information Networks and Key Communicators

Three agricultural information networks were observed as playing an important role in the provision of information. These networks are discussed along with their characteristics. The implications of these characteristics for information provision in networks are also considered.

5.1.1 Implications of Network Characteristics for Provision of Agricultural Information

A total of three networks were observed in the three communities studied. These networks had varying sizes yet shared common characteristics. All the three networks displayed a core-periphery structure. Core farmers were consulted by other core and periphery farmers more often than the other farmers, leading to a high number of information ties originating from within the small group (core farmers). Consequently, tie density was found to be very low between the core and periphery

groups. Generally, a comparatively little, dense group of farmers was sought by the larger farming community for information on farming practices. This finding agrees with Borgatti and Everett (1999), who observed that in a core-periphery network there exists a group of agents that is densely connected internally, while all remaining network members are sparingly connected among themselves. Barsky (1999) also proposes that core-periphery models in information networks develop from a persistent choice of exact actors who possess exclusive characteristics that enhance their entry into the core membership group.

The core-periphery concept in networks has implications on the provision of information in a network. As Csermeley, London, Wu, and Uzzi (2013) point out, the forcefulness and solidity of core members in a network is as a result of their affluent link configuration which helps them to almost guarantee support and the ability to provide numerous alternatives of directing information in a network when desired. Importantly, the presence of a core group facilitates a smooth transfer of information within an information network. Consequently, at any rate, whether information originates from external sources or inside the community, informal ties between the core and periphery are used as a vital mode of conveying agricultural information to farmers in the networks. This effectively results in stability in the network, in view of the variety of information sources for farmers, in addition to maintaining a balance between formal and informal sources of information within networks (Isaac, Erickson, Quashie-Sam, and Trimmer, 2007).

5.1.2 The Role of Key Communicators in Agricultural Information Provision

A total of 23 major providers of information were identified in the three networks. These ones, referred to as key communicators in this study were observed to be

invaluable to the provision of information to members of the network. The characteristics of actors identified as key communicators were studied in comparison to the characteristics of the population.

Key communicators in all three networks were found to be significantly older than the rest of the population when the means of both groups were compared by means of a one-sample *t*-test. Thus key communicators who were consulted most turned out to be comparatively older. This observation is consistent with the explanation of Oakley and Garforth, (1997) that even though younger people tend to have different values, attitudes, and aims, elderly people are treated with great respect and their advice is listened to carefully. Mittal and Mehar (2013) also indicate that older farmers are more likely to be consulted by younger farmers for agricultural information.

The key communicators also had significantly higher output per acreage when compared to the population by means of the *t*-test. Thus farmers who were perceived as successful were contacted by other farmers in the various networks. This is consistent with the findings of several authors who posit that farmers who have higher yields and are seen as successful by other farmers tend to provide information to other farmers and are seen as role models (Faust, 1997; Borgatti, 2005; Goswami and Basu, 2010). A possible reason for this could be the training received by the key communicators by various extension service providers. All 23 actors had benefitted from training programs in areas like choice of good planting material (cocoa), weed and disease control, fertilizer application (cocoa), proper record keeping, and proper use of chemicals (fertilizers, pesticides, weedicides, etc.) in rice production. Consequently, they had connections to external sources of information that gave them an advantage over the other actors. This is consistent with Gueye's findings (2009) in

his study of poultry farmers that noteworthy progress in poultry production can be realized by means of properly designed and implemented training programs that equip farmers with essential knowledge and skills. He further explains that training farmers allows them to acquire and spread knowledge, views, experiences as well as research and development results with other farmers so as to bring about required changes to farms.

In addition, the key communicators identified in the various information networks occupied various leadership positions in their communities. It was observed that by virtue of their status in the community they were seen as role models to their colleague farmers. As a result they were regularly consulted for help to problems encountered on the various farms. The provision of information in informal information networks is highly dependent on the presence of leaders who are perceived as role models due to their status in the communities in which they live. These individuals have attained elevated degrees of trust and reliance with others in the community and are usually willing to do more to help others out.

Having used the sociometric method to identify opinion leaders, Flodgren, Parmelli, Doumit, Gattellari, O'Brien, Grimshaw, and Eccles (2011) discovered that dissemination and implementation of new evidence-based activities by local leaders was a promising approach to bridge observed gaps in practice. They explain that the leaders identified are people who are seen as likeable, reliable and prominent. As a result of their influence, it is thought that they are capable of helping and persuading the target audience in the local community. This view is also supported by Rogers (2010), who stated that farmers in leadership positions in their local communities are

indispensable with respect to providing agricultural information to farmers and influencing adoption of new agricultural technologies.

5.2 Structural Properties of Networks and the Provision of Agricultural Information

In this section, the various structural properties of the various networks studied are discussed with emphasis on how they influence the flow of agricultural information. The structural properties are discussed individually across the various communities.

5.2.1 Network Density and the Flow of Agricultural Information

Density of a network is the ratio of the actual number of relationships that exist in a network and the total number of potential relationships in the network (Thaden and Rotolo, 2009). If all farmers had direct ties with all other farmers, then the density would be 1. The density of a network gives meaning to trends such as the rate at which information diffuses among the nodes. In the three networks studied, the density values averaged over the networks established that a higher density of ties was present among the core farmer group, than between the core and periphery, periphery and core, and periphery and periphery. This is understandable, considering the fact that most of the ties originated from the core group. In connection with the whole network values, it was observed that the whole density values decreased as network size increased. Thus the larger the network, the less dense the network.

Leonard (2008) states that the closer the density value is to zero, the flow of information in the network becomes slower. Noor, Mrvar, and Batagelj (2005), also explain that density is inversely related to the size of a network; the larger the social network, the lower the density because the number of possible ties increases rapidly with the number of actors, whereas the number of ties which each person can

maintain is limited. Thus larger networks are generally characterised by lower densities. Consequently, Yu and Bao (2011) confirm that smaller networks with higher densities possess stronger relationship ties, richer interactions, and exchange more resources and information. Thus smaller information networks are preferable when seeking to strengthen adoption of agricultural technologies as compared to larger networks where the strength of relationship between actors is reduced. However, networks with low densities do not necessarily indicate a disadvantage. A low network density could imply that the network's sources of information will be varied or unique (Burt, 1992). In these types of networks, ties are often "weak," meaning that they signify interactions concerning fairly low familiarity and irregular contact (Granovetter, 1973). Thus weak ties or low network density opens up networks to diverse information sources.

5.2.2 Degree Centralization and the Provision of Agricultural Information

Whole network degree centrality (in-degree and out-degree) measures refer to the number of direct links between farmers, indicated per individual by number of ties and in total as a percentage of a completely centralized network where one person would be at the center of a star like structure with all others in the network connected only to the centralactors. Thus, the higher the percentage, the higher the degree of network centralization (Marks, Barnett, Foulker, Hawe, and Allender, 2013) . With the exception of the Kunsu network that had a higher percentage (50.052%) than the other networks, the networks did not show any considerable differences with respect to the whole network centrality measures. The low degree centrality measures indicate that despite the presence of a significant quantity of centralization within the networks, the influence of the various actors differ and there is a considerable disparity in the amount of power wielded by influential actors in the networks. This is

explained by the fact that the key communicators who possess high amounts of ties are comparatively few as compared to the other actors.

Marks et al (2013) explained that low network degree centralization measures (less than 50%) as seen in the Afreseni and Dunyankwanta networks indicate that actors in the network share frequent and valuable information with one another through relationships with several central individual actors rather than through one centralized person or position, thus reducing the danger of information flow being dependent on just one central actor. Mandarano (2007) adds that such network degree centralization values can be used to point out gaps in resource exchange networks. Individuals that have higher access to the required information can be identified by means of their high ties sent out to other actors. This implies that these actors are vital and can be engaged in collaborative efforts to disseminate information (Mendel, Damberg, Sorbero, Varda, and Farley, 2009). Thus, on the basis of the whole network degree centralization measures, conclusions can be drawn as to how important the central actors are. As Rana (2010) explains, high degree network centralization measures indicate that central actors are critical to providing information to the network, whereas, low whole network degree centralization measures show that central actors are not very crucial to the provision of information.

5.2.3 Betweenness Centrality and the Provision of Agricultural Information

Betweenness centrality measures explain the extent to which an actor is positioned between other actors in a network. Therefore, actors with high betweenness centrality, are capable of directly or indirectly influencing the flow of information to others. A node with high betweenness centrality has the ability to control the transfer of

information within a network, by assisting, obstructing, or even manipulating the communication between others (Newman, 2003).

In the three networks, the network betweenness centralization were very low, with the Dunyankwanta network (10.45%) exhibiting the highest network betweenness centralization value. As Hopkins (2011) explains, low betweenness scores indicates that the actors are situated between few pairs of other actors. The low mean betweenness scores of all three networks, the large number of actors with a betweenness measure of zero, and the extremely low network betweenness centralization index across all three networks indicate that there are few information brokers within the network. Marks et al (2013), highlight an advantage of low network betweenness centralities by pointing out that such low scores indicate the absence of "information gatekeepers" who could obstruct or alter information from reaching other actors.

However, Hopkins (2011) explains that betweenness centrality measures can improve understanding of knowledge acquisition. Since the sociometric method is focused on learning by direct questioning, knowledge acquired through circumstantial learning and unsolicited information cannot be accounted for. That could explain the reason for the low betweenness centralization measures.

5.3 Homophily and Information Transfer

The study examined homophily of the various networks using several characteristics of actors in the various networks. The characteristics examined were age, sex, level of education, and membership of local groups. In this section, these characteristics are discussed with the aim of examining the level of influence they may have on the transfer of information in the various networks.

5.3.1 Age

In all three networks that were examined, it was realized that there was a prevalence of external ties over internal ties when actors were grouped on the basis of age. All three networks demonstrated a negative association between age and homophily. This phenomenon can be explained in the light of the age of the key communicators in the networks. The key communicators in the networks averaged 50.17 years. Since most of the ties originate with the key communicators, it is logical that the provision of information is not restricted within groups. This means that individuals in various age categories sought information beyond farmers who were in the same age bracket as they were. Considering the average age of the key communicators with whom most of the information ties originate, it explains that key communicators shared information not just within their age category, but also with younger farmers.

These findings agree with Louch (2000) who realized that the probability that two actors who are not kinsmen will be connected decreases with age difference. Marsden (1988) also found an interesting pattern of age homophily for various age groupings. With respect to formation of ties, he observed that there existed a greater distance between the middle age categories and other age categories than there was between other age categories. Middle age groups usually exhibit noteworthy levels of out ties. Older people often connect with younger confidants, an indication of the significance of older, experienced individuals. Smitha, McPherson, and Smith-Lovin (2014), also found a significant relationship between age and homophily. Interestingly, they discovered that in contrast, the young had few ties with older individuals. However, they explain that changes in economic inequalities, cultural boundaries, and other factors could be responsible for this trend.

5.3.2 Gender

The three networks were homophilous with regard to gender. A positive correlation and association between gender and homophily was observed. This means that male farmers had the tendency to share agricultural information among themselves while the same was true in the case of females. Consequently, that accounted for the prevalence of internal ties over external ties within both gender categories.

Several research works discovered comparatively higher gender homophily in communication ties than in other characteristics such as age, religion, and level of education (Ibarra, 1992; McPherson, et al., 2001). Ibarra (1997) found that men and women search for and utilize informal networks in unusual ways, and suggests a reason: Whereas men formed ties and relations with other men in their networks, women appeared to form twofold networks: One network with other women to gratify the need for friendships and support, and another network with males to fulfill the need for information and organizational knowledge. In contrast, Brashears' (2008) study revealed that males and females vary in terms of choice of formation of ties across the sexes, thus pointing to a lack of homophily in connection with gender. In spite of the unbalanced distribution of gender across the various occupations, the support networks of actors were found to consist of ties between actors mainly of the same gender. Gender homophily is thus asignificant factor in the formation of network ties.

5.3.3 Level of Education

The three networks were heterophilous on the basis of the level of education. The various actors fell into three different groups: those with no formal education, farmers who had been educated to basic level and farmers who had been educated to the

secondary school level. The distribution of ties showed a higher proportion of external ties (ties sent outside groups) than internal ties (ties within groups). This is reflected in the educational levels of the key communicators responsible for a majority of out-degree ties. These individuals were evenly distributed across all three groups, leading to majority of information ties being formed with other actors in different educational level categories. This is understandable considering that unlike the previous dimensions of homophily which are ascribed or inherited, the level of an individual's education is acquired.

These findings are in agreement with the findings of Louch (2010) who discovered that education was unlikely to create links between confidants than most other characteristics (religion, race, etc.). Mittal and Mehar (2013) also found level of education to be significantly related to homophily with regards to the formation of network ties among farmers. However they found that the level of homophily reduced considerably with farmers who had higher levels of education. Demiryurek et al (2008) explain further that farmers who acquire a considerable level of knowledge do not consult their colleague farmers for information, rather they seek out more detailed information from external sources, thus the reason for decreased homophily in network members with higher levels of education.

5.3.4 Local Group Membership

Membership of local groups accounted for a large number of network ties observed in all three communities. Two of the communities (Dunyankwanta and Kunsu) demonstrated homophily with respect to the membership of groups. Unlike the other two information networks, the Afreseni network demonstrated heterophily on the basis of group membership. The differences in group homophily of the networks

could be as a result of the inequalities in the networks studied. The structural features of a social network considerably influence the information seeking behavior of its constituent actors. Thus, while members of local groups in Dunyankwanta and Kunsu sought information from members of their local groups, members of groups in Afreseni were hesitant to seek advice within the local group and rather sought information from others. This is understandable, since a majority of the key communicators in Afreseni were not members of local groups as compared to the other networks (Dunyankwanta and Kunsu) where key communicators belonged to various local farmer groups.

Darr and Pretzsch (2008) explain that farmer groups are one of the most successful conduits of information dissemination since they efficiently facilitate the spread of innovation within the group. However, this is dependent on the membership of the group as well as the strength and cohesion within the group.

Membership of local groups was responsible for a large number of network ties observed. In all three communities, key communicators and other network actors were members of the same community-based local groups. The local groups observed in the communities were those formed by the farmers in the community for the welfare of the local farmers and groups formed by external organizations (produce buying companies, NGOs, etc). Some farmers belonged to more than one group, thus allowing them further opportunities to pass on or obtain information since they had high prospects of additional network ties. Those groups established by the local farmers for their welfare and improved production ensured regular communication among group members. There were regular meetings where issues related to agricultural and social problems were handled. Farmers interviewed indicated that at

one point or the other, they had received helpful agricultural information at a group meeting. The groups established by external organizations also improved network ties among farmers in the communities since there were opportunities for discussions among group members. Another observation that was made was the presence of several undefined, informal labour groups, also known as the "nnoboa". These groups exist mainly with the aim of providing unpaid labour services to member farmers. There are no fixed members; instead, the group is composed of farmers who are available and willing to help on a colleague's farm as and when such help is needed. During those sessions, farmers take the opportunity to seek agricultural information from their colleagues, thus strengthening their personal network ties.

These findings agree with Soyka and Streiffeler (2003) who discovered that farmers ask for advice and concentrate their information seeking activities within small groups in their neighborhoods, consulting farmers with similar interests. Madukwe (2006) agrees when he says that farmer groups allow the passing on of agricultural technology to farmers. Since farmer groups are constituted by farmers working together with each other towards accomplishing a joint goal, generally, there exists an interaction between constituents of the group. Consequently, farmer groups are invaluable to information transfer. A key advantage of local farmer groups is that the farmers help one another to gain knowledge and skills. Network ties are thus strengthened among members of local farmer groups.

5.3.5 Heterogeneity of Key Communicators

The actors identified as key communicators in the various were found to be heterogeneous as a group. They differed in terms of age, gender, level of education, membership of local group, religion, etc. The actors identified as key communicators

exhibited varying characteristics.The implication of this finding is that in making use of key communicators to aid extension delivery, characteristics of key communicators should be considered and examined before selecting any as contact farmers. Perry-Smith (2006) posits that among key communicators in a network, there are differences in levels of knowledge concerning required information, differences in perspectives, and strength of ties with external sources.

5.4 Summary

In summary, the networks had a number of key communicators who serve as primary sources of information related to cocoa and rice production. Transfer of information in these networks were influenced by experience acquired over the years by key communicators, leadership positions/status in the community and farmer training programs. Ties among actors in the network were fairly distributed on the basis of age, gender, level of education, and membership of local groups. The networks displayed a considerable amount of homophily in terms of gender and membership of local groups.

By means of network density a core-periphery structure was identified, indicating that a small group of specific farmers were responsible for most of the network ties observed. These farmers were chosen due to their possession of various characteristics that appealed to other network actors. This was reflected in the network structure which revealed a separate group of farmers that received a high quantity of inquiries from network members. The centrality measures showed no significant differences across the three networks. Even though the measures indicated a level of centralization within the networks, the central actors were unequally distributed in the various networks with just a few being positioned in between other actors. Those

identified as key communicators were heterogeneous even though this did not have any significant effect on the flow of information in the network.

CHAPTER SIX

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.0 Introduction

In this chapter the conclusions and recommendations arrived at the end of the study are stated.

6.1 Summary

The objectives of the study were: to find out the existing local information networks for the transmission of agricultural information, their characteristics, and the major providers of information in the various networks; to determine the strength of network ties among members of the information networks and how these affect availability of agricultural information; and to examine the differences between actors in the various information networks and its influence on the availability of information.

From the study, three local information networks were identified. One in each of the three communities (Afreseni, Dunyankwanta, and Kunsu).The network sizes were thirty-two (Kunsu), fifty-eight (Afreseni) and seventy-two (Dunyankwanta). The networks had a total of twenty-three key communicators made up of six from Kunsu, eight from Afreseni, and nine from Dunyankwanta. These farmers provided information on fertilizer application, weed control, pest control, choice of planting materials, and harvesting of cocoa and rice. Farmers in the network consulted the key communicators in order to fulfill their need for information. However, they consulted people they perceived to be successful in the community, farmers who were experienced and had access to training and information from credible external sources.

All three information networks were heterogeneous on the basis of age, gender, religion, level of education, membership of local farmer groups, and contact with agricultural extension officers. The key communicators in the networks displayed a level of homogeneity in terms of crops grown, contact with extension officers and status/leadership positions occupied in the community. However, the key communicators were heterogeneous in terms of age, religion, gender, level of education, membership of local groups and family size.

The mode of information transfer was primarily through oral communication and mainly occurred in informal settings. The twenty-three key communicators turned out to be major providers of information in the network. These had received training from various organizations in the past. Others had acquired a wealth of experience over the years and were deemed knowledgeable enough to provide helpful information to fill the needs of the other actors.

Degree centrality measures indicated that actors who had many ties to other actors occupied privileged points in the network. The low network degree centralities however showed that actors in the network share frequent and valuable information with one another through relationships with several central individual actors rather than through one centralized person or position.

Betweenness centrality measures also indicated the strength of ties present in the network on the basis of how centrally placed actors in the network were. The three communities displayed a level of significant tie strength, albeit fairly weak. However, it also showed that aside the key communicators present in the network, there were other central actors in the network who facilitated the dissemination of information throughout the network. In view of the low betweeness centrality measures across the

three networks, it can be said that there a few intermediaries who have the ability to hinder or improve the flow of information in a network.

The networks generally displayed a significant lack of homophily. The networks were heterophilous on the basis of age, level of education, and membership of local groups. The only characteristic where there seemed to be a level of homophily was regarding gender. The networks were sufficiently heterophilous with respect to age and level of education attained. This was largely as a result of the key communicators falling across different age groups and educational level categories. Consequently, the interactions in the network were dominated by external ties rather than internal ties or ties within age/educational level categories. There were also significant differences with regards to membership of local farmer groups. The networks were not sufficiently homophilous enough and generally displayed heterophily.

6.2 Conclusion

The study found a local information network for transmitting agricultural information in each of the three communities studied. The mode of information was primarily oral. The major providers of information were homogenous in terms of ages, gender, contact with extension and status in community.

Significant but weak network ties were found among members of the networks suggesting that other actors also facilitated the flow of information through the network. It can be concluded that the informal information networks in the three communities had access to a variety of agricultural information. Actors in the networks were generally heterophilous indicating that individuals were exposed to a variety of information sources.

6.3 Recommendations

In the light of the observations made and ensuing conclusions arrived at certain recommendations have been made. These are discussed in terms of recommendations for agricultural extension practice and further research.

6.3.1 Recommendations for Agricultural Extension Practice

- In introducing, transferring, and implementing specialized formal information or technologies, extension agents should seek out not just successful or "rich" farmers. Rather, farmers who are highly sought after or consulted by their peers should also be contacted.
- It is recommended that extension agents and other extension service providers should target key communicators of informal information networks as they can serve as essential sources of information in disseminating information to farmers in a community.
- In view of the potential of local farmer groups, extension service providers should take special interest in local farmer groups. This could strengthen and promote any possible informal information networks that could be harnessed to improve agricultural delivery.
- Considering the characteristics of informal agricultural information networks such as ease of access, affordability, regularity of use by farmers, providing means for sending and receiving feedback, etc. it can be said that such agricultural information networks have very high prospects in terms of disseminating or introducing new information and technologies. Extension agents would need to determine structural properties of existing networks to identify key actors for the exchange and provision of agricultural information.

- The presence of intermediaries or information brokers as indicated by the betweeness centrality measures indicate the importance of these mediators. It is recommended that in disseminating information, extension service providers should identify not just actors who have numerous ties with many others (central actors), but should also make use of farmers who can serve as intermediaries by virtue of their links between actors.

6.3.2 Recommendations for Future Research

- The study made generalizations for agricultural knowledge-concentrated interactions. These generalizations may not be applicable when considering interactions that are not knowledge related, e.g. transfer of agricultural resources, etc. Future research can be geared towards examining interactions involving the exchange of physical/material ties.
- The study used a representative model of a district in one region of the country. The surveyed farmers engaged in rice and cocoa farming. Further studies could be designed towards gaining insight into the networks that exist in districts with more crop diversity.
- In analyzing the differences in characteristics, emphasis was placed on homophily. It is recommended that further studies be conducted into the patterns of heterophily, investigating why individuals in the same community would avoid other community members or develop few ties with them.
- The focus of this study was on network measures that were studied at a particular point in time. Subsequent research may possibly investigate how network measures and their influence on information availability vary over time.

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APPENDIX A -QUESTIONNAIRE FOR FARMERS

CHARACTERISTICS OF RESPONDENTS

1. Name: ……..
2. Sex : [ ] Male [ ] Female
3. Age: ……..
4. Marital Status: [ ] Married [ ] Single [ ] Divorced [ ] Separated [ ] Widowed
5. Religion: [ ] Christian [ ] Islam [ ] Traditional [ ] Other (please indicate)……..
6. Level of education: [ ] No formal education [ ] Basic education [ ] Secondary level [ ] Tertiary
7. What is the size of your household? ……..
8. Are you the household head? [ ] Yes [ ] No
9. If no, what is your relationship with the household head? ……
10. What is your major occupation? …….
11. What are the major crops you grow?
    [ ] Cocoa [ ] Maize [ ] Tomato [ ] Cassava [ ] Yam [ ] Beans
12. How is the farm owned? [ ] Sole proprietorship [ ] Partnership [ ] Family owned
13. Which type of land tenure system do you use? [ ] Rent [ ] Outright purchase [ ] Shared rights [ ] Other (please specify) ……..
14. Do you face any problems in producing these crops? [ ] Yes [ ] No

PROBLEM	SOLUTION

15. Who in your household is involved in making decisions concerning your farming activities?

RELATIONSHIP

SOURCES OF AGRICULTURAL INFORMATION

16. From which individuals do you get information about activities, skills and practices related to farming?

NAME OF SOURCE	ACTIVITY/SKILL/ PRACTICE	RELATIONSHIP	FREQUENCY

Key: For frequency choose from the following: a) Daily b) Weekly c) Fortnightly d) Monthly e) Yearly

17. What are your mode(s) of contacting these source(s) of information and what problems do you face in receiving information from them?

INFORMATION SOURCE	MODE OF CONTACT	PROBLEM FACED

18. Do you reside in the same community with your source(s) of information?
    [ ] Yes [ ] No
19. How useful is the information that you receive from these sources?
    [ ] Not at all useful [ ] Not useful [ ] Average [ ] Useful [ ] Very useful
20. How strong is your trust in the information you receive from your source(s)?
    [ ] Very weak [ ] Weak [ ] Moderate [ ] Strong [ ] Very strong

SOURCE	STRENGTH OF TRUST

21. Do you use the information your source(s) of information provide? [ ] Yes [ ] No
22. If yes, why do you do so?

    ……
    ……
    ……

    If no, why not?

    ……
    ……
    ……

23. If yes, is the information provided clear enough for you to implement? [ ] Yes [ ] No
    If no, what alternative sources of information do you patronize?
    ……
    ……
    ……
24. What is the relationship between you and those who consult you for agricultural information, if any? Please indicate type of information provided

NAME	RELATIONSHIP	TYPE OF INFORMATION

25. Do you know others in this community who serve as sources of agricultural information to other people? [ ] Yes [ ] No

NAME	TYPE OF INFORMATION

MODE OF INFORMATION FLOW

26. Are you able to seek clarification or any answers to additional questions you might have? [ ] Yes [ ] No
27. How do you seek such clarification/answers/send feedback from/to your informants?
    ……
    ……
28. How do you provide others with the information they ask from you?
    ……
    ……
    ……
29. Do you receive any information from the Agricultural Extension Agent (AEA)? [ ] Yes [ ] No
30. What kind of information do you receive from the AEA?
    ……
    ……
    ……..

……
…..

31. Do you receive any agricultural information from the mass media (radio, TV, internet, etc)? [ ] Yes [ ] No

If yes, indicate

TYPE OF MEDIA	INFORMATION RECEIVED

LOCAL GROUP MEMBERSHIP

32. Do you belong to any group in the community? [ ] Yes [ ] No
33. If yes, please name the group(s) you belong to and position(s) held if any

GROUP	POSITION HELD	ACTIVITIES ENGAGED IN

34. Do people from outside the community join your group(s) [ ] Yes [ ] No

35. Are there similar groups in other communities? [ ] Yes [ ] No
If yes, please indicate the communities…….....

36. If yes, do you communicate with members of those group(s)? [ ] Yes [ ] No
37. Do you discuss agriculture related topics with members of your group(s)? [ ] Yes [ ] No

GROUP MEMBER	AGRICULTURAL INFORMATION

38. Have you received any new agriculture related skills, knowledge, or practices from members of your group? [ ] Yes [ ] No

    If yes, please indicate

    ……
    ……
    ……

39. Have you provided members of your group with any new agriculture related skills, knowledge, or practices? [ ] Yes [ ] No

    If yes, please specify

    ……
    ……
    ……

APPENDIX B-QUESTIONNAIRE FOR PRIMARY SOURCES OF INFORMATION

1. Name: ……..
2. Sex : [ ] Male [ ] Female
3. Age: ……..
4. Marital Status: [ ] Married [ ] Single [ ] Divorced [ ] Separated [ ] Widowed
5. Religion: [ ] Christian [ ] Islam [ ] Traditional [ ] Other (please indicate)……..
6. Level of education: [ ] No formal education [ ] Basic education [ ] Secondary level [ ] Tertiary
7. What is the size of your household? ……..
8. Are you the household head? [ ] Yes [ ] No
9. If no, what is your relationship with the household head? ……
10. What specific agricultural skills, practices or knowledge do people consult you for agricultural information?
    .....
    .....
    ...
11. For how long have you been using these skills, practices, or knowledge?
    …….....
    .....
    .....
    .....
12. From whom did you receive these skills, knowledge, and practices firsthand?
    ……
    ……
    ……
    ……
13. Have you undergone any kind of training to acquire any of the skills, practices, or knowledge in (1) above? [ ] Yes [ ] No
    If yes, please indicate

TRAINER/TRAINING ORGANIZATION(S)	SKILLS, KNOWLEDGE, PRACTICES ACQUIRED

14. On what basis were you chosen for the training?

……
……I
f no, how did you acquire the agricultural skills, knowledge, and practices that you share with others?
……
……
……

15. Do you receive any information from the Agricultural Extension Agent (AEA)? [ ] Yes [ ] No
16. What kind of information do you receive from the AEA?
……
……
……..
……
…..
17. Excluding the AEA and the mass media, is there any other individual(s) who pass(es) on agricultural information to other farmers in the community?
[ ] Yes [ ] No
If yes, please indicate
……
……
……..
18. If yes, do you consult this/these individuals for agricultural information?
[ ] Yes [ ] No
19. If yes, what agricultural skills, knowledge, or/and practices do you consult them for?
……
……
……

LOCAL GROUP MEMBERSHIP

20. Do you belong to any group in the community? [ ] Yes [ ] No
21. If yes, please name the group(s) you belong to, any position held if any, and

GROUP	ACTIVITIES ENGAGED IN	POSITION HELD	RESPONSIBILITIES

22. Do people from outside the community join your group(s) [ ] Yes [ ] No
    If yes, please name them
    ……
    ……
    ……...
23. Are there similar groups in other communities? [ ] Yes [ ] No
    If yes, please indicate the communities…….....
24. If yes, do you communicate with members of those group(s)? [ ] Yes [ ] No
25. Do you pass on agricultural information to members of your group(s)?
    [ ] Yes [ ] No
26. If yes, what are some of the agricultural topics you pass on to them?

GROUP MEMBER	AGRICULTURAL INFORMATION

STATUS IN THE COMMUNITY

27. What crops do you grow?
    ……
    ……
    ……
28. What is the acreage per crop grown?

CROP	ACREAGE

29. On the average, what is your average output per crop each season?

CROP	YIELD

30. What positions do you occupy in the community?

……
……
……
……
……
……

31. Have you received any award(s) or recognition for your farming activities in this community? [ ] Yes [ ] No